PostGIS 3.5.1 □□□□□□

Contents

Abstract

PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ GIS(⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠ GiST ⊠⊠ R-Tree ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, GIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠ 3.5.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Chapter 1

⊠⊠

PostGIS is a spatial extension for the PostgreSQL relational database that was created by Refractions Research Inc, as a spatial database technology research project. Refractions is a GIS and database consulting company in Victoria, British Columbia, Canada, specializing in data integration and custom software development.

PostGIS is now a project of the OSGeo Foundation and is developed and funded by many FOSS4G developers and organizations all over the world that gain great benefit from its functionality and versatility.

The PostGIS project development group plans on supporting and enhancing PostGIS to better support a range of important GIS functionality in the areas of OGC and SQL/MM spatial standards, advanced topological constructs (coverages, surfaces, networks), data source for desktop user interface tools for viewing and editing GIS data, and web-based access tools.

1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Project Steering Committee; PSC) ⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PSC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠, PSC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ API ⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Raúl Marín Rodríguez MVT support, Bug fixing, Performance and stability improvements, GitHub curation, alignment of PostGIS with PostgreSQL releases

⊠⊠⊠⊠⊠ (Regina Obe) CI and website maintenance, Windows production and experimental builds, documentation, alignment of PostGIS with PostgreSQL releases, X3D support, TIGER geocoder support, management functions.

Darafei Praliaskouski Index improvements, bug fixing and geometry/geography function improvements, SFCGAL, raster, GitHub curation, and ci maintenance.

⊠⊠⊠ (Paul Ramsey) (⊠⊠) Co-founder of PostGIS project. General bug fixing, geography support, geography and geometry index support (2D, 3D, nD index and anything spatial index), underlying geometry internal structures, GEOS functionality integration and alignment with GEOS releases, alignment of PostGIS with PostgreSQL releases, loader/dumper, and Shapefile GUI loader.

⊠⊠⊠⊠⊠⊠ (Sandro Santilli) Bug fixes and maintenance, ci maintenance, git mirror management, management functions, integration of new GEOS functionality and alignment with GEOS releases, topology support, and raster framework and low level API functions.

1.2 ⊠⊠⊠⊠⊠ - ⊠⊠

⊠⊠⊠⊠⊠⊠ (Nicklas Avén) ⊠⊠⊠⊠⊠⊠ (3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠, TWKB(Tiny WKB) ⊠⊠⊠⊠ (⊠⊠⊠), ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

Loïc Bartoletti SFCGAL enhancements and maintenance and ci support

⊠⊠⊠⊠ (Dan Baston) Geometry clustering function additions, other geometry algorithm enhancements, GEOS enhancements and general user support

Martin Davis GEOS enhancements and documentation

Björn Harrtell MapBox Vector Tile, GeoBuf, and Flatgeobuf functions. Gitea testing and GitLab experimentation.

Aliaksandr Kalenik Geometry Processing, PostgreSQL gist, general bug fixing

1.3 ⊠⊠⊠⊠⊠ - ⊠⊠

⊠⊠⊠ (Bborie Park) Prior PSC Member. Raster development, integration with GDAL, raster loader, user support, general bug fixing, testing on various OS (Slackware, Mac, Windows, and more)

⊠⊠⊠⊠⊠-⊠⊠⊠⊠ (Mark Cave-Ayland) Prior PSC Member. Coordinated bug fixing and maintenance effort, spatial index selectivity and binding, loader/dumper, and Shapefile GUI Loader, integration of new and new function enhancements.

⊠⊠⊠⊠⊠⊠⊠⊠ (Jorge Arévalo) ⊠⊠⊠⊠⊠, GDAL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠ (Olivier Courtin) XML(KML, GML)/GeoJSON ⊠⊠⊠⊠⊠, 3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠ (Chris Hodgson) ⊠ PSC ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, OSGeo ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Mateusz Loskot) PostGIS ⊠ CMake ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ API ⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠ (Kevin Neufeld) ⊠ PSC ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠, PostGIS ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠, PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠ (Dave Blasby) PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠ (Jeff Lounsbury) shapefile ⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠ (Mark Leslie) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, shapefile GUI ⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠ (Pierre Racine) Architect of PostGIS raster implementation. Raster overall architecture, prototyping, programming support

⊠⊠⊠⊠⊠⊠⊠⊠ (David Zwarg) ⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠

1.4 ⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠

Alex Bodnaru
Alex Mayrhofer
Andrea Peri
Andreas Forø Tollefsen
Andreas Neumann
Andrew Gierth
Anne Ghisla
Antoine Bajolet
Arthur Lesuisse
Artur Zakirov
Barbara Phillipot
Ben Jubb
Bernhard Reiter
Björn Esser
Brian Hamlin
Bruce Rindahl
Bruno Wolff III
Bryce L. Nordgren
Carl Anderson
Charlie Savage
Chris Mayo
Christian Schroeder
Christoph Berg
Christoph Moench-Tegeder
Dane Springmeyer
Dapeng Wang
Daryl Herzmann
Dave Fuhry
⊠⊠⊠⊠⊠⊠⊠⊠ (David Zwarg)
⊠⊠⊠⊠⊠⊠⊠⊠ (David Zwarg)
⊠⊠⊠⊠⊠⊠⊠⊠ (David Zwarg)
Dian M Fay
Dmitry Vasilyev
Eduin Carrillo
Esteban Zimanyi
Eugene Antimirov
Even Rouault
Florian Weimer
Frank Warmerdam
George Silva
Gerald Fenoy
Gino Lucrezi
Greg Troxel
Guillaume Lelarge
Giuseppe Broccolo
Han Wang
Hans Lemuet
Haribabu Kommi
Havard Tveite
IIDA Tetsushi
Ingvild Nystuen
Jackie Leng
James Addison
James Marca
Jan Katins
Jan Tojnar
Jason Smith
Jeff Adams
Jelte Fennema
Jim Jones
Joe Conway
Jonne Savolainen
Jose Carlos Martinez Llari
Jörg Habenicht
Julien Rouhaud
Kashif Rasul
Klaus Foerster
Kris Jurka
Laurenz Albe
Lars Roessiger
Leo Hsu
Loic Dachary
Luca S. Percich
Lucas C. Villa Real
Maria Arias de Reyna
Marc Ducobu
Mark Sondheim
Markus Schaber
Markus Wanner
Matt Amos
Matt Bretl
Matthias Bay
Maxime Guillaud
Maxime van Noppen
Maxime Schoemans
Michael Fuhr
Mike Toews
Nathan Wagner
Nathaniel Clay
Nikita Shulga
Norman Vine
Patricia Tozer
Rafal Magda
Ralph Mason
Rémi Cura
Richard Greenwood
Robert Coup
Roger Crew
Ron Mayer
Sam Peters
Sebastiaan Couwenberg
Sergei Shoulbakov
Sergey Fedoseev
Shinichi Sugiyama
Shoaib Burq
Silvio Grosso
Stefan Corneliu Petrea
Steffen Macke
Stepan Kuzmin
Stephen Frost
Steven Ottens
Talha Rizwan
Teramoto Ikuhiro
Tom Glancy
Tom van Tilburg
Victor Collod
Vincent Bre
Vincent Mora
Vincent Picavet
Volf Tomáš
Zuo Chenwei

⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- Aiven
- Arrival 3D
- Associazione Italiana per l'Informazione Geografica Libera (GFOSS.it)
- AusVet
- Avencia
- Azavea
- Boundless
- Cadcorp

- Camptocamp
- Carto
- Crunchy Data
- City of Boston (DND)
- City of Helsinki
- Clever Elephant Solutions
- Cooperativa Alveo
- Deimos Space
- Faunalia
- Geographic Data BC
- HighGo
- Hunter Systems Group
- >The National Institute for Agricultural and Food Research and Technology (INIA-CSIC)
- ISciences, LLC
- Kontur
- Lidwala Consulting Engineers
- LISAsoft
- Logical Tracking & Tracing International AG
- Maponics
- Michigan Tech Research Institute
- Natural Resources Canada
- Norwegian Forest and Landscape Institute
- Norwegian Institute of Bioeconomy Research (NIBIO)
- OSGeo
- Oslandia
- Palantir Technologies
- Paragon Corporation
- R3 GIS
- Refractions Research
- Regione Toscana - SITA
- Safe Software
- Sirius Corporation plc
- Stadt Uster
- UC Davis Center for Vectorborne Diseases
- Université Laval
- U.S. Department of State (HIU)
- Zonar Systems

[illegible] [illegible], [illegible]. [illegible]. [illegible], [illegible]. [illegible], PostGIS [illegible] [illegible].

PostGIS 2.0.0 [illegible]. [illegible] PledgBank [illegible].

postgistopology - 10 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2.0.0 ⊠⊠⊠⊠ toTopGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ 250 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

postgis64windows - ⊠⊠⊠ 20 ⊠⊠⊠⊠⊠⊠⊠ 64 ⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 100 ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠. ⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠ PostGIS 2.0.1 64 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠ The GEOS geometry operations library

The GDAL Geospatial Data Abstraction Library used to power much of the raster functionality introduced in PostGIS 2. In kind, improvements needed in GDAL to support PostGIS are contributed back to the GDAL project.

The PROJ cartographic projection library

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, PostGIS ⊠⊠⊠⊠⊠ PostgreSQL DBMS - PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠, GiST ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.

Chapter 2

PostGIS ☒☒

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2.1 ☒☒☒☒

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```
tar -xvzf postgis-3.5.1.tar.gz
cd postgis-3.5.1
./configure
make
make install
```

PostGIS ☒☒☒☒☒, PostGIS ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (Section 3.3) ☒☒☒ ☒☒ (Section 3.4) ☒☒☒☒☒.

2.2 ☒☒☒☒☒☒☒☒☒☒☒☒

> **Note**
> ☒☒☒☒ OS ☒☒☒☒☒ PostgreSQL/PostGIS ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒, ☒☒ ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
> This section includes general compilation instructions, if you are compiling for Windows etc or another OS, you may find additional more detailed help at PostGIS User contributed compile guides and PostGIS Dev Wiki.
> Pre-Built Packages for various OS are listed in PostGIS Pre-built Packages
> ☒☒☒☒☒☒☒☒☒☒☒ Stackbuilder ☒☒ PostGIS Windows download site ☒☒☒☒☒☒☒☒☒☒☒☒ ☒☒☒☒☒. ☒ 1~2 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ very bleeding-edge windows experimental builds ☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒ PostGIS ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

The PostGIS module is an extension to the PostgreSQL backend server. As such, PostGIS 3.5.1 *requires* full PostgreSQL server headers access in order to compile. It can be built against PostgreSQL versions 12 - 17. Earlier versions of PostgreSQL are *not* supported.

Refer to the PostgreSQL installation guides if you haven't already installed PostgreSQL. https://www.postgre
.

> **Note**
> GEOS ☒☒☒☒☒☒ PostgreSQL ☒☒☒☒☒ C++ ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
>
> ```
> LDFLAGS=-lstdc++ ./configure [YOUR OPTIONS HERE]
> ```
>
> ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ C++ ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒ (☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒) ☒☒☒☒☒ PostgreSQL ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ ☒.

☒☒☒ PostGIS ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ ☒☒☒☒☒☒☒☒☒☒.

2.2.1 ☒☒☒☒

PostGIS ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ https://download.osgeo.org/postgis/source/postgis-3.5.1.tar.gz ☒☒☒☒☒☒☒☒☒☒.

```
wget https://download.osgeo.org/postgis/source/postgis-3.5.1.tar.gz
tar -xvzf postgis-3.5.1.tar.gz
cd postgis-3.5.1
```

☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ postgis-3.5.1 (☒) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒☒☒☒, svn ☒☒☒ http://svn.osgeo.org/postgis/trunk/ ☒☒☒☒☒☒☒☒☒ (checkout) ☒☒☒☒☒ ☒.

```
git clone https://git.osgeo.org/gitea/postgis/postgis.git postgis
cd postgis
sh autogen.sh
```

☒☒☒☒☒☒☒☒☒☒☒☒ postgis-3.5.1 ☒☒☒☒☒☒☒☒☒☒.

```
./configure
```

2.2.2 ☒☒☒☒☒☒

PostGIS ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

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- PostgreSQL 12 - 17. A complete installation of PostgreSQL (including server headers) is required. PostgreSQL is available from https://www.postgresql.org .

  For a full PostgreSQL / PostGIS support matrix and PostGIS/GEOS support matrix refer to https://trac.osgeo.org/postgis/wiki/UsersWikiPostgreSQLPostGIS
- GNU C ☒☒☒☒ (gcc). PostGIS ☒☒☒☒☒☒☒☒☒☒☒☒☒ ANSI C ☒☒☒☒☒☒☒☒☒☒☒☒☒ gcc ☒ ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- GNU Make(gmake ☒☒ make). ☒☒☒☒☒☒☒☒☒ GNU make ☒ make ☒☒☒☒☒☒☒☒☒. make -v ☒☒☒ ☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒ make ☒ PostGIS Makefile ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- Proj reprojection library. Proj 6.1 or above is required. The Proj library is used to provide coordinate reprojection support within PostGIS. Proj is available for download from https://proj.org/ .
- GEOS geometry library, version 3.8.0 or greater, but GEOS 3.12+ is required to take full advantage of all the new functions and features. GEOS is available for download from https://libgeos.org .

- LibXML2, version 2.5.x or higher. LibXML2 is currently used in some imports functions (ST_GeomFromGM and ST_GeomFromKML). LibXML2 is available for download from https://gitlab.gnome.org/GNOME/-libxml2/-/releases.
- JSON-C 0.9 □□□□□□. JSON-C □□□ ST_GeomFromGeoJson □□□□□ GeoJSON □□□□□□□□□□□□□□□. JSON-C □ https://github.com/json-c/json-c/releases/ □□□□□□□□□□□□.
- GDAL, version 3+ is preferred. This is required for raster support. https://gdal.org/download.html.
- □□□□□□□□□□□□□□□□□. □□□□□ PostgreSQL □□□□□□□□□□□□□□□□□. □□□□□□□□□□□ http://trac.osgeo.org/postgis/ticket/635 □□□□□□□.

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- □ Section 2.1 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.
- shapefile □□ shp2pgsql-gui □□□□□□□□ GTK(GTK+2.0, 2.8+ □□). http://www.gtk.org/.
- SFCGAL, 1.4.1 or higher is required and 1.5.0+ is needed to be able to use all functionality. SFCGAL can be used to provide additional 2D and 3D advanced analysis functions to PostGIS cf Chapter 8. And also allow to use SFCGAL rather than GEOS for some 2D functions provided by both backends (like ST_Intersection or ST_Area, for instance). A PostgreSQL configuration variable `postgis.backend` allow end user to control which backend he want to use if SFCGAL is installed (GEOS by default). Nota: SFCGAL 1.2 require at least CGAL 4.3 and Boost 1.54 (cf: https://sfcgal.org) https://gitlab.com/sfcgal/SFCGAL/.
- In order to build the Section 12.1 you will also need PCRE http://www.pcre.org (which generally is already installed on nix systems). Section 12.1 will automatically be built if it detects a PCRE library, or you pass in a valid `--with-pcre-dir=/path/to/pcre` during configure.
- To enable ST_AsMVT protobuf-c library 1.1.0 or higher (for usage) and the protoc-c compiler (for building) are required. Also, pkg-config is required to verify the correct minimum version of protobuf-c. See protobuf-c. By default, Postgis will use Wagyu to validate MVT polygons faster which requires a c++11 compiler. It will use CXXFLAGS and the same compiler as the PostgreSQL installation. To disable this and use GEOS instead use the `--without-wagyu` during the configure step.
- CUnit(`CUnit`). □□□□□□□□□□□□□. http://cunit.sourceforge.net/
- DocBook(`xsltproc`) □□□□□□□□□□□□□. DocBook □ http://www.docbook.org/ □□□□□□□□□□□□□.
- DBLatex(`dblatex`) □ PDF □□□□□□□□□□□□□□□. DBLatex □ http://dblatex.sourceforge.net/-□□□□□□□□□□□□.
- ImageMagick(`convert`) □□□□□□□□□□□□□□□□□□□□□□□. ImageMagick □ http://www.imagem □□□□□□□□□□□□.

2.2.3 □□

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ Makefile □□□□□□□□□. □□□□□□□□□□□ Makefile □□□□□□.

./configure

□□□□□□□□□□□□, □□□□□□□□□ PostGIS □□□. **./configure** □□□□□□□□□□□□□□□□, □□.

□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□ **--help** □□ **--help=short** □□□□□□□□□□□.

--with-library-minor-version Starting with PostGIS 3.0, the library files generated by default will no longer have the minor version as part of the file name. This means all PostGIS 3 libs will end in `postgis-3`. This was done to make pg_upgrade easier, with downside that you can only install one version PostGIS 3 series in your server. To get the old behavior of file including the minor version: e.g. `postgis-3.0` add this switch to your configure statement.

--prefix=PREFIX PostGIS ⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Caution
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ http://trac.osgeo.org/postgis/ticket/635 ⊠⊠⊠⊠⊠⊠⊠⊠.

--with-pgconfig=FILE PostgreSQL ⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ **pg_config** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (**--with-pgconfig=/path/to/pg_config**) ⊠⊠⊠⊠⊠⊠⊠⊠.

--with-gdalconfig=FILE GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ **gdal-config** ⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (**--with-gdalconfig=/path/to/gdal-config**) ⊠⊠⊠⊠⊠⊠⊠⊠.

--with-geosconfig=FILE GEOS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, GEOS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ **geos-config** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GEOS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (**--with-geosconfig=/path/to/geos-config**) ⊠⊠⊠⊠⊠⊠⊠.

--with-xml2config=FILE LibXML is the library required for doing GeomFromKML/GML processes. It normally is found if you have libxml installed, but if not or you want a specific version used, you'll need to point PostGIS at a specific `xml2-config` confi file to enable software installations to locate the LibXML installation directory. Use this parameter (**>--with-xml2config=/path/to/xml2-config**) to manually specify a particular LibXML installation that PostGIS will build against.

--with-projdir=DIR Proj4 ⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Proj4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (**--with-projdir=/path/to/projdir**) ⊠⊠⊠⊠⊠⊠⊠⊠.

--with-libiconv=DIR iconv ⊠⊠⊠⊠

--with-jsondir=DIR JSON-C ⊠ MIT-⊠⊠⊠⊠⊠ JSON ⊠⊠⊠⊠⊠⊠, PostGIS ⊠ ST_GeomFromJSON ⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ JSON-C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (**--with-jsondir=/path/to/jsondir**) ⊠⊠⊠⊠⊠⊠⊠⊠.

--with-pcredir=DIR PCRE ⊠ BSD-⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, address_standardizer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PCRE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (**--with-pcredir=/path/to/pcredir**) ⊠⊠⊠⊠⊠⊠⊠⊠.

--with-gui ⊠⊠⊠⊠⊠⊠⊠ GUI ⊠⊠⊠ (GTK+2.0 ⊠⊠). shp2pgsql-gui ⊠ shp2pgsql ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

--without-raster ⊠⊠⊠⊠⊠⊠⊠⊠

--without-topology Disable topology support. There is no corresponding library as all logic needed for topology is in postgis-3.5.1 library.

--with-gettext=no ⊠⊠⊠⊠⊠⊠ PostGIS ⊠ gettext ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ gettext ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ http://trac.osgeo.org/postgis/ticket/748 ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠: gettext ⊠⊠⊠. gettext ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GUI ⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

--with-sfcgal=PATH ☒☒☒☒☒ PostGIS ☒☒☒☒☒☒☒☒☒ sfcgal ☒☒☒☒☒☒☒☒☒☒☒☒☒☒. PATH ☒ sfcgal-config ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

--without-phony-revision Disable updating postgis_revision.h to match current HEAD of the git repository.

Note

PostGIS ☒ SVN ☒☒☒ ☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

./autogen.sh

☒☒☒☒☒☒ **configure** ☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒ PostGIS ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒ tar ☒☒☒☒☒ PostGIS ☒☒☒☒☒☒☒☒ **configure** ☒☒☒☒☒☒☒☒☒ **./autogen.sh** ☒☒☒☒☒☒☒☒☒☒☒☒.

2.2.4 ☒☒

☒☒ Makefile ☒☒☒☒☒ PostGIS ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

make

☒☒☒☒☒☒☒☒☒”`PostGIS was built successfully. Ready to install.`” ☒☒☒☒☒☒☒☒☒☒☒.

As of PostGIS v1.4.0, all the functions have comments generated from the documentation. If you wish to install these comments into your spatial databases later, run the command which requires docbook. The postgis_comments.sql and other package comments files raster_comments.sql, topology_comments.sql are also packaged in the tar.gz distribution in the doc folder so no need to make comments if installing from the tar ball. Comments are also included as part of the CREATE EXTENSION install.

make comments

PostGIS 2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (cheat sheet) html ☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒ xsltproc ☒☒☒☒☒☒, doc ☒☒☒☒☒☒☒`topology_cheatsheet.html`, `tiger_geocoder_cheatsheet.html`, `raster_cheatsheet.html`, `postgis_cheatsheet.html` 4 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

html ☒ pdf ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ PostGIS / PostgreSQL Study Guides ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

make cheatsheets

2.2.5 PostGIS Extensions ☒☒☒☒☒

PostgreSQL 9.1 ☒☒☒☒☒☒☒☒☒☒ PostGIS extentions ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒ function descriptions ☒☒☒☒☒☒☒☒☒. docbook ☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒:

make comments

☒☒☒☒☒☒ tar ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ tar ☒☒☒☒☒☒☒☒☒☒☒ comments ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒ PostgreSQL 9.1 ☒☒☒☒☒☒☒☒☒☒☒☒ extensions ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒ extensions ☒☒☒.

```
cd extensions
cd postgis
make clean
```

```
make
export PGUSER=postgres #overwrite psql variables
make check #to test before install
make install
# to test extensions
make check RUNTESTFLAGS=--extension
```

Note
make check uses psql to run tests and as such can use psql environment variables. Common ones useful to override are PGUSER,PGPORT, and PGHOST. Refer to psql environment variables

extension ⊠⊠⊠ OS ⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ PostGIS binaries ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ extension ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠ PostgreSQL / share / extension ⊠⊠⊠⊠⊠ extensions ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ extension ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `postgis.control`, `postgis_topology.control`.
- ⊠ extension ⊠ /sql ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ postgreSQL ⊠ share/extension ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `extensions/postgis/sql/*.sql`, `extensions/postgis_topology/sql/*.sql`

Once you do that, you should see `postgis`, `postgis_topology` as available extensions in PgAdmin -> extensions.

⊠⊠ psql ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT name, default_version,installed_version
FROM pg_available_extensions WHERE name LIKE 'postgis%' or name LIKE 'address%';

             name             | default_version | installed_version
------------------------------+-----------------+-------------------
 address_standardizer         | 3.5.1           | 3.5.1
 address_standardizer_data_us | 3.5.1           | 3.5.1
 postgis                      | 3.5.1           | 3.5.1
 postgis_raster               | 3.5.1           | 3.5.1
 postgis_sfcgal               | 3.5.1           |
 postgis_tiger_geocoder       | 3.5.1           | 3.5.1
 postgis_topology             | 3.5.1           |
(6 rows)
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ extension ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ `installed_version` ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ postgis extension ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PgAdmin III 1.14 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `extensions` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

extension ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ pgAdmin extension ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ sql ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ postgis extension ⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
CREATE EXTENSION postgis;
CREATE EXTENSION postgis_raster;
CREATE EXTENSION postgis_sfcgal;
CREATE EXTENSION fuzzystrmatch; --needed for postgis_tiger_geocoder
--optional used by postgis_tiger_geocoder, or can be used standalone
CREATE EXTENSION address_standardizer;
```

```
CREATE EXTENSION address_standardizer_data_us;
CREATE EXTENSION postgis_tiger_geocoder;
CREATE EXTENSION postgis_topology;
```

PSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
\connect mygisdb
\x
\dx postgis*
```

```
List of installed extensions
-[ RECORD 1 ]-------------------------------------------------
Name        | postgis
Version     | 3.5.1
Schema      | public
Description | PostGIS geometry, geography, and raster spat..
-[ RECORD 2 ]-------------------------------------------------
Name        | postgis_raster
Version     | 3.0.0dev
Schema      | public
Description | PostGIS raster types and functions
-[ RECORD 3 ]-------------------------------------------------
Name        | postgis_tiger_geocoder
Version     | 3.5.1
Schema      | tiger
Description | PostGIS tiger geocoder and reverse geocoder
-[ RECORD 4 ]-------------------------------------------------
Name        | postgis_topology
Version     | 3.5.1
Schema      | topology
Description | PostGIS topology spatial types and functions
```

Warning

spatial_ref_sys, layer, topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ postgis ⊠⊠ postgis_topology extension ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PosgGIS 2.0.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ srid ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ trac ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. extension ⊠⊠⊠⊠⊠⊠⊠⊠⊠ CREATE EXTENSION ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ PostgreSQL extension ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3.5.1 ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠: postgis_upgrade_22_minor.sql,raster_upgrade_22_minor.sql,topology_upgrade_22_minor.sql.

```
CREATE EXTENSION postgis FROM unpackaged;
CREATE EXTENSION postgis_raster FROM unpackaged;
CREATE EXTENSION postgis_topology FROM unpackaged;
CREATE EXTENSION postgis_tiger_geocoder FROM unpackaged;
```

2.2.6 ⊠⊠⊠

⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠.

make check

⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠.

Note

PostgreSQL, GEOS, ⊠⊠ Proj4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, LD_LIBRARY_PATH ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Caution

⊠⊠, **make check** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PATH ⊠ PGPORT ⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL ⊠⊠⊠ ⊠⊠⊠⊠⊠ **--with-pgconfig** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠. ⊠⊠⊠, PostgreSQL ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PATH ⊠⊠⊠⊠⊠⊠⊠⊠.

If successful, make check will produce the output of almost 500 tests. The results will look similar to the following (numerous lines omitted below):

```
CUnit - A unit testing framework for C - Version 2.1-3
     http://cunit.sourceforge.net/

        .
        .
        .

Run Summary:    Type  Total    Ran Passed Failed Inactive
              suites     44     44    n/a      0        0
               tests    300    300    300      0        0
             asserts   4215   4215   4215      0      n/a
Elapsed time =    0.229 seconds

        .
        .
        .

Running tests

        .
        .
        .

Run tests: 134
Failed: 0


-- if you build with SFCGAL

        .
        .
        .

Running tests

        .
        .
        .

Run tests: 13
Failed: 0

-- if you built with raster support

        .
```

```
        .
        .

Run Summary:    Type  Total    Ran Passed Failed Inactive
              suites     12     12    n/a      0        0
               tests     65     65     65      0        0
             asserts  45896  45896  45896      0      n/a


        .
        .
        .

Running tests

        .
        .
        .

Run tests: 101
Failed: 0

-- topology regress

.
.
.

Running tests

        .
        .
        .

Run tests: 51
Failed: 0

-- if you built --with-gui, you should see this too

     CUnit - A unit testing framework for C - Version 2.1-2
     http://cunit.sourceforge.net/

        .
        .
        .

Run Summary:    Type  Total    Ran Passed Failed Inactive
              suites      2      2    n/a      0        0
               tests      4      4      4      0        0
             asserts      4      4      4      0      n/a
```

postgis_tiger_geocoder □ address_standardizer □□□□□□□□□□□ PostgreSQL □□□□ (installcheck) □□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□. □□: □□ PostGIS □□□□□□□□□ make install □□□□□□□□□□□□□□□□□□.

address_standardizer □□□:

```
cd extensions/address_standardizer
make install
make installcheck
```

□□□□□□□□□□□□□□:

```
============== dropping database "contrib_regression" ==============
DROP DATABASE
============== creating database "contrib_regression" ==============
CREATE DATABASE
ALTER DATABASE
============== running regression test queries        ==============
test test-init-extensions     ... ok
test test-parseaddress        ... ok
test test-standardize_address_1 ... ok
test test-standardize_address_2 ... ok

=====================
 All 4 tests passed.
=====================
```

TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠ fuzzystrmatch ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. address_standardizer ⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠ address_standardizer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
cd extensions/postgis_tiger_geocoder
make install
make installcheck
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
============== dropping database "contrib_regression" ==============
DROP DATABASE
============== creating database "contrib_regression" ==============
CREATE DATABASE
ALTER DATABASE
============== installing fuzzystrmatch               ==============
CREATE EXTENSION
============== installing postgis                     ==============
CREATE EXTENSION
============== installing postgis_tiger_geocoder      ==============
CREATE EXTENSION
============== installing address_standardizer        ==============
CREATE EXTENSION
============== running regression test queries        ==============
test test-normalize_address   ... ok
test test-pagc_normalize_address ... ok

=====================
All 2 tests passed.
=====================
```

2.2.7 ⊠⊠

PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

make install

⊠⊠⊠ **--prefix** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ⊠⊠ (loader) ⊠⊠⊠⊠⊠⊠⊠⊠⊠ `[prefix]/bin` ⊠⊠⊠⊠⊠⊠.
- `postgis.sql` ⊠⊠⊠ SQL ⊠⊠⊠⊠ `[prefix]/share/contrib` ⊠⊠⊠⊠⊠⊠.
- PostGIS ⊠⊠⊠⊠⊠⊠⊠ `[prefix]/lib` ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠ `postgis_comments.sql`, `raster_comments.sql` ⊠⊠⊠⊠⊠⊠⊠⊠⊠ **make comments** ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ sql ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

make comments-install

> **Note**
> **xsltproc** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `postgis_comments.sql`, `raster_comments.sql`, `topology_comments.sql` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

`address_standardizer` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 2.2 ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ Section 12.1 ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠ Normalize_Address ⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠ (geocoder) ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Section 2.4.2 ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (building block) ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PCRE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PCRE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, http://www.pcre.org ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Section 2.2.3 ⊠⊠⊠⊠⊠ PCRE ⊠⊠⊠⊠⊠⊠, ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PCRE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ ⊠⊠⊠ `--with-pcredir=/path/to/pcre` ⊠ `/path/to/pcre` ⊠⊠⊠⊠⊠⊠⊠⊠ PCRE include ⊠ lib ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS 2.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ address_standardizer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠ `CREATE EXTENSION` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
CREATE EXTENSION address_standardizer;
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rules, gaz, ⊠⊠ lex ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT num, street, city, state, zip
 FROM parse_address('1 Devonshire Place PH301, Boston, MA 02109');
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
num |         street         |  city  | state |  zip
-----+------------------------+--------+-------+-------
 1   | Devonshire Place PH301 | Boston | MA    | 02109
```

2.4 Installing, Upgrading Tiger Geocoder, and loading data

Extras like Tiger geocoder may not be packaged in your PostGIS distribution. If you are missing the tiger geocoder extension or want a newer version than what your install comes with, then use the `share/extension/postgis_tiger_geocoder.*` files from the packages in Windows Unreleased Versions section for your version of PostgreSQL. Although these packages are for windows, the postgis_tiger_geocoder extension files will work on any OS since the extension is an SQL/plpgsql only extension.

2.4.1 Tiger Geocoder Enabling your PostGIS database

1. These directions assume your PostgreSQL installation already has the postgis_tiger_geocoder extension installed.

2. PSQL, pgAdmin ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ `fuzzystrmatch` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

   ```
   CREATE EXTENSION postgis;
   CREATE EXTENSION fuzzystrmatch;
   CREATE EXTENSION postgis_tiger_geocoder;
   --this one is optional if you want to use the rules based standardizer ( ←
      pagc_normalize_address)
   CREATE EXTENSION address_standardizer;
   ```

   ⊠⊠ postgis_tiger_geocoder ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

   ```
   ALTER EXTENSION postgis UPDATE;
   ALTER EXTENSION postgis_tiger_geocoder UPDATE;
   ```

   `tiger.loader_platform` ⊠ `tiger.loader_variables` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

3. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠:

   ```
   SELECT na.address, na.streetname,na.streettypeabbrev, na.zip
           FROM normalize_address('1 Devonshire Place, Boston, MA 02109') AS na;
   ```

   ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

   ```
   address | streetname | streettypeabbrev |  zip
   ---------+------------+------------------+-------
              1 | Devonshire | Pl               | 02109
   ```

4. `tiger.loader_platform` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
   ⊠⊠⊠⊠ `sh` ⊠⊠ (convention) ⊠⊠⊠⊠ debbie ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

   ```
   INSERT INTO tiger.loader_platform(os, declare_sect, pgbin, wget, unzip_command, psql,  ←
      path_sep,
                      loader, environ_set_command, county_process_command)
   SELECT 'debbie', declare_sect, pgbin, wget, unzip_command, psql, path_sep,
              loader, environ_set_command, county_process_command
     FROM tiger.loader_platform
     WHERE os = 'sh';
   ```

   ⊠⊠⊠ debbie ⊠ pg, unzip,shp2pgsql, PSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ *declare_sect* ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

   ⊠ `loader_platform` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ (common case) ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

5. As of PostGIS 2.4.1 the Zip code-5 digit tabulation area `zcta5` load step was revised to load current zcta5 data and is part of the Loader_Generate_Nation_Script when enabled. It is turned off by default because it takes quite a bit of time to load (20 to 60 minutes), takes up quite a bit of disk space, and is not used that often.

   To enable it, do the following:

   ```
   UPDATE tiger.loader_lookuptables SET load = true WHERE table_name = 'zcta520';
   ```

   If present the Geocode function can use it if a boundary filter is added to limit to just zips in that boundary. The Reverse_Geocode function uses it if the returned address is missing a zip, which often happens with highway reverse geocoding.

6. ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PC ⊠⊠⊠⊠ gisdata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, tiger.loader_variables ⊠⊠⊠⊠ staging_fold ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
7. gisdata ⊠⊠⊠⊠⊠⊠⊠⊠⊠ staging_fold ⊠⊠⊠⊠⊠⊠⊠⊠ temp ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠ temp ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
8. Then run the Loader_Generate_Nation_Script SQL function make sure to use the name of your custom profile and copy the script to a .sh or .bat file. So for example to build the nation load:

```
psql -c "SELECT Loader_Generate_Nation_Script('debbie')" -d geocoder -tA > /gisdata/ ↩
    nation_script_load.sh
```

9. Run the generated nation load commandline scripts.

```
cd /gisdata
sh nation_script_load.sh
```

10. After you are done running the nation script, you should have three tables in your `tiger_data` schema and they should be filled with data. Confirm you do by doing the following queries from psql or pgAdmin

```
SELECT count(*) FROM tiger_data.county_all;
```

```
count
-------
  3235
(1 row)
```

```
SELECT count(*) FROM tiger_data.state_all;
```

```
count
-------
    56
(1 row)
```

This will only have data if you marked zcta5 to be loaded

```
SELECT count(*) FROM tiger_data.zcta5_all;
```

```
count
-------
  33933
(1 row)
```

11. By default the tables corresponding to `bg`, `tract`, `tabblock20` are not loaded. These tables are not used by the geocoder but are used by folks for population statistics. If you wish to load them as part of your state loads, run the following statement to enable them.

```
UPDATE tiger.loader_lookuptables SET load = true WHERE load = false AND lookup_name IN ↩
    ('tract', 'bg', 'tabblock20');
```

Alternatively you can load just these tables after loading state data using the Loader_Generate_Census_

12. For each state you want to load data for, generate a state script Loader_Generate_Script.

Warning
DO NOT Generate the state script until you have already loaded the nation data, because the state script utilizes county list loaded by nation script.

13.
```
psql -c "SELECT Loader_Generate_Script(ARRAY['MA'], 'debbie')" -d geocoder -tA > /gisdata/ma_load.sh
```

14. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
```
cd /gisdata
sh ma_load.sh
```

15. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠ (stat) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
```
SELECT install_missing_indexes();
vacuum (analyze, verbose) tiger.addr;
vacuum (analyze, verbose) tiger.edges;
vacuum (analyze, verbose) tiger.faces;
vacuum (analyze, verbose) tiger.featnames;
vacuum (analyze, verbose) tiger.place;
vacuum (analyze, verbose) tiger.cousub;
vacuum (analyze, verbose) tiger.county;
vacuum (analyze, verbose) tiger.state;
vacuum (analyze, verbose) tiger.zcta5;
vacuum (analyze, verbose) tiger.zip_lookup_base;
vacuum (analyze, verbose) tiger.zip_state;
vacuum (analyze, verbose) tiger.zip_state_loc;
```

2.4.2 ⊠⊠⊠⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Normalize_Address ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ address_standardizer ⊠⊠⊠⊠⊠⊠, Section 2.3 ⊠⊠.

postgis_tiger_geocoder ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, Normalize_Address ⊠⊠ Pagc_Normalize_Address ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rules table (tiger.pagc_rules) , gaz table (tiger.pagc_gaz), ⊠⊠⊠ lex table (tiger.pagc_lex) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠.

2.4.3 Required tools for tiger data loading

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ tiger ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, Drop_State_Tables_Generate_Script⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠
  Unix ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ unzip ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
  ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠ 7-zip ⊠ http://www.7-zip.org/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠ `shp2pgsql` ⊠⊠
- ⊠⊠⊠⊠⊠⊠⊠ `wget` ⊠⊠⊠⊠⊠ Unix/Linux ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ http://gnuwin32.sourceforge.net/packages/wget.htm⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

If you are upgrading from tiger_2010, you'll need to first generate and run Drop_Nation_Tables_Generate_Sc Before you load any state data, you need to load the nation wide data which you do with Loader_Generate_Na Which will generate a loader script for you. Loader_Generate_Nation_Script is a one-time step that should be done for upgrading (from a prior year tiger census data) and for new installs.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Loader_Generate_Script ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Install_Missing_Indexes⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
SELECT install_missing_indexes();
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Geocode⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.4.4 Upgrading your Tiger Geocoder Install and Data

First upgrade your postgis_tiger_geocoder extension as follows:

```
ALTER EXTENSION postgis_tiger_geocoder UPDATE;
```

⊠⊠⊠⊠⊠⊠ nation ⊠⊠⊠⊠ drop ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ SQL ⊠⊠⊠⊠ drop ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Drop_Nation_Tables_Generate_Script

```
SELECT drop_nation_tables_generate_script();
```

⊠⊠⊠ drop SQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠ SELECT ⊠⊠⊠⊠ nation load ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Loader_Generate_Natio

⊠⊠⊠⊠

```
SELECT loader_generate_nation_script('windows');
```

unix/linux ⊠

```
SELECT loader_generate_nation_script('sh');
```

Refer to Section 2.4.1 for instructions on how to run the generate script. This only needs to be done once.

> **Note**
> You can have a mix of different year state tables and can upgrade each state separately. Before you upgrade a state you first need to drop the prior year state tables for that state using Drop_State_Tables_Generate_Script.

2.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1. PostgreSQL 12 □□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□ PostgreSQL □ □□□□□□□ PostgreSQL □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. (Linux) □□□□□□□ PostgreSQL □□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□. PostGIS □ PostgreSQL 12 □□. □□ PostgreSQL □□□□□□□□□□□□□□□□□□□□□□ psql □□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□:

   ```
   SELECT version();
   ```

   RPM □□□□□□□□□□□□ **rpm** □□□□□□□□□□□□□□□□□□□□□□□□□□□□□: **rpm -qa | grep postgresql**

2. □□□□□□□□□□□□□□□□□ PostGIS □□□□□□□□□□□□□□□□□.

   ```
   SELECT postgis_full_version();
   ```

□□ PostreSQL, Proj4 □□□□□□□ GEOS □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

1. □□□ `postgis_config.hh` □□□□□□□□□□□□□□□□□. `POSTGIS_PGSQL_VERSION`, `POSTGIS_PROJ_VERS` and `POSTGIS_GEOS_VERSION` □□□□□□□□□□□□□□□□.

Chapter 3

PostGIS Administration

3.1 Performance Tuning

Tuning for PostGIS performance is much like tuning for any PostgreSQL workload. The only additional consideration is that geometries and rasters are usually large, so memory-related optimizations generally have more of an impact on PostGIS than other types of PostgreSQL queries.

For general details about optimizing PostgreSQL, refer to Tuning your PostgreSQL Server.

For PostgreSQL 9.4+ configuration can be set at the server level without touching `postgresql.conf` or `postgresql.auto.conf` by using the `ALTER SYSTEM` command.

```
ALTER SYSTEM SET work_mem = '256MB';
-- this forces non-startup configs to take effect for new connections
SELECT pg_reload_conf();
-- show current setting value
-- use SHOW ALL to see all settings
SHOW work_mem;
```

In addition to the Postgres settings, PostGIS has some custom settings which are listed in Section 7.22.

3.1.1 Startup

These settings are configured in `postgresql.conf`:

constraint_exclusion

- Default: partition
- This is generally used for table partitioning. The default for this is set to "partition" which is ideal for PostgreSQL 8.4 and above since it will force the planner to only analyze tables for constraint consideration if they are in an inherited hierarchy and not pay the planner penalty otherwise.

shared_buffers

- Default: ~128MB in PostgreSQL 9.6
- Set to about 25% to 40% of available RAM. On windows you may not be able to set as high.

max_worker_processes This setting is only available for PostgreSQL 9.4+. For PostgreSQL 9.6+ this setting has additional importance in that it controls the max number of processes you can have for parallel queries.

- Default: 8
- Sets the maximum number of background processes that the system can support. This parameter can only be set at server start.

3.1.2 Runtime

work_mem - sets the size of memory used for sort operations and complex queries

- Default: 1-4MB
- Adjust up for large dbs, complex queries, lots of RAM
- Adjust down for many concurrent users or low RAM.
- If you have lots of RAM and few developers:

```
SET work_mem TO '256MB';
```

maintenance_work_mem - the memory size used for VACUUM, CREATE INDEX, etc.

- Default: 16-64MB
- Generally too low - ties up I/O, locks objects while swapping memory
- Recommend 32MB to 1GB on production servers w/lots of RAM, but depends on the # of concurrent users. If you have lots of RAM and few developers:

```
SET maintenance_work_mem TO '1GB';
```

max_parallel_workers_per_gather

This setting is only available for PostgreSQL 9.6+ and will only affect PostGIS 2.3+, since only PostGIS 2.3+ supports parallel queries. If set to higher than 0, then some queries such as those involving relation functions like `ST_Intersects` can use multiple processes and can run more than twice as fast when doing so. If you have a lot of processors to spare, you should change the value of this to as many processors as you have. Also make sure to bump up `max_worker_processes` to at least as high as this number.

- Default: 0
- Sets the maximum number of workers that can be started by a single `Gather` node. Parallel workers are taken from the pool of processes established by `max_worker_processes`. Note that the requested number of workers may not actually be available at run time. If this occurs, the plan will run with fewer workers than expected, which may be inefficient. Setting this value to 0, which is the default, disables parallel query execution.

3.2 Configuring raster support

If you enabled raster support you may want to read below how to properly configure it.

As of PostGIS 2.1.3, out-of-db rasters and all raster drivers are disabled by default. In order to re-enable these, you need to set the following environment variables `POSTGIS_GDAL_ENABLED_DRIVERS` and `POSTGIS_ENABLE_OUTDB_RASTERS` in the server environment. For PostGIS 2.2, you can use the more cross-platform approach of setting the corresponding Section 7.22.

If you want to enable offline raster:

```
POSTGIS_ENABLE_OUTDB_RASTERS=1
```

Any other setting or no setting at all will disable out of db rasters.

In order to enable all GDAL drivers available in your GDAL install, set this environment variable as follows

```
POSTGIS_GDAL_ENABLED_DRIVERS=ENABLE_ALL
```

If you want to only enable specific drivers, set your environment variable as follows:

```
POSTGIS_GDAL_ENABLED_DRIVERS="GTiff PNG JPEG GIF XYZ"
```

Note
If you are on windows, do not quote the driver list

Setting environment variables varies depending on OS. For PostgreSQL installed on Ubuntu or Debian via apt-postgresql, the preferred way is to edit `/etc/postgresql/10/main/environment` where 10 refers to version of PostgreSQL and main refers to the cluster.

On windows, if you are running as a service, you can set via System variables which for Windows 7 you can get to by right-clicking on Computer->Properties Advanced System Settings or in explorer navigating to `Control Panel\All Control Panel Items\System`. Then clicking *Advanced System Settings ->Advanced->Environment Variables* and adding new system variables.

After you set the environment variables, you'll need to restart your PostgreSQL service for the changes to take effect.

3.3 ☒☒☒☒☒☒☒☒☒☒

3.3.1 Spatially enable database using EXTENSION

If you are using PostgreSQL 9.1+ and have compiled and installed the extensions/postgis modules, you can turn a database into a spatial one using the EXTENSION mechanism.

Core postgis extension includes geometry, geography, spatial_ref_sys and all the functions and comments. Raster and topology are packaged as a separate extension.

Run the following SQL snippet in the database you want to enable spatially:

```
CREATE EXTENSION IF NOT EXISTS plpgsql;
      CREATE EXTENSION postgis;
      CREATE EXTENSION postgis_raster; -- OPTIONAL
      CREATE EXTENSION postgis_topology; -- OPTIONAL
```

3.3.2 Spatially enable database without using EXTENSION (discouraged)

Note
This is generally only needed if you cannot or don't want to get PostGIS installed in the PostgreSQL extension directory (for example during testing, development or in a restricted environment).

Adding PostGIS objects and function definitions into your database is done by loading the various sql files located in `[prefix]/share/contrib` as specified during the build phase.

The core PostGIS objects (geometry and geography types, and their support functions) are in the `postgis.sql` script. Raster objects are in the `rtpostgis.sql` script. Topology objects are in the `topology.sql` script.

For a complete set of EPSG coordinate system definition identifiers, you can also load the `spatial_ref_sys.sql` definitions file and populate the `spatial_ref_sys` table. This will permit you to perform ST_Transform() operations on geometries.

If you wish to add comments to the PostGIS functions, you can find them in the `postgis_comments.sql` script. Comments can be viewed by simply typing **\dd [function_name]** from a **psql** terminal window.

Run the following Shell commands in your terminal:

```
DB=[yourdatabase]
    SCRIPTSDIR=`pg_config --sharedir`/contrib/postgis-3.4/

    # Core objects
    psql -d ${DB} -f ${SCRIPTSDIR}/postgis.sql
    psql -d ${DB} -f ${SCRIPTSDIR}/spatial_ref_sys.sql
    psql -d ${DB} -f ${SCRIPTSDIR}/postgis_comments.sql # OPTIONAL

    # Raster support (OPTIONAL)
    psql -d ${DB} -f ${SCRIPTSDIR}/rtpostgis.sql
    psql -d ${DB} -f ${SCRIPTSDIR}/raster_comments.sql # OPTIONAL

    # Topology support (OPTIONAL)
    psql -d ${DB} -f ${SCRIPTSDIR}/topology.sql
    psql -d ${DB} -f ${SCRIPTSDIR}/topology_comments.sql # OPTIONAL
```

3.4 Upgrading spatial databases

Upgrading existing spatial databases can be tricky as it requires replacement or introduction of new PostGIS object definitions.

Unfortunately not all definitions can be easily replaced in a live database, so sometimes your best bet is a dump/reload process.

PostGIS provides a SOFT UPGRADE procedure for minor or bugfix releases, and a HARD UPGRADE procedure for major releases.

Before attempting to upgrade PostGIS, it is always worth to backup your data. If you use the -Fc flag to pg_dump you will always be able to restore the dump with a HARD UPGRADE.

3.4.1 Soft upgrade

If you installed your database using extensions, you'll need to upgrade using the extension model as well. If you installed using the old sql script way, you are advised to switch your install to extensions because the script way is no longer supported.

3.4.1.1 Soft Upgrade 9.1+ using extensions

If you originally installed PostGIS with extensions, then you need to upgrade using extensions as well. Doing a minor upgrade with extensions, is fairly painless.

If you are running PostGIS 3 or above, then you should use the PostGIS_Extensions_Upgrade function to upgrade to the latest version you have installed.

```
SELECT postgis_extensions_upgrade();
```

If you are running PostGIS 2.5 or lower, then do the following:

```
ALTER EXTENSION postgis UPDATE;
SELECT postgis_extensions_upgrade();
-- This second call is needed to rebundle postgis_raster extension
SELECT postgis_extensions_upgrade();
```

If you have multiple versions of PostGIS installed, and you don't want to upgrade to the latest, you can explicitly specify the version as follows:

```
ALTER EXTENSION postgis UPDATE TO "3.5.1";
ALTER EXTENSION postgis_topology UPDATE TO "3.5.1";
```

If you get an error notice something like:

```
No migration path defined for b''…b'' to 3.5.1
```

Then you'll need to backup your database, create a fresh one as described in Section 3.3.1 and then restore your backup on top of this new database.

If you get a notice message like:

```
Version "3.5.1" of extension "postgis" is already installed
```

Then everything is already up to date and you can safely ignore it. **UNLESS** you're attempting to upgrade from an development version to the next (which doesn't get a new version number); in that case you can append "next" to the version string, and next time you'll need to drop the "next" suffix again:

```
ALTER EXTENSION postgis UPDATE TO "3.5.1next";
ALTER EXTENSION postgis_topology UPDATE TO "3.5.1next";
```

Note

If you installed PostGIS originally without a version specified, you can often skip the reinstallation of postgis extension before restoring since the backup just has `CREATE EXTENSION postgis` and thus picks up the newest latest version during restore.

Note

If you are upgrading PostGIS extension from a version prior to 3.0.0, you will have a new extension *postgis_raster* which you can safely drop, if you don't need raster support. You can drop as follows:

```
DROP EXTENSION postgis_raster;
```

3.4.1.2 Soft Upgrade Pre 9.1+ or without extensions

This section applies only to those who installed PostGIS not using extensions. If you have extensions and try to upgrade with this approach you'll get messages like:

```
can't drop b''…b'' because postgis extension depends on it
```

NOTE: if you are moving from PostGIS 1.* to PostGIS 2.* or from PostGIS 2.* prior to r7409, you cannot use this procedure but would rather need to do a HARD UPGRADE.

After compiling and installing (make install) you should find a set of `*_upgrade.sql` files in the installation folders. You can list them all with:

```
ls `pg_config --sharedir`/contrib/postgis-3.5.1/*_upgrade.sql
```

Load them all in turn, starting from `postgis_upgrade.sql`.

```
psql -f postgis_upgrade.sql -d your_spatial_database
```

The same procedure applies to raster, topology and sfcgal extensions, with upgrade files named `rtpostgis_upgrade.sql`, `topology_upgrade.sql` and `sfcgal_upgrade.sql` respectively. If you need them:

```
psql -f rtpostgis_upgrade.sql -d your_spatial_database
```

```
psql -f topology_upgrade.sql -d your_spatial_database
```

```
psql -f sfcgal_upgrade.sql -d your_spatial_database
```

You are advised to switch to an extension based install by running

```
psql -c ”SELECT postgis_extensions_upgrade();”
```

Note
If you can't find the `postgis_upgrade.sql` specific for upgrading your version you are using a version too early for a soft upgrade and need to do a HARD UPGRADE.

The PostGIS_Full_Version function should inform you about the need to run this kind of upgrade using a ”procs need upgrade” message.

3.4.2 Hard upgrade

By HARD UPGRADE we mean full dump/reload of postgis-enabled databases. You need a HARD UPGRADE when PostGIS objects' internal storage changes or when SOFT UPGRADE is not possible. The Release Notes appendix reports for each version whether you need a dump/reload (HARD UPGRADE) to upgrade.

The dump/reload process is assisted by the postgis_restore script which takes care of skipping from the dump all definitions which belong to PostGIS (including old ones), allowing you to restore your schemas and data into a database with PostGIS installed without getting duplicate symbol errors or bringing forward deprecated objects.

Supplementary instructions for windows users are available at Windows Hard upgrade.

The Procedure is as follows:

1. Create a ”custom-format” dump of the database you want to upgrade (let's call it `olddb`) include binary blobs (-b) and verbose (-v) output. The user can be the owner of the db, need not be postgres super account.

   ```
   pg_dump -h localhost -p 5432 -U postgres -Fc -b -v -f ”/somepath/olddb.backup” olddb
   ```

2. Do a fresh install of PostGIS in a new database -- we'll refer to this database as `newdb`. Please refer to Section 3.3.2 and Section 3.3.1 for instructions on how to do this.

   The spatial_ref_sys entries found in your dump will be restored, but they will not override existing ones in spatial_ref_sys. This is to ensure that fixes in the official set will be properly propagated to restored databases. If for any reason you really want your own overrides of standard entries just don't load the spatial_ref_sys.sql file when creating the new db.

   If your database is really old or you know you've been using long deprecated functions in your views and functions, you might need to load `legacy.sql` for all your functions and views etc. to properly come back. Only do this if _really_ needed. Consider upgrading your views and functions before dumping instead, if possible. The deprecated functions can be later removed by loading `uninstall_legacy.sql`.

3. Restore your backup into your fresh `newdb` database using postgis_restore. Unexpected errors, if any, will be printed to the standard error stream by psql. Keep a log of those.

```
postgis_restore "/somepath/olddb.backup" | psql -h localhost -p 5432 -U postgres newdb ↩
    2> errors.txt
```

Errors may arise in the following cases:

1. Some of your views or functions make use of deprecated PostGIS objects. In order to fix this you may try loading `legacy.sql` script prior to restore or you'll have to restore to a version of PostGIS which still contains those objects and try a migration again after porting your code. If the `legacy.sql` way works for you, don't forget to fix your code to stop using deprecated functions and drop them loading `uninstall_legacy.sql`.

2. Some custom records of spatial_ref_sys in dump file have an invalid SRID value. Valid SRID values are bigger than 0 and smaller than 999000. Values in the 999000.999999 range are reserved for internal use while values > 999999 can't be used at all. All your custom records with invalid SRIDs will be retained, with those > 999999 moved into the reserved range, but the spatial_ref_sys table would lose a check constraint guarding for that invariant to hold and possibly also its primary key (when multiple invalid SRIDS get converted to the same reserved SRID value).

   In order to fix this you should copy your custom SRS to a SRID with a valid value (maybe in the 910000..910999 range), convert all your tables to the new srid (see UpdateGeometrySRID), delete the invalid entry from spatial_ref_sys and re-construct the check(s) with:

```
ALTER TABLE spatial_ref_sys ADD CONSTRAINT spatial_ref_sys_srid_check check (srid
> 0 AND srid < 999000 );
```

```
ALTER TABLE spatial_ref_sys ADD PRIMARY KEY(srid));
```

   If you are upgrading an old database containing french IGN cartography, you will have probably SRIDs out of range and you will see, when importing your database, issues like this :

```
WARNING: SRID 310642222 converted to 999175 (in reserved zone)
```

   In this case, you can try following steps : first throw out completely the IGN from the sql which is resulting from postgis_restore. So, after having run :

```
postgis_restore "/somepath/olddb.backup" > olddb.sql
```

   run this command :

```
grep -v IGNF olddb.sql > olddb-without-IGN.sql
```

   Create then your newdb, activate the required Postgis extensions, and insert properly the french system IGN with : this script After these operations, import your data :

```
psql -h localhost -p 5432 -U postgres -d newdb -f olddb-without-IGN.sql  2> errors.txt
```

Chapter 4

Data Management

4.1 GIS (☒☒) ☒☒☒☒☒

4.1.1 OGC Geometry

The Open Geospatial Consortium (OGC) developed the *Simple Features Access* standard (SFA) to provide a model for geospatial data. It defines the fundamental spatial type of **Geometry**, along with operations which manipulate and transform geometry values to perform spatial analysis tasks. PostGIS implements the OGC Geometry model as the PostgreSQL data types geometry and geography.

Geometry is an *abstract* type. Geometry values belong to one of its *concrete* subtypes which represent various kinds and dimensions of geometric shapes. These include the **atomic** types Point, LineString, LinearRing and Polygon, and the **collection** types MultiPoint, MultiLineString, MultiPolygon and GeometryCollection. The *Simple Features Access - Part 1: Common architecture v1.2.1* adds subtypes for the structures PolyhedralSurface, Triangle and TIN.

Geometry models shapes in the 2-dimensional Cartesian plane. The PolyhedralSurface, Triangle, and TIN types can also represent shapes in 3-dimensional space. The size and location of shapes are specified by their **coordinates**. Each coordinate has a X and Y **ordinate** value determining its location in the plane. Shapes are constructed from points or line segments, with points specified by a single coordinate, and line segments by two coordinates.

Coordinates may contain optional Z and M ordinate values. The Z ordinate is often used to represent elevation. The M ordinate contains a measure value, which may represent time or distance. If Z or M values are present in a geometry value, they must be defined for each point in the geometry. If a geometry has Z or M ordinates the **coordinate dimension** is 3D; if it has both Z and M the coordinate dimension is 4D.

Geometry values are associated with a **spatial reference system** indicating the coordinate system in which it is embedded. The spatial reference system is identified by the geometry SRID number. The units of the X and Y axes are determined by the spatial reference system. In **planar** reference systems the X and Y coordinates typically represent easting and northing, while in **geodetic** systems they represent longitude and latitude. SRID 0 represents an infinite Cartesian plane with no units assigned to its axes. See Section 4.5.

The geometry **dimension** is a property of geometry types. Point types have dimension 0, linear types have dimension 1, and polygonal types have dimension 2. Collections have the dimension of the maximum element dimension.

A geometry value may be **empty**. Empty values contain no vertices (for atomic geometry types) or no elements (for collections).

An important property of geometry values is their spatial **extent** or **bounding box**, which the OGC model calls **envelope**. This is the 2 or 3-dimensional box which encloses the coordinates of a geometry.

It is an efficient way to represent a geometry's extent in coordinate space and to check whether two geometries interact.

The geometry model allows evaluating topological spatial relationships as described in Section 5.1.1. To support this the concepts of **interior**, **boundary** and **exterior** are defined for each geometry type. Geometries are topologically closed, so they always contain their boundary. The boundary is a geometry of dimension one less than that of the geometry itself.

The OGC geometry model defines validity rules for each geometry type. These rules ensure that geometry values represents realistic situations (e.g. it is possible to specify a polygon with a hole lying outside the shell, but this makes no sense geometrically and is thus invalid). PostGIS also allows storing and manipulating invalid geometry values. This allows detecting and fixing them if needed. See Section 4.4

4.1.1.1 Point

A Point is a 0-dimensional geometry that represents a single location in coordinate space.

```
POINT (1 2)
POINT Z (1 2 3)
POINT ZM (1 2 3 4)
```

4.1.1.2 LineString

A LineString is a 1-dimensional line formed by a contiguous sequence of line segments. Each line segment is defined by two points, with the end point of one segment forming the start point of the next segment. An OGC-valid LineString has either zero or two or more points, but PostGIS also allows single-point LineStrings. LineStrings may cross themselves (self-intersect). A LineString is **closed** if the start and end points are the same. A LineString is **simple** if it does not self-intersect.

```
LINESTRING (1 2, 3 4, 5 6)
```

4.1.1.3 LinearRing

A LinearRing is a LineString which is both closed and simple. The first and last points must be equal, and the line must not self-intersect.

```
LINEARRING (0 0 0, 4 0 0, 4 4 0, 0 4 0, 0 0 0)
```

4.1.1.4 Polygon

A Polygon is a 2-dimensional planar region, delimited by an exterior boundary (the shell) and zero or more interior boundaries (holes). Each boundary is a LinearRing.

```
POLYGON ((0 0 0,4 0 0,4 4 0,0 4 0,0 0 0),(1 1 0,2 1 0,2 2 0,1 2 0,1 1 0))
```

4.1.1.5 MultiPoint

A MultiPoint is a collection of Points.

```
MULTIPOINT ( (0 0), (1 2) )
```

4.1.1.6 MultiLineString

A MultiLineString is a collection of LineStrings. A MultiLineString is closed if each of its elements is closed.

```
MULTILINESTRING ( (0 0,1 1,1 2), (2 3,3 2,5 4) )
```

4.1.1.7 MultiPolygon

A MultiPolygon is a collection of non-overlapping, non-adjacent Polygons. Polygons in the collection may touch only at a finite number of points.

```
MULTIPOLYGON (((1 5, 5 5, 5 1, 1 1, 1 5)), ((6 5, 9 1, 6 1, 6 5)))
```

4.1.1.8 GeometryCollection

A GeometryCollection is a heterogeneous (mixed) collection of geometries.

```
GEOMETRYCOLLECTION ( POINT(2 3), LINESTRING(2 3, 3 4))
```

4.1.1.9 PolyhedralSurface

A PolyhedralSurface is a contiguous collection of patches or facets which share some edges. Each patch is a planar Polygon. If the Polygon coordinates have Z ordinates then the surface is 3-dimensional.

```
POLYHEDRALSURFACE Z (
  ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
  ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
  ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
  ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
  ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
  ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )
```

4.1.1.10 Triangle

A Triangle is a polygon defined by three distinct non-collinear vertices. Because a Triangle is a polygon it is specified by four coordinates, with the first and fourth being equal.

```
TRIANGLE ((0 0, 0 9, 9 0, 0 0))
```

4.1.1.11 TIN

A TIN is a collection of non-overlapping Triangles representing a Triangulated Irregular Network.

```
TIN Z ( ((0 0 0, 0 0 1, 0 1 0, 0 0 0)), ((0 0 0, 0 1 0, 1 1 0, 0 0 0)) )
```

4.1.2 SQL-MM Part 3

The *ISO/IEC 13249-3 SQL Multimedia - Spatial* standard (SQL/MM) extends the OGC SFA to define Geometry subtypes containing curves with circular arcs. The SQL/MM types support 3DM, 3DZ and 4D coordinates.

Note
SQL-MM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ 1E-8 ⊠⊠⊠.

4.1.2.1 CircularString

CIRCULARSTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ LINESTRING ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, LINESTRING ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
CIRCULARSTRING(0 0, 1 1, 1 0)

CIRCULARSTRING(0 0, 4 0, 4 4, 0 4, 0 0)
```

4.1.2.2 CompoundCurve

⊠⊠⊠⊠ (compound curve) ⊠⊠⊠⊠ (⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, (⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠.

```
COMPOUNDCURVE( CIRCULARSTRING(0 0, 1 1, 1 0),(1 0, 0 1))
```

4.1.2.3 CurvePolygon

CURVEPOLYGON ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

PostGIS ⊠ 1.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
CURVEPOLYGON(
  CIRCULARSTRING(0 0, 4 0, 4 4, 0 4, 0 0),
  (1 1, 3 3, 3 1, 1 1) )
```

Example: A CurvePolygon with the shell defined by a CompoundCurve containing a CircularString and a LineString, and a hole defined by a CircularString

```
CURVEPOLYGON(
  COMPOUNDCURVE( CIRCULARSTRING(0 0,2 0, 2 1, 2 3, 4 3),
                 (4 3, 4 5, 1 4, 0 0)),
  CIRCULARSTRING(1.7 1, 1.4 0.4, 1.6 0.4, 1.6 0.5, 1.7 1) )
```

4.1.2.4 MultiCurve

MULTICURVE ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
MULTICURVE( (0 0, 5 5), CIRCULARSTRING(4 0, 4 4, 8 4))
```

4.1.2.5 MultiSurface

MULTISURFACE ⊠⊠⊠⊠⊠⊠, (⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
MULTISURFACE(
  CURVEPOLYGON(
    CIRCULARSTRING( 0 0, 4 0, 4 4, 0 4, 0 0),
    (1 1, 3 3, 3 1, 1 1)),
  ((10 10, 14 12, 11 10, 10 10), (11 11, 11.5 11, 11 11.5, 11 11)))
```

4.1.3 OpenGIS WKB ⊠ WKT

OpenGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠: Well-Known Text (WKT) ⊠⊠⊠ Well-Known Binary (WKB) ⊠⊠. WKT ⊠ WKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ WKT SRS ⊠⊠⊠⊠⊠⊠⊠⊠:

- POINT(0 0)
- POINT(0 0)
- POINT(0 0)
- POINT EMPTY
- LINESTRING(0 0,1 1,1 2)
- LINESTRING
- POLYGON((0 0,4 0,4 4,0 4,0 0),(1 1, 2 1, 2 2, 1 2,1 1))
- MULTIPOINT((0 0),(1 2))
- MULTIPOINT((0 0),(1 2))
- MULTIPOINT
- MULTILINESTRING((0 0,1 1,1 2),(2 3,3 2,5 4))
- MULTIPOLYGON(((0 0,4 0,4 4,0 4,0 0),(1 1,2 1,2 2,1 2,1 1)), ((-1 -1,-1 -2,-2 -2,-2 -1,-1 -1)))
- GEOMETRYCOLLECTION(POINT(2 3),LINESTRING(2 3,3 4))
- GEOMETRYCOLLECTION

Input and output of WKT is provided by the functions ST_AsText and ST_GeomFromText:

```
text WKT = ST_AsText(geometry);
geometry = ST_GeomFromText(text WKT, SRID);
```

⊠⊠⊠⊠ OGC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
INSERT INTO geotable ( geom, name )
  VALUES ( ST_GeomFromText('POINT(-126.4 45.32)', 312), 'A Place');
```

Well-Known Binary (WKB) provides a portable, full-precision representation of spatial data as binary data (arrays of bytes). Examples of the WKB representations of spatial objects are:

- POINT(0 0)

  WKB: 0101000000000000000000F03F000000000000F03

- LINESTRING(0 0,1 1,1 2)

  WKB: 0102000000020000000000000000000000400000000000000040000000000000224000000000000002

Input and output of WKB is provided by the functions ST_AsBinary and ST_GeomFromWKB:

```
bytea WKB = ST_AsBinary(geometry);
geometry = ST_GeomFromWKB(bytea WKB, SRID);
```

⊠⊠⊠⊠ OGC ⊠⊠:

```
INSERT INTO geotable ( geom, name )
  VALUES ( ST_GeomFromWKB('\x0101000000000000000000f03f000000000000f03f', 312), 'A Place');
```

4.2 Geometry Data Type

PostGIS implements the OGC Simple Features model by defining a PostgreSQL data type called `geometry`. It represents all of the geometry subtypes by using an internal type code (see GeometryType and ST_GeometryType). This allows modelling spatial features as rows of tables defined with a column of type `geometry`.

The `geometry` data type is *opaque*, which means that all access is done via invoking functions on geometry values. Functions allow creating geometry objects, accessing or updating all internal fields, and compute new geometry values. PostGIS supports all the functions specified in the OGC *Simple feature access - Part 2: SQL option* (SFS) specification, as well many others. See Chapter 7 for the full list of functions.

> **Note**
> PostGIS follows the SFA standard by prefixing spatial functions with "ST_". This was intended to stand for "Spatial and Temporal", but the temporal part of the standard was never developed. Instead it can be interpreted as "Spatial Type".

OpenGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRID) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠.

To make querying geometry efficient PostGIS defines various kinds of spatial indexes, and spatial operators to use them. See Section 4.9 and Section 5.2 for details.

4.2.1 OpenGIS WKB ⊠ WKT

OGC SFA specifications initially supported only 2D geometries, and the geometry SRID is not included in the input/output representations. The OGC SFA specification 1.2.1 (which aligns with the ISO 19125 standard) adds support for 3D (ZYZ) and measured (XYM and XYZM) coordinates, but still does not include the SRID value.

Because of these limitations PostGIS defined extended EWKB and EWKT formats. They provide 3D (XYZ and XYM) and 4D (XYZM) coordinate support and include SRID information. Including all geometry information allows PostGIS to use EWKB as the format of record (e.g. in DUMP files).

EWKB and EWKT are used for the "canonical forms" of PostGIS data objects. For input, the canonical form for binary data is EWKB, and for text data either EWKB or EWKT is accepted. This allows geometry values to be created by casting a text value in either HEXEWKB or EWKT to a geometry value using `::geometry`. For output, the canonical form for binary is EWKB, and for text it is HEXEWKB (hex-encoded EWKB).

For example this statement creates a geometry by casting from an EWKT text value, and outputs it using the canonical form of HEXEWKB:

```
SELECT 'SRID=4;POINT(0 0)'::geometry;
  geometry
  ----------------------------------------------------
  01010000200400000000000000000000000000000000000000
```

PostGIS EWKT output has a few differences to OGC WKT:

- For 3DZ geometries the Z qualifier is omitted:

  POINT(0 0)

  POINT(0 0)

- For 3DM geometries the M qualifier is included:

  POINT(0 0)

  POINT(0 0)

- For 4D geometries the ZM qualifier is omitted:

  POINT(0 0)

  POINT(0 0)

EWKT avoids over-specifying dimensionality and the inconsistencies that can occur with the OGC/ISO format, such as:

- POINT(0 0)
- POINT(0 0)
- POINT(0 0)

Caution
PostGIS □□□ OGC □□□□□□□□□□□□□□□□ (□□□□□ WKB/WKT □□□□ EWKB/EWKT □□□□). □□□□□□□□□□□□□□□. □□ OGC □ PostGIS □□□□□□□□□□□□□□□□ □□□□□□□□□□. □□□□□□□□□□□□□□□□□□!

□□□□□□□□□□□□□□□□□□□□□□□□□ (WKT) □□□□□□□□□□□□□□□□□□□□:

- POINT(0 0 0) -- XYZ
- SRID=32632;POINT(0 0) -- SRID □□ XY
- POINTM(0 0 0) -- XYM
- POINT(0 0 0 0) -- XYZM
- SRID=4326;MULTIPOINTM(0 0 0,1 2 1) -- SRID □□ XYM

- MULTILINESTRING((0 0 0,1 1 0,1 2 1),(2 3 1,3 2 1,5 4 1))
- POLYGON((0 0 0,4 0 0,4 4 0,0 4 0,0 0 0),(1 1 0,2 1 0,2 2 0,1 2 0,1 1 0))
- MULTIPOLYGON(((0 0 0,4 0 0,4 4 0,0 4 0,0 0 0),(1 1 0,2 1 0,2 2 0,1 2 0,1 1 0)),((-1 -1 0,-1 -2 0,-2 -2 0,-2 -1 0,-1 -1 0)))
- GEOMETRYCOLLECTIONM(POINTM(2 3 9), LINESTRINGM(2 3 4, 3 4 5))
- MULTICURVE((0 0, 5 5), CIRCULARSTRING(4 0, 4 4, 8 4))
- POLYHEDRALSURFACE(((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)), ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)), ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)), ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)))
- TRIANGLE ((0 0, 0 9, 9 0, 0 0))
- TIN(((0 0 0, 0 0 1, 0 1 0, 0 0 0)), ((0 0 0, 0 1 0, 1 1 0, 0 0 0)))

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠.

```
bytea EWKB = ST_AsEWKB(geometry);
text EWKT = ST_AsEWKT(geometry);
geometry = ST_GeomFromEWKB(bytea EWKB);
geometry = ST_GeomFromEWKT(text EWKT);
```

⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
INSERT INTO geotable ( geom, name )
  VALUES ( ST_GeomFromEWKT('SRID=312;POINTM(-126.4 45.32 15)'), 'A Place' )
```

4.3 PostGIS ⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠ (⊠⊠” ⊠⊠” ⊠⊠, ⊠⊠” ⊠⊠/⊠⊠” ⊠” ⊠⊠/⊠⊠” ⊠⊠⊠⊠⊠) ” ⊠⊠” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠⊠⊠⊠ (球面) ⊠⊠⊠⊠⊠.

PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠, ⊠⊠, ⊠⊠, ⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.

PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (大圈; great circle arc) ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠, ⊠⊠, ⊠⊠, ⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (spheroidal shape) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Like the geometry data type, geography data is associated with a spatial reference system via a spatial reference system identifier (SRID). Any geodetic (long/lat based) spatial reference system defined in the `spatial_ref_sys` table can be used. (Prior to PostGIS 2.2, the geography type supported only WGS 84 geodetic (SRID:4326)). You can add your own custom geodetic spatial reference system as described in Section 4.5.2.

For all spatial reference systems the units returned by measurement functions (e.g. ST_Distance, ST_Length, ST_Perimeter, ST_Area) and for the distance argument of ST_DWithin are in meters.

4.3.1 ⊠⊠⊠⊠⊠⊠⊠⊠

You can create a table to store geography data using the CREATE TABLE SQL statement with a column of type `geography`. The following example creates a table with a geography column storing 2D LineStrings in the WGS84 geodetic coordinate system (SRID 4326):

```
CREATE TABLE global_points (
    id SERIAL PRIMARY KEY,
    name VARCHAR(64),
    location geography(POINT,4326)
  );
```

The geography type supports two optional type modifiers:

- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. POINT, LINESTRING, POLYGON, MULTIPOINT, MULTILINESTRING, MULTIPOLYGON. ⊠⊠⊠⊠⊠ Z, M ⊠ ZM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠'LINESTRINGM' ⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠'POINTZM' ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- the SRID modifier restricts the spatial reference system SRID to a particular number. If omitted, the SRID defaults to 4326 (WGS84 geodetic), and all calculations are performed using WGS84.

Examples of creating tables with geography columns:

- POINT: 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

  ```
  CREATE TABLE ptgeogwgs(gid serial PRIMARY KEY, geog geography(POINT) );
  ```

- POINT: 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

  ```
  CREATE TABLE ptgeognad83(gid serial PRIMARY KEY, geog geography(POINT,4269) );
  ```

- Create a table with 3D (XYZ) POINTs and an explicit SRID of 4326:

  ```
  CREATE TABLE ptzgeogwgs84(gid serial PRIMARY KEY, geog geography(POINTZ,4326) );
  ```

- Create a table with 2D LINESTRING geography with the default SRID 4326:

  ```
  CREATE TABLE lgeog(gid serial PRIMARY KEY, geog geography(LINESTRING) );
  ```

- POINT: 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

  ```
  CREATE TABLE lgeognad27(gid serial PRIMARY KEY, geog geography(POLYGON,4267) );
  ```

Geography fields are registered in the `geography_columns` system view. You can query the `geography_colum` view and see that the table is listed:

```
SELECT * FROM geography_columns;
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
-- Index the test table with a spherical index
CREATE INDEX global_points_gix ON global_points USING GIST ( location );
```

4.3.2 PostGIS □□□□□□

You can insert data into geography tables in the same way as geometry. Geometry data will autocast to the geography type if it has SRID 4326. The EWKT and EWKB formats can also be used to specify geography values.

```
-- Add some data into the test table
INSERT INTO global_points (name, location) VALUES ('Town', 'SRID=4326;POINT(-110 30)');
INSERT INTO global_points (name, location) VALUES ('Forest', 'SRID=4326;POINT(-109 29)');
INSERT INTO global_points (name, location) VALUES ('London', 'SRID=4326;POINT(0 49)');
```

Any geodetic (long/lat) spatial reference system listed in `spatial_ref_sys` table may be specified as a geography SRID. Non-geodetic coordinate systems raise an error if used.

```
-- NAD 83 lon/lat
SELECT 'SRID=4269;POINT(-123 34)'::geography;
                    geography
----------------------------------------------------
 0101000020AD1000000000000000C05EC00000000000004140
```

```
-- NAD27 lon/lat
SELECT 'SRID=4267;POINT(-123 34)'::geography;
                    geography
----------------------------------------------------
 0101000020AB1000000000000000C05EC00000000000004140
```

```
-- NAD83 UTM zone meters - gives an error since it is a meter-based planar projection
SELECT 'SRID=26910;POINT(-123 34)'::geography;

ERROR:  Only lon/lat coordinate systems are supported in geography.
```

□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□, □□□□□□ (□□□□□□□□□□□) □□□□□□□□.

```
-- A distance query using a 1000km tolerance
SELECT name FROM global_points WHERE ST_DWithin(location, 'SRID=4326;POINT(-110 29)':: ↩
    geography, 1000000);
```

□□□□□□□□□□□□□□□□ (LINESTRING(-122.33 47.606, 0.0 51.5)) □□□□□□ (POINT(-21.96 64.15)) □□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□.

□□□.

```
-- Distance calculation using GEOGRAPHY
SELECT ST_Distance('LINESTRING(-122.33 47.606, 0.0 51.5)'::geography, 'POINT(-21.96 64.15) ↩
    '::geography);
   st_distance
-----------------
 122235.23815667
```

□□□□ (Great Circle mapper) □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□” □ (degree)” □□□□□□□□□, □ □□□□□□□□□□□□□□□□□□□□□□□□□□□□” □” □□□□□□□□□□□□□□□□.

```
-- Distance calculation using GEOMETRY
SELECT ST_Distance('LINESTRING(-122.33 47.606, 0.0 51.5)'::geometry, 'POINT(-21.96 64.15) ↩
    '::geometry);
      st_distance
--------------------
 13.342271221453624
```

4.3.3 [illegible]

[illegible]/[illegible], [illegible]. [illegible], [illegible] CPU [illegible].

[illegible]. [illegible], [illegible], [illegible]?

- [illegible], [illegible], [illegible].
- [illegible], [illegible]. [illegible]/[illegible], [illegible].
- [illegible], [illegible], [illegible], [illegible]. [illegible]/[illegible].

[illegible] Section 13.11 [illegible]. [illegible] Section 13.4 [illegible].

4.3.4 [illegible] FAQ

1. [illegible]?

   [illegible], [illegible]. [illegible]. [illegible]. [illegible]'FALSE' [illegible]. [illegible]. [illegible].

2. [illegible]/[illegible]?

   [illegible]. [illegible] ([illegible]/[illegible]) [illegible], [illegible], [illegible].

3. [illegible]?

   [illegible]" [illegible]" [illegible] (great circle arc) [illegible]. [illegible]. [illegible]' [illegible]' [illegible]. [illegible], 180 [illegible].

4. [illegible]?

   [illegible]! [illegible]. [illegible]. [illegible], [illegible], [illegible] n [illegible] ([illegible] n [illegible]) [illegible]. [illegible], [illegible]" [illegible]" [illegible] (subquery) [illegible]. [illegible].

4.4 Geometry Validation

PostGIS is compliant with the Open Geospatial Consortium's (OGC) Simple Features specification. That standard defines the concepts of geometry being *simple* and *valid*. These definitions allow the

Simple Features geometry model to represent spatial objects in a consistent and unambiguous way that supports efficient computation. (Note: the OGC SF and SQL/MM have the same definitions for simple and valid.)

4.4.1 Simple Geometry

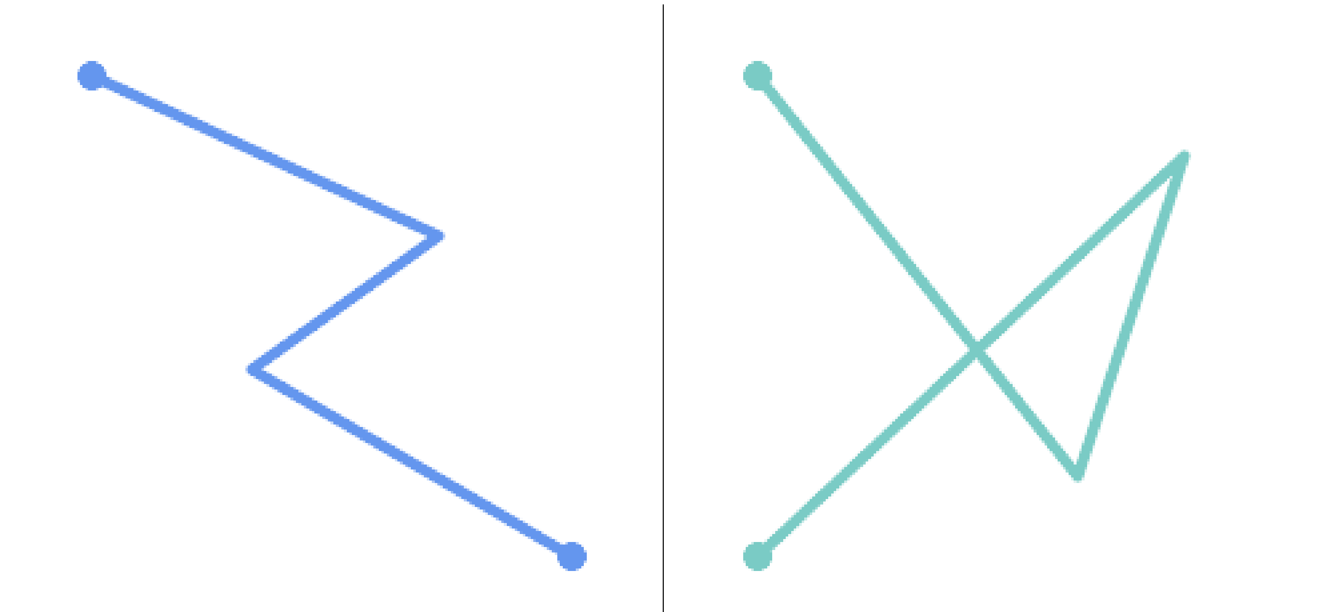
A *simple* geometry is one that has no anomalous geometric points, such as self intersection or self tangency.

`POINT` ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.

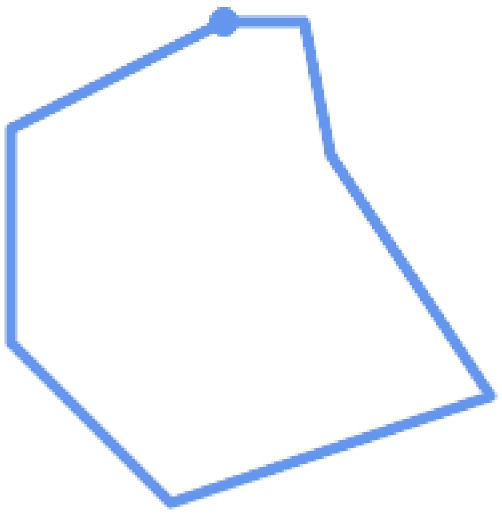
`MULTIPOINT` ⊠⊠⊠⊠⊠⊠ (`POINT`) ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.

A `LINESTRING` is *simple* if it does not pass through the same point twice, except for the endpoints. If the endpoints of a simple LineString are identical it is called *closed* and referred to as a Linear Ring.

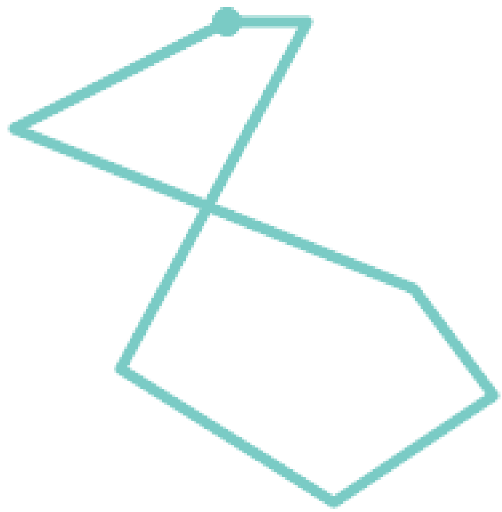
***(a)** and **(c)** are simple `LINESTRING`s. **(b)** and **(d)** are not simple. **(c)** is a closed Linear Ring.*



(a) ***(b)***



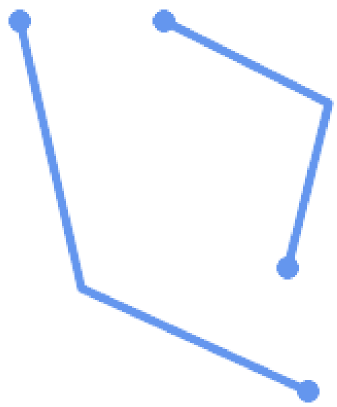
(c)



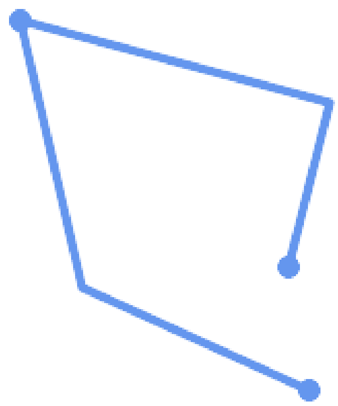
(d)

A `MULTILINESTRING` is *simple* only if all of its elements are simple and the only intersection between any two elements occurs at points that are on the boundaries of both elements.

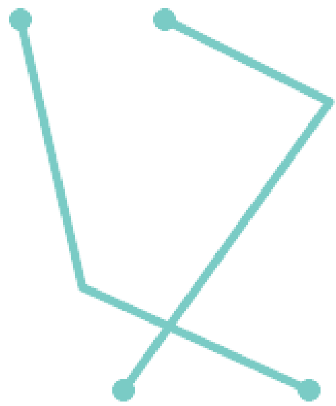
***(e)** and **(f)** are simple `MULTILINESTRING`s. **(g)** is not simple.*



(e)



(f)



(g)

`POLYGON`s are formed from linear rings, so valid polygonal geometry is always *simple*.

To test if a geometry is simple use the ST_IsSimple function:

```
SELECT
   ST_IsSimple('LINESTRING(0 0, 100 100)') AS straight,
   ST_IsSimple('LINESTRING(0 0, 100 100, 100 0, 0 100)') AS crossing;

 straight | crossing
----------+----------
 t        | f
```

Generally, PostGIS functions do not require geometric arguments to be simple. Simplicity is primarily used as a basis for defining geometric validity. It is also a requirement for some kinds of spatial data models (for example, linear networks often disallow lines that cross). Multipoint and linear geometry can be made simple using ST_UnaryUnion.

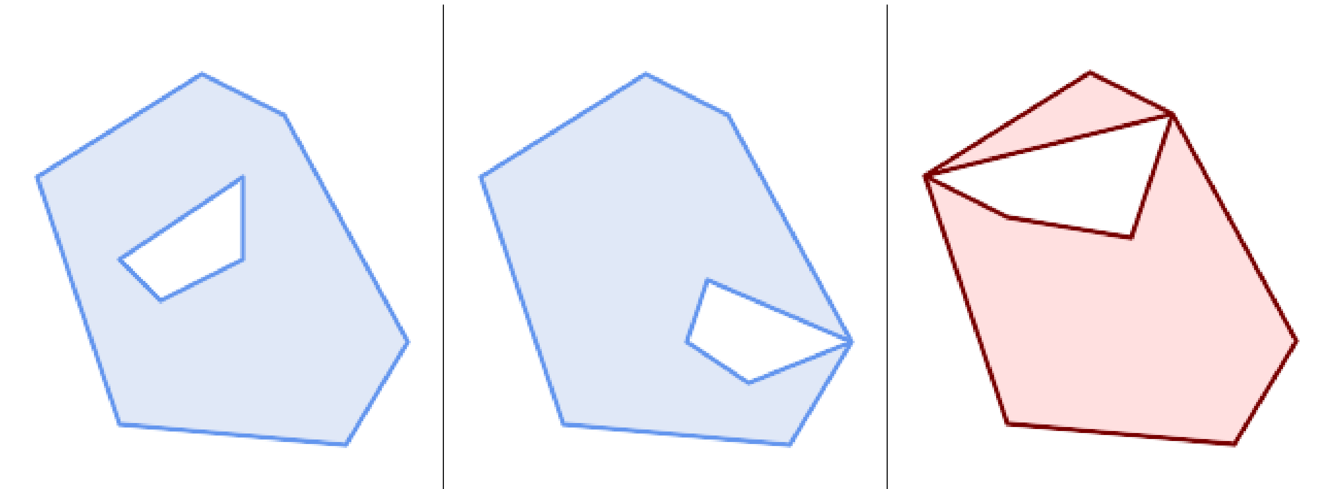
4.4.2 Valid Geometry

Geometry validity primarily applies to 2-dimensional geometries (`POLYGON`s and `MULTIPOLYGON`s) . Validity is defined by rules that allow polygonal geometry to model planar areas unambiguously.

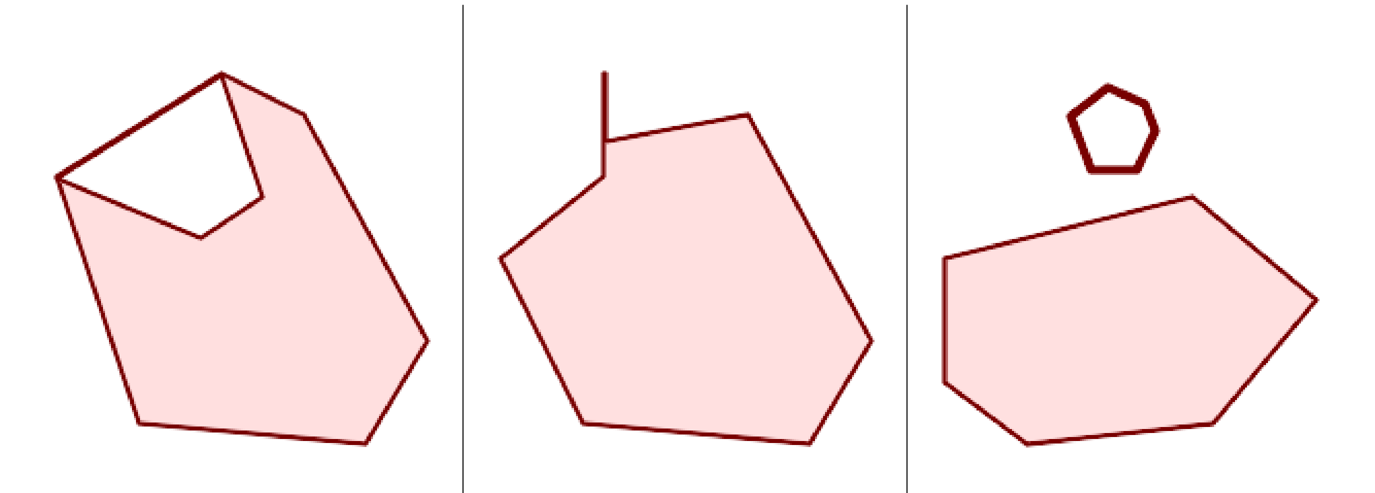
A `POLYGON` is *valid* if:

1. the polygon boundary rings (the exterior shell ring and interior hole rings) are *simple* (do not cross or self-touch). Because of this a polygon cannot have cut lines, spikes or loops. This implies that polygon holes must be represented as interior rings, rather than by the exterior ring self-touching (a so-called ”inverted hole”).
2. boundary rings do not cross
3. boundary rings may touch at points but only as a tangent (i.e. not in a line)
4. interior rings are contained in the exterior ring
5. the polygon interior is simply connected (i.e. the rings must not touch in a way that splits the polygon into more than one part)

(h) *and* ***(i)*** *are valid `POLYGON`s.* ***(j-m)*** *are invalid.* ***(j)*** *can be represented as a valid `MULTIPOLYGON`.*



(h) ***(i)*** ***(j)***

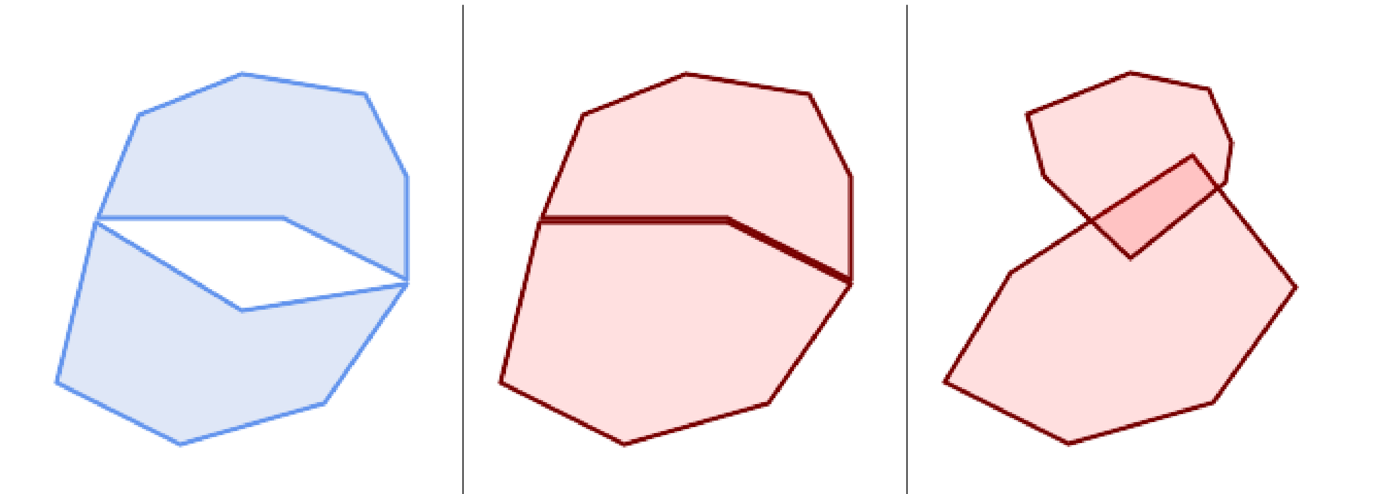


(k) ***(l)*** ***(m)***

A `MULTIPOLYGON` is *valid* if:

1. its element `POLYGON`s are valid
2. elements do not overlap (i.e. their interiors must not intersect)
3. elements touch only at points (i.e. not along a line)

(n) *is a valid `MULTIPOLYGON`.* ***(o)*** *and* ***(p)*** *are invalid.*



(n) ***(o)*** ***(p)***

These rules mean that valid polygonal geometry is also *simple*.

For linear geometry the only validity rule is that `LINESTRING`s must have at least two points and have non-zero length (or equivalently, have at least two distinct points.) Note that non-simple (self-intersecting) lines are valid.

```
SELECT
   ST_IsValid('LINESTRING(0 0, 1 1)') AS len_nonzero,
   ST_IsValid('LINESTRING(0 0, 0 0, 0 0)') AS len_zero,
   ST_IsValid('LINESTRING(10 10, 150 150, 180 50, 20 130)') AS self_int;
```

```
 len_nonzero | len_zero | self_int
-------------+----------+----------
 t           | f        | t
```

`POINT` and `MULTIPOINT` geometries have no validity rules.

4.4.3 Managing Validity

PostGIS allows creating and storing both valid and invalid Geometry. This allows invalid geometry to be detected and flagged or fixed. There are also situations where the OGC validity rules are stricter than desired (examples of this are zero-length linestrings and polygons with inverted holes.)

Many of the functions provided by PostGIS rely on the assumption that geometry arguments are valid. For example, it does not make sense to calculate the area of a polygon that has a hole defined outside of the polygon, or to construct a polygon from a non-simple boundary line. Assuming valid geometric inputs allows functions to operate more efficiently, since they do not need to check for topological correctness. (Notable exceptions are that zero-length lines and polygons with inversions are generally handled correctly.) Also, most PostGIS functions produce valid geometry output if the inputs are valid. This allows PostGIS functions to be chained together safely.

If you encounter unexpected error messages when calling PostGIS functions (such as "GEOS Intersection() threw an error!"), you should first confirm that the function arguments are valid. If they are not, then consider using one of the techniques below to ensure the data you are processing is valid.

> **Note**
> If a function reports an error with valid inputs, then you may have found an error in either PostGIS or one of the libraries it uses, and you should report this to the PostGIS project. The same is true if a PostGIS function returns an invalid geometry for valid input.

To test if a geometry is valid use the ST_IsValid function:

```
SELECT ST_IsValid('POLYGON ((20 180, 180 180, 180 20, 20 20, 20 180))');
-----------------
 t
```

Information about the nature and location of an geometry invalidity are provided by the ST_IsValidDetail function:

```
SELECT valid, reason, ST_AsText(location) AS location
    FROM ST_IsValidDetail('POLYGON ((20 20, 120 190, 50 190, 170 50, 20 20))') AS t;

 valid |      reason       |                  location
-------+-------------------+---------------------------------------------
 f     | Self-intersection | POINT(91.51162790697674 141.56976744186045)
```

In some situations it is desirable to correct invalid geometry automatically. Use the ST_MakeValid function to do this. (`ST_MakeValid` is a case of a spatial function that *does* allow invalid input!)

By default, PostGIS does not check for validity when loading geometry, because validity testing can take a lot of CPU time for complex geometries. If you do not trust your data sources, you can enforce a validity check on your tables by adding a check constraint:

```
ALTER TABLE mytable
  ADD CONSTRAINT geometry_valid_check
        CHECK (ST_IsValid(geom));
```

4.5 SPATIAL_REF_SYS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

A Spatial Reference System (SRS) (also called a Coordinate Reference System (CRS)) defines how geometry is referenced to locations on the Earth's surface. There are three types of SRS:

- A **geodetic** SRS uses angular coordinates (longitude and latitude) which map directly to the surface of the earth.
- A **projected** SRS uses a mathematical projection transformation to "flatten" the surface of the spheroidal earth onto a plane. It assigns location coordinates in a way that allows direct measurement of quantities such as distance, area, and angle. The coordinate system is Cartesian, which means it has a defined origin point and two perpendicular axes (usually oriented North and East). Each projected SRS uses a stated length unit (usually metres or feet). A projected SRS may be limited in its area of applicability to avoid distortion and fit within the defined coordinate bounds.
- A **local** SRS is a Cartesian coordinate system which is not referenced to the earth's surface. In PostGIS this is specified by a SRID value of 0.

There are many different spatial reference systems in use. Common SRSes are standardized in the European Petroleum Survey Group EPSG database. For convenience PostGIS (and many other spatial systems) refers to SRS definitions using an integer identifier called a SRID.

A geometry is associated with a Spatial Reference System by its SRID value, which is accessed by ST_SRID. The SRID for a geometry can be assigned using ST_SetSRID. Some geometry constructor functions allow supplying a SRID (such as ST_Point and ST_MakeEnvelope). The EWKT format supports SRIDs with the `SRID=n;` prefix.

Spatial functions processing pairs of geometries (such as overlay and relationship functions) require that the input geometries are in the same spatial reference system (have the same SRID). Geometry data can be transformed into a different spatial reference system using ST_Transform and ST_TransformPipe Geometry returned from functions has the same SRS as the input geometries.

4.5.1 SPATIAL_REF_SYS Table

The `SPATIAL_REF_SYS` table used by PostGIS is an OGC-compliant database table that defines the available spatial reference systems. It holds the numeric SRIDs and textual descriptions of the coordinate systems.

`SPATIAL_REF_SYS` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
CREATE TABLE spatial_ref_sys (
  srid       INTEGER NOT NULL PRIMARY KEY,
  auth_name  VARCHAR(256),
  auth_srid  INTEGER,
  srtext     VARCHAR(2048),
  proj4text  VARCHAR(2048)
)
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

srid ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRS) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

auth_name ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠"EPSG" ⊠⊠⊠⊠ `AUTH_NAME` ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

auth_srid The ID of the Spatial Reference System as defined by the Authority cited in the `auth_name`. In the case of EPSG, this is the EPSG code.

srtext ⊠⊠⊠⊠⊠⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ WKT SRS ⊠⊠⊠⊠⊠⊠⊠⊠:

```
PROJCS["NAD83 / UTM Zone 10N",
  GEOGCS["NAD83",
        DATUM["North_American_Datum_1983",
          SPHEROID["GRS 1980",6378137,298.257222101]
        ],
        PRIMEM["Greenwich",0],
        UNIT["degree",0.0174532925199433]
  ],
  PROJECTION["Transverse_Mercator"],
  PARAMETER["latitude_of_origin",0],
  PARAMETER["central_meridian",-123],
  PARAMETER["scale_factor",0.9996],
  PARAMETER["false_easting",500000],
  PARAMETER["false_northing",0],
  UNIT["metre",1]
]
```

For a discussion of SRS WKT, see the OGC standard Well-known text representation of coordinate reference systems.

proj4text PostGIS □□□□□□□□□□□□□□□ proj4 □□□□□□□□□□□□. PROJ4TEXT □□□□ SRID □□□□□□ proj4 □□□□□□□□□□□□□□□. □□□□□□□□□:

```
+proj=utm +zone=10 +ellps=clrk66 +datum=NAD27 +units=m
```

□□□□□□□□□□□ http://trac.osgeo.org/proj/ □□□ proj4 □□□□□□□□□□□□. `spatial_ref_sys.sql` □□□□□ EPSG □□□□□ SRTEXT □ PROJ4TEXT □□□□□□□□□□.

When retrieving spatial reference system definitions for use in transformations, PostGIS uses fhe following strategy:

- If `auth_name` and `auth_srid` are present (non-NULL) use the PROJ SRS based on those entries (if one exists).
- If `srtext` is present create a SRS using it, if possible.
- If `proj4text` is present create a SRS using it, if possible.

4.5.2 SPATIAL_REF_SYS □□□□□□□□□□□□□

PostGIS □ SPATIAL_REF_SYS □□□□ proj □□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□ 3000 □□□, □□□□□ proj4 □□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

□□ SPATIAL_REF_SYS □□□□□□□□□□□□□□□□□□□□□□ http://spatialreference.org/ □□□□□□□□ □□□□□□.

□□□□□□□□□□□□□□□□□□□□ 4326 - WGS 84 Long Lat, 4269 - NAD 83 Long Lat, 3395 - WGS 84 World Mercator, 2163 - US National Atlas Equal Area, □□□ NAD 83 □ WGS 84 UTM □ (帯; zone) □ □□□□□□□□□□□□□□. □ UTM □□□□□□□□□□□□□□□□□□□□□□□□□□, 6 □□□□□□□□□□□□ □□□□□.

□□□□□□□□□□□□□□□□□□□ (□□□□□□□□□□) □□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□ □□□□□□□□□ SPATIAL_REF_SYS □□□□□□□□□□□, □□□□□□□ ESRI □□□□□□□□□□□□□□□□□ □□□□□□□ spatialreference.org □□□□□□□□□□□.

You can even define non-Earth-based coordinate systems, such as Mars 2000 This Mars coordinate system is non-planar (it's in degrees spheroidal), but you can use it with the `geography` type to obtain length and proximity measurements in meters instead of degrees.

Here is an example of loading a custom coordinate system using an unassigned SRID and the PROJ definition for a US-centric Lambert Conformal projection:

```
INSERT INTO spatial_ref_sys (srid, proj4text)
VALUES ( 990000,
  '+proj=lcc  +lon_0=-95 +lat_0=25 +lat_1=25 +lat_2=25 +x_0=0 +y_0=0 +datum=WGS84 +units=m  ←
      +no_defs'
);
```

4.6 ⊠⊠⊠⊠⊠⊠⊠

4.6.1 ⊠⊠⊠⊠⊠⊠⊠

You can create a table to store geometry data using the CREATE TABLE SQL statement with a column of type `geometry`. The following example creates a table with a geometry column storing 2D (XY) LineStrings in the BC-Albers coordinate system (SRID 3005):

```
CREATE TABLE roads (
    id SERIAL PRIMARY KEY,
    name VARCHAR(64),
    geom geometry(LINESTRING,3005)
  );
```

The `geometry` type supports two optional **type modifiers**:

- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. POINT, LINESTRING, POLYGON, MULTIPOINT, MULTILINESTRING, MULTIPOLYGON. ⊠⊠⊠⊠⊠⊠ Z, M ⊠ ZM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠, ⊠⊠⊠⊠⊠’LINESTRINGM’ ⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠’POINTZM’ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- the **SRID modifier** restricts the spatial reference system SRID to a particular number. If omitted, the SRID defaults to 0.

Examples of creating tables with geometry columns:

- Create a table holding any kind of geometry with the default SRID:

```
CREATE TABLE geoms(gid serial PRIMARY KEY, geom geometry );
```

- Create a table with 2D POINT geometry with the default SRID:

```
CREATE TABLE pts(gid serial PRIMARY KEY, geom geometry(POINT) );
```

- Create a table with 3D (XYZ) POINTs and an explicit SRID of 3005:

```
CREATE TABLE pts(gid serial PRIMARY KEY, geom geometry(POINTZ,3005) );
```

- Create a table with 4D (XYZM) LINESTRING geometry with the default SRID:

```
CREATE TABLE lines(gid serial PRIMARY KEY, geom geometry(LINESTRINGZM) );
```

- Create a table with 2D POLYGON geometry with the SRID 4267 (NAD 1927 long lat):

```
CREATE TABLE polys(gid serial PRIMARY KEY, geom geometry(POLYGON,4267) );
```

It is possible to have more than one geometry column in a table. This can be specified when the table is created, or a column can be added using the ALTER TABLE SQL statement. This example adds a column that can hold 3D LineStrings:

```
ALTER TABLE roads ADD COLUMN geom2 geometry(LINESTRINGZ,4326);
```

4.6.2 The GEOMETRY_COLUMNS VIEW

OpenGIS □"SQL □□□□□□□□ (Simple Features Specification for SQL)" □□□ GIS □□□□, □□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ OpenGIS □□□□□□□□□□□□□□□□□□□□□.

```
\d geometry_columns
```

```
View "public.geometry_columns"
      Column       |           Type           | Modifiers
-------------------+------------------------+-----------
 f_table_catalog   | character varying(256) |
 f_table_schema    | character varying(256) |
 f_table_name      | character varying(256) |
 f_geometry_column | character varying(256) |
 coord_dimension   | integer                |
 srid              | integer                |
 type              | character varying(30)  |
```

□□□□□□□□□□□□□□□□□□:

f_table_catalog, f_table_schema, f_table_name □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. " □□□□□" □" □□□" □□□□□□□□□□□□□□□□□□□. " □□□□□" □□□□□□ PostgreSQL □□□□□□□□□□□□□□□□□□□□□□□□□□. " □□□" □□□ PostgreSQL □□□□□□□□□□□□ (□□□□ public □□□).

f_geometry_column □□□□□□□□□□□□□□□□□□□□□□□□□□.

coord_dimension □□□□□□□ (2, 3, □□ 4 □□) □□□.

srid □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ ID □, SPATIAL_REF_SYS □□□□□□□□□ (foreign key) □□□.

type □□□□□□□□□□□. □□□. POINT, LINESTRING, POLYGON, MULTIPOINT, MULTILINESTRING, MULTIPOLYGON, GEOMETRYCOLLECTION □□□□□□□□□ XYM □□□ POINTM, LINESTRINGM, POLYGONM, MULTIPOINTM, MULTILINESTRINGM, MULTIPOLYGONM, GEOMETRYCOLLECTIONM. □□□□□□□□□□□□□□□□□□"GEOMETRY" □□□□□□□□□□.

4.6.3 geometry_columns □□□□□□□□□□□□□

AddGeometryColumn() □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, SQL □□□□□□□□□□ (bulk insert) □□□□□□□. □□□□, □□□□□□□□□□□□□□ geometry_columns □□□□□□□□□□□□□□□□. PostGIS 2.0 □□□□□□□□, □□□□□□ typmod □□.

```
-- Lets say you have a view created like this
CREATE VIEW public.vwmytablemercator AS
        SELECT gid, ST_Transform(geom, 3395) As geom, f_name
        FROM public.mytable;

-- For it to register correctly
-- You need to cast the geometry
--
DROP VIEW public.vwmytablemercator;
CREATE VIEW  public.vwmytablemercator AS
        SELECT gid, ST_Transform(geom, 3395)::geometry(Geometry, 3395) As geom, f_name
        FROM public.mytable;
```

```
-- If you know the geometry type for sure is a 2D POLYGON then you could do
DROP VIEW public.vwmytablemercator;
CREATE VIEW  public.vwmytablemercator AS
        SELECT gid, ST_Transform(geom,3395)::geometry(Polygon, 3395) As geom, f_name
        FROM public.mytable;
```

```
--Lets say you created a derivative table by doing a bulk insert
SELECT poi.gid, poi.geom, citybounds.city_name
INTO myschema.my_special_pois
FROM poi INNER JOIN citybounds ON ST_Intersects(citybounds.geom, poi.geom);

-- Create 2D index on new table
CREATE INDEX idx_myschema_myspecialpois_geom_gist
  ON myschema.my_special_pois USING gist(geom);

-- If your points are 3D points or 3M points,
-- then you might want to create an nd index instead of a 2D index
CREATE INDEX my_special_pois_geom_gist_nd
        ON my_special_pois USING gist(geom gist_geometry_ops_nd);

-- To manually register this new table's geometry column in geometry_columns.
-- Note it will also change the underlying structure of the table to
-- to make the column typmod based.
SELECT populate_geometry_columns('myschema.my_special_pois'::regclass);

-- If you are using PostGIS 2.0 and for whatever reason, you
-- you need the constraint based definition behavior
-- (such as case of inherited tables where all children do not have the same type and srid)
-- set optional use_typmod argument to false
SELECT populate_geometry_columns('myschema.my_special_pois'::regclass, false);
```

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```
CREATE TABLE pois_ny(gid SERIAL PRIMARY KEY, poi_name text, cat text, geom geometry(POINT ,4326));
SELECT AddGeometryColumn('pois_ny', 'geom_2160', 2160, 'POINT', 2, false);
```

PSQL ⊠⊠⊠⊠⊠⊠⊠

```
\d pois_ny;
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ typmod, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
Table "public.pois_ny"
  Column   |         Type          |                       Modifiers

-----------+-----------------------+------------------------------------------------------
 gid       | integer               | not null default nextval('pois_ny_gid_seq'::regclass)
 poi_name  | text                  |
 cat       | character varying(20) |
 geom      | geometry(Point,4326)  |
 geom_2160 | geometry              |
Indexes:
    "pois_ny_pkey" PRIMARY KEY, btree (gid)
Check constraints:
    "enforce_dims_geom_2160" CHECK (st_ndims(geom_2160) = 2)
    "enforce_geotype_geom_2160" CHECK (geometrytype(geom_2160) = 'POINT'::text
        OR geom_2160 IS NULL)
    "enforce_srid_geom_2160" CHECK (st_srid(geom_2160) = 2160)
```

□□ geometry_columns □□□□□□□□□□□□□.

```
SELECT f_table_name, f_geometry_column, srid, type
        FROM geometry_columns
        WHERE f_table_name = 'pois_ny';
```

```
f_table_name | f_geometry_column | srid | type
-------------+-------------------+------+-------
pois_ny      | geom              | 4326 | POINT
pois_ny      | geom_2160         | 2160 | POINT
```

□□□ -- □□□□□□□□□□□□□□

```
CREATE VIEW vw_pois_ny_parks AS
SELECT *
  FROM pois_ny
  WHERE cat='park';

SELECT f_table_name, f_geometry_column, srid, type
        FROM geometry_columns
        WHERE f_table_name = 'vw_pois_ny_parks';
```

typmod □□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□.

```
f_table_name   | f_geometry_column | srid |   type
------------------+-------------------+------+----------
 vw_pois_ny_parks | geom              | 4326 | POINT
 vw_pois_ny_parks | geom_2160         |    0 | GEOMETRY
```

PostGIS □□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□:

```
DROP VIEW vw_pois_ny_parks;
CREATE VIEW vw_pois_ny_parks AS
SELECT gid, poi_name, cat,
  geom,
  geom_2160::geometry(POINT,2160) As geom_2160
  FROM pois_ny
  WHERE cat = 'park';
SELECT f_table_name, f_geometry_column, srid, type
        FROM geometry_columns
        WHERE f_table_name = 'vw_pois_ny_parks';
```

```
f_table_name   | f_geometry_column | srid | type
------------------+-------------------+------+-------
 vw_pois_ny_parks | geom              | 4326 | POINT
 vw_pois_ny_parks | geom_2160         | 2160 | POINT
```

4.7 GIS (□□) □□□□□

□□□□□□□□□□□□, □□□□□□□□□□□ GIS □□□□□□□□□□□□□□□□□. □□, □□□□ SQL □□□□□□□□□ shapefile □□/□□□□□□□□□□□□□□□ PostGIS/PostgreSQL □□□□□□□□ □□□□□□□□□□□.

4.7.1 SQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

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⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠ roads.sql) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
BEGIN;
INSERT INTO roads (road_id, roads_geom, road_name)
  VALUES (1,'LINESTRING(191232 243118,191108 243242)','Jeff Rd');
INSERT INTO roads (road_id, roads_geom, road_name)
  VALUES (2,'LINESTRING(189141 244158,189265 244817)','Geordie Rd');
INSERT INTO roads (road_id, roads_geom, road_name)
  VALUES (3,'LINESTRING(192783 228138,192612 229814)','Paul St');
INSERT INTO roads (road_id, roads_geom, road_name)
  VALUES (4,'LINESTRING(189412 252431,189631 259122)','Graeme Ave');
INSERT INTO roads (road_id, roads_geom, road_name)
  VALUES (5,'LINESTRING(190131 224148,190871 228134)','Phil Tce');
INSERT INTO roads (road_id, roads_geom, road_name)
  VALUES (6,'LINESTRING(198231 263418,198213 268322)','Dave Cres');
COMMIT;
```

”psql” SQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
psql -d [database] -f roads.sql
```

4.7.2 shp2pgsql: ESRI shapefile ⊠⊠⊠⊠⊠⊠⊠

shp2pgsql ⊠⊠⊠⊠⊠⊠⊠ ESRI shapefile ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, PostGIS/PostgreSQL ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (command line) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

shp2pgsql ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ shp2pgsql-gui ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠. shp2pgsql-gui ⊠ pgAdmin III ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

c|a|d|p -- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠**:**

-c ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ shapefile ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-a ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ shapefile ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-d ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (drop) ⊠⊠⊠ shapefile ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-p ⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-? ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ” ⊠⊠ (dump)” ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ -a, -c ⊠ -d ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠” ⊠⊠” SQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-s [<FROM_SRID>:]<SRID> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠. ⊠⊠ shapefile ⊠⊠⊠⊠ FROM_SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. FROM_SRID ⊠ -D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-k ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠, ⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. shapefile ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-i DBF ⊠⊠⊠⊠⊠ 64 ⊠⊠ bigint ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ 32 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 64 ⊠⊠ bigint ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-I ⊠⊠⊠⊠ GiST ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-m ”-m ⊠⊠⊠” ⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠ 10 ⊠⊠ DBF ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠:

```
COLUMNNAME DBFFIELD1
AVERYLONGCOLUMNNAME DBFFIELD2
```

-S ⊠⊠ (multi) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-t <dimensionality> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠: 2D, 3DZ, 3DM, 4D

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-w WKB ⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ ⊠.

-e ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ” ⊠⊠” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ -D ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-W <encoding> ⊠⊠⊠⊠⊠⊠ (DBF ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, DBF ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠ UTF8 ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠ `SET CLIENT_ENCODING to UTF8` ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ UTF8 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.

-N <policy> NULL ⊠⊠⊠⊠⊠⊠⊠ -- insert*(⊠⊠⊠⊠⊠⊠⊠), skip(⊠⊠⊠⊠⊠), abort(⊠⊠)

-n DBF ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ shapefile ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ DBF ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ shapefile ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-G (⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠ WGS84 ⊠⊠⊠⊠ (SRID=4326) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-T <tablespace> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. -X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-X <tablespace> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (primary key) ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠, -I ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GiST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-Z When used, this flag will prevent the generation of `ANALYZE` statements. Without the -Z flag (default behavior), the `ANALYZE` statements will be generated.

⊠⊠⊠:

```
# shp2pgsql -c -D -s 4269 -i -I shaperoads.shp myschema.roadstable
> roads.sql
# psql -d roadsdb -f roads.sql
```

UNIX ⊠⊠⊠⊠ (pipe) ⊠⊠:

```
# shp2pgsql shaperoads.shp myschema.roadstable | psql -d roadsdb
```

4.8 □□□□□□□

SQL □□ shapefile □□/□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. SQL □□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

4.8.1 SQL □□□□□□□□□□□□

□□□□□□□□□□□□□□□□□□□□□□□□□ SQL □□ (select) □□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□:

```
db=# SELECT road_id, ST_AsText(road_geom) AS geom, road_name FROM roads;

road_id | geom                                    | road_name
--------+-----------------------------------------+-----------
       1 | LINESTRING(191232 243118,191108 243242) | Jeff Rd
       2 | LINESTRING(189141 244158,189265 244817) | Geordie Rd
       3 | LINESTRING(192783 228138,192612 229814) | Paul St
       4 | LINESTRING(189412 252431,189631 259122) | Graeme Ave
       5 | LINESTRING(190131 224148,190871 228134) | Phil Tce
       6 | LINESTRING(198231 263418,198213 268322) | Dave Cres
       7 | LINESTRING(218421 284121,224123 241231) | Chris Way
(6 rows)
```

□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□, □□□□ □□□□□□□□□□□□□□ SQL □□□□□□□□. □□□□□□□, □□□□□□□□□□□□□□□□.

ST_Intersects This function tells whether two geometries share any space.

= □□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□, 'POLYGON((0 0,1 1,1 0,0 0))' □'POLYGON((0 0,1 1,1 0,0 0))' □□□□□□□□□□ (□□□□□).

□□□□, □□□□□□□□□□□□□□□. SQL □□□□□□□□□□□□□□□□, "ST_GeomFromText()" □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□ □ 312 □□□. □□□□□□□□□:

```
SELECT road_id, road_name
  FROM roads
  WHERE roads_geom='SRID=312;LINESTRING(191232 243118,191108 243242)'::geometry;
```

□□□□□□□□□□□□□□□□□□"ROADS_GEOM" □□□□□□□□□□□□□□□□□□□.

To check whether some of the roads passes in the area defined by a polygon:

```
SELECT road_id, road_name
FROM roads
WHERE ST_Intersects(roads_geom, 'SRID=312;POLYGON((...))');
```

□□" □□□□ (map frame)" □□□□□□□□□□□□□□□□□□□□□" □□□□□ (frame-based)" □□□□□□□□.

"&&" □□□□□□, □□□□□ BOX3D □□□□□□□□□□□□□. □□□□□□□□□□□□, □□□□□ □□□□□□□□□□□□□□.

Using a "BOX3D" object for the frame, such a query looks like this:

```
SELECT ST_AsText(roads_geom) AS geom
FROM roads
WHERE
  roads_geom && ST_MakeEnvelope(191232, 243117,191232, 243119,312);
```

□□□□□□□□□□□□□□□□□□□□ SRID 312 □□□□□□□□□□□□□.

4.8.2 □□□□□□□

pgsql2shp □□□□□□□□□□□□□□□□□□□□□□ (□□□□□□□□□□□) □□□□ shapefile □□□□□□. □□□□□□□□□□□□□:

```
pgsql2shp [<options
>] <database
> [<schema
>.]<table>
```

```
pgsql2shp [<options
>] <database
> <query>
```

□□□□□□□□□□□□□□□□:

-f <filename> □□□□□□□□□□□□□□□□□.

-h <host> □□□□□□□□□□□□□□□□□□□□.

-p <port> □□□□□□□□□□□□□□□□□□□□□□□□□□□□.

-P <password> □□□□□□□□□□□□□□□□□□□□□□□□□□.

-u <user> □□□□□□□□□□□□□□□□□□□□□□□□□□□□.

-g <geometry column> □□□□□□□□□□□□□□□□□, shapefile □□□□□□□□□□□□□□□□□□.

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The B-tree index method commonly used for attribute data is not very useful for spatial data, since it only supports storing and querying data in a single dimension. Data such as geometry (which has 2 or more dimensions) requires an index method that supports range query across all the data dimensions. One of the key advantages of PostgreSQL for spatial data handling is that it offers several kinds of index methods which work well for multi-dimensional data: GiST, BRIN and SP-GiST indexes.

- GiST(Generalized Search Tree) □□□□□□□□□” □□□□□□□”, ” □□□□□”, ” □□□□□□□” □□□□ □□ GIS □□□□□□□□□□□□□□□□□□□□□□□□□□□□□. PostGIS □ GiST □□□ GIS □□□□□□□□ □□□□□□□, □□□□□□□□□□□□□ R-Tree □□□□□□□□□□□.
- **BRIN (Block Range Index)** indexes operate by summarizing the spatial extent of ranges of table records. Search is done via a scan of the ranges. BRIN is only appropriate for use for some kinds of data (spatially sorted, with infrequent or no update). But it provides much faster index create time, and much smaller index size.

- **SP-GiST (Space-Partitioned Generalized Search Tree)** is a generic index method that supports partitioned search trees such as quad-trees, k-d trees, and radix trees (tries).

Spatial indexes store only the bounding box of geometries. Spatial queries use the index as a **primary filter** to quickly determine a set of geometries potentially matching the query condition. Most spatial queries require a **secondary filter** that uses a spatial predicate function to test a more specific spatial condition. For more information on queying with spatial predicates see Section 5.2.

See also the PostGIS Workshop section on spatial indexes, and the PostgreSQL manual.

4.9.1 GiST ⊠⊠⊠

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```
CREATE INDEX [indexname] ON [tablename] USING GIST ( [geometryfield] );
```

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```
CREATE INDEX [indexname] ON [tablename] USING GIST ([geometryfield] gist_geometry_ops_nd);
```

Building a spatial index is a computationally intensive exercise. It also blocks write access to your table for the time it creates, so on a production system you may want to do in in a slower CONCURRENTLY-aware way:

```
CREATE INDEX CONCURRENTLY [indexname] ON [tablename] USING GIST ( [geometryfield] );
```

After building an index, it is sometimes helpful to force PostgreSQL to collect table statistics, which are used to optimize query plans:

```
VACUUM ANALYZE [table_name] [(column_name)];
```

4.9.2 GiST ⊠⊠⊠

BRIN stands for ”Block Range Index”. It is a general-purpose index method introduced in PostgreSQL 9.5. BRIN is a *lossy* index method, meaning that a secondary check is required to confirm that a record matches a given search condition (which is the case for all provided spatial indexes). It provides much faster index creation and much smaller index size, with reasonable read performance. Its primary purpose is to support indexing very large tables on columns which have a correlation with their physical location within the table. In addition to spatial indexing, BRIN can speed up searches on various kinds of attribute data structures (integer, arrays etc). For more information see the PostgreSQL manual.

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A BRIN index stores the bounding box enclosing all the geometries contained in the rows in a contiguous set of table blocks, called a *block range*. When executing a query using the index the block ranges are scanned to find the ones that intersect the query extent. This is efficient only if the data is physically ordered so that the bounding boxes for block ranges have minimal overlap (and ideally are mutually exclusive). The resulting index is very small in size, but is typically less performant for read than a GiST index over the same data.

Building a BRIN index is much less CPU-intensive than building a GiST index. It's common to find that a BRIN index is ten times faster to build than a GiST index over the same data. And because a BRIN index stores only one bounding box for each range of table blocks, it's common to use up to a thousand times less disk space than a GiST index.

You can choose the number of blocks to summarize in a range. If you decrease this number, the index will be bigger but will probably provide better performance.

For BRIN to be effective, the table data should be stored in a physical order which minimizes the amount of block extent overlap. It may be that the data is already sorted appropriately (for instance, if it is loaded from another dataset that is already sorted in spatial order). Otherwise, this can be accomplished by sorting the data by a one-dimensional spatial key. One way to do this is to create a new table sorted by the geometry values (which in recent PostGIS versions uses an efficient Hilbert curve ordering):

```
CREATE TABLE table_sorted AS
   SELECT * FROM table  ORDER BY geom;
```

Alternatively, data can be sorted in-place by using a GeoHash as a (temporary) index, and clustering on that index:

```
CREATE INDEX idx_temp_geohash ON table
    USING btree (ST_GeoHash( ST_Transform( geom, 4326 ), 20));
CLUSTER table USING idx_temp_geohash;
```

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```
CREATE INDEX [indexname] ON [tablename] USING BRIN ( [geome_col] );
```

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```
CREATE INDEX [indexname] ON [tablename]
    USING BRIN ([geome_col] brin_geometry_inclusion_ops_3d);
```

You can also get a 4D-dimensional index using the 4D operator class:

```
CREATE INDEX [indexname] ON [tablename]
    USING BRIN ([geome_col] brin_geometry_inclusion_ops_4d);
```

The above commands use the default number of blocks in a range, which is 128. To specify the number of blocks to summarise in a range, use this syntax

```
CREATE INDEX [indexname] ON [tablename]
    USING BRIN ( [geome_col] ) WITH (pages_per_range = [number]);
```

Keep in mind that a BRIN index only stores one index entry for a large number of rows. If your table stores geometries with a mixed number of dimensions, it's likely that the resulting index will have poor performance. You can avoid this performance penalty by choosing the operator class with the least number of dimensions of the stored geometries

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```
CREATE INDEX [indexname] ON [tablename] USING BRIN ( [geog_col] );
```

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Currently, only "inclusion support" is provided, meaning that just the &&, ~ and @ operators can be used for the 2D cases (for both `geometry` and `geography`), and just the &&& operator for 3D geometries. There is currently no support for kNN searches.

An important difference between BRIN and other index types is that the database does not maintain the index dynamically. Changes to spatial data in the table are simply appended to the end of the index. This will cause index search performance to degrade over time. The index can be updated by performing a `VACUUM`, or by using a special function `brin_summarize_new_values(regclass)`. For this reason BRIN may be most appropriate for use with data that is read-only, or only rarely changing. For more information refer to the manual.

To summarize using BRIN for spatial data:

- Index build time is very fast, and index size is very small.
- Index query time is slower than GiST, but can still be very acceptable.
- Requires table data to be sorted in a spatial ordering.
- Requires manual index maintenance.
- Most appropriate for very large tables, with low or no overlap (e.g. points), which are static or change infrequently.
- More effective for queries which return relatively large numbers of data records.

4.9.3 GiST ⊠⊠⊠

SP-GiST stands for "Space-Partitioned Generalized Search Tree" and is a generic form of indexing for multi-dimensional data types that supports partitioned search trees, such as quad-trees, k-d trees, and radix trees (tries). The common feature of these data structures is that they repeatedly divide the search space into partitions that need not be of equal size. In addition to spatial indexing, SP-GiST is used to speed up searches on many kinds of data, such as phone routing, ip routing, substring search, etc. For more information see the PostgreSQL manual.

As it is the case for GiST indexes, SP-GiST indexes are lossy, in the sense that they store the bounding box enclosing spatial objects. SP-GiST indexes can be considered as an alternative to GiST indexes.

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```
CREATE INDEX [indexname] ON [tablename] USING SPGIST ( [geometryfield] );
```

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```
CREATE INDEX [indexname] ON [tablename] USING SPGIST ([geometryfield]  ↩
    spgist_geometry_ops_3d);
```

Building a spatial index is a computationally intensive operation. It also blocks write access to your table for the time it creates, so on a production system you may want to do in in a slower CONCURRENTLY-aware way:

```
CREATE INDEX CONCURRENTLY [indexname] ON [tablename] USING SPGIST ( [geometryfield] );
```

After building an index, it is sometimes helpful to force PostgreSQL to collect table statistics, which are used to optimize query plans:

```
VACUUM ANALYZE [table_name] [(column_name)];
```

An SP-GiST index can accelerate queries involving the following operators:

- <<, &<, &>, >>, <<|, &<|, |&>, |>>, &&, @>, <@, and ~=, for 2-dimensional indexes,
- &/&, ~==, @>>, and <<@, for 3-dimensional indexes.

There is no support for kNN searches at the moment.

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- Examine the query plan and check your query actually computes the thing you need. An erroneous JOIN, either forgotten or to the wrong table, can unexpectedly retrieve table records multiple times. To get the query plan, execute with `EXPLAIN` in front of the query.
- Make sure statistics are gathered about the number and distributions of values in a table, to provide the query planner with better information to make decisions around index usage. **VACUUM ANALYZE** will compute both.

  You should regularly vacuum your databases anyways. Many PostgreSQL DBAs run **VACUUM** as an off-peak cron job on a regular basis.
- ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ **SET ENABLE_SEQSCAN=OFF** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B-Tree ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `ENABLE_SEQSCAN` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (cost) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, postgresql.conf ⊠⊠⊠ random_page_cost ⊠⊠⊠⊠⊠⊠⊠⊠”SET random_page_cost=#” ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 4 ⊠⊠⊠, 1 ⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- If **SET ENABLE_SEQSCAN TO OFF;** does not help your query, the query may be using a SQL construct that the Postgres planner is not yet able to optimize. It may be possible to rewrite the query in a way that the planner is able to handle. For example, a subquery with an inline SELECT may not produce an efficient plan, but could possibly be rewritten using a LATERAL JOIN.

For more information see the Postgres manual section on Query Planning.

Chapter 5

Spatial Queries

The *raison d'etre* of spatial databases is to perform queries inside the database which would ordinarily require desktop GIS functionality. Using PostGIS effectively requires knowing what spatial functions are available, how to use them in queries, and ensuring that appropriate indexes are in place to provide good performance.

5.1 Determining Spatial Relationships

Spatial relationships indicate how two geometries interact with one another. They are a fundamental capability for querying geometry.

5.1.1 Dimensionally Extended 9-Intersection Model

According to the OpenGIS Simple Features Implementation Specification for SQL, "the basic approach to comparing two geometries is to make pair-wise tests of the intersections between the Interiors, Boundaries and Exteriors of the two geometries and to classify the relationship between the two geometries based on the entries in the resulting 'intersection' matrix."

In the theory of point-set topology, the points in a geometry embedded in 2-dimensional space are categorized into three sets:

Boundary

The boundary of a geometry is the set of geometries of the next lower dimension. For `POINT`s, which have a dimension of 0, the boundary is the empty set. The boundary of a `LINESTRING` is the two endpoints. For `POLYGON`s, the boundary is the linework of the exterior and interior rings.

Interior

The interior of a geometry are those points of a geometry that are not in the boundary. For `POINT`s, the interior is the point itself. The interior of a `LINESTRING` is the set of points between the endpoints. For `POLYGON`s, the interior is the areal surface inside the polygon.

Exterior

The exterior of a geometry is the rest of the space in which the geometry is embedded; in other words, all points not in the interior or on the boundary of the geometry. It is a 2-dimensional non-closed surface.

The Dimensionally Extended 9-Intersection Model (DE-9IM) describes the spatial relationship between two geometries by specifying the dimensions of the 9 intersections between the above sets for each geometry. The intersection dimensions can be formally represented in a 3x3 **intersection matrix**.

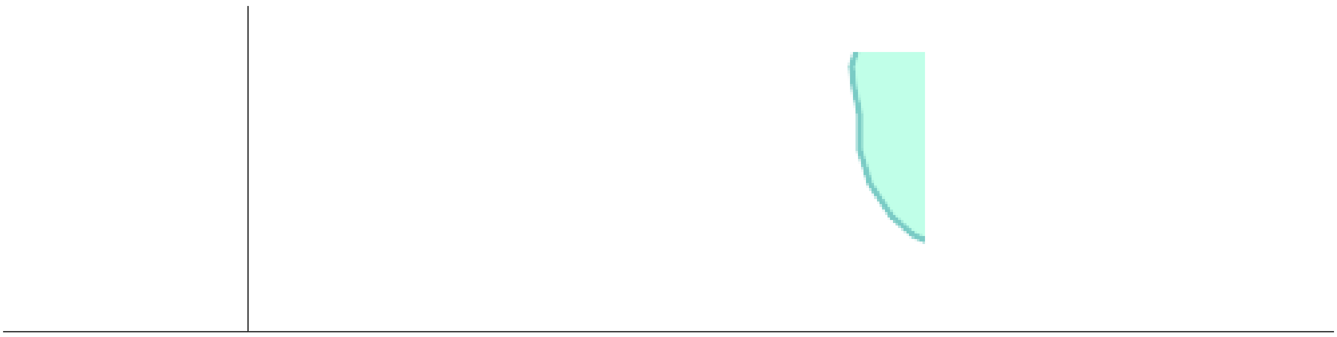
For a geometry *g* the *Interior*, *Boundary*, and *Exterior* are denoted using the notation *I(g)*, *B(g)*, and *E(g)*. Also, *dim(s)* denotes the dimension of a set *s* with the domain of `{0,1,2,F}`:

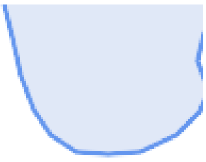
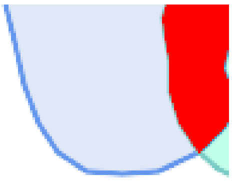
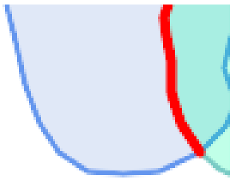
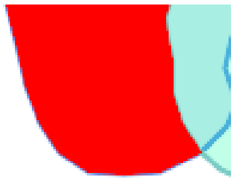
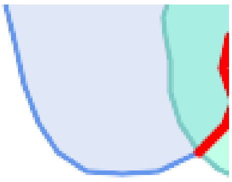
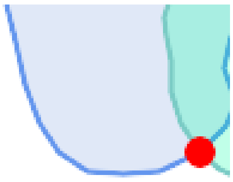
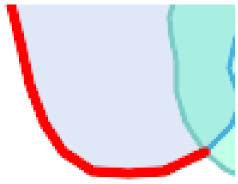
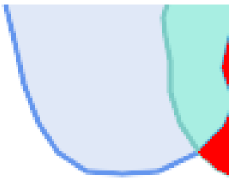
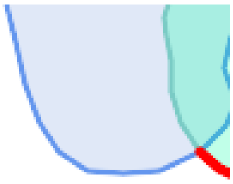
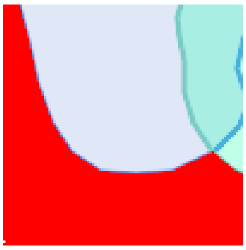
- `0` => point
- `1` => line
- `2` => area
- `F` => empty set

Using this notation, the intersection matrix for two geometries *a* and *b* is:

	Interior	**Boundary**	**Exterior**
Interior	*dim(I(a) ∩ I(b))*	*dim(I(a) ∩ B(b))*	*dim(I(a) ∩ E(b))*
Boundary	*dim(B(a) ∩ I(b))*	*dim(B(a) ∩ B(b))*	*dim(B(a) ∩ E(b))*
Exterior	*dim(E(a) ∩ I(b))*	*dim(E(a) ∩ B(b))*	*dim(E(a) ∩ E(b))*

Visually, for two overlapping polygonal geometries, this looks like:



		Interior	Boundary	Exterior
	**Interior**	 *dim(I(a) ∩ I(b))* = **2**	 *dim(I(a) ∩ B(b)* = **1**	 *dim(I(a) ∩ E(b))* = **2**
	Boundary	 *dim(B(a) ∩ I(b))* = **1**	 *dim(B(a) ∩ B(b))* = **0**	 *dim(B(a) ∩ E(b))* = **1**
	Exterior	 *dim(E(a) ∩ I(b))* = **2**	 *dim(E(a) ∩ B(b))* = **1**	 *dim(E(a) ∩ E(b)* = **2**

Reading from left to right and top to bottom, the intersection matrix is represented as the text string '**212101212**'.

For more information, refer to:

- OpenGIS Simple Features Implementation Specification for SQL (version 1.1, section 2.1.13.2)
- Wikipedia: Dimensionally Extended Nine-Intersection Model (DE-9IM)
- GeoTools: Point Set Theory and the DE-9IM Matrix

5.1.2 Named Spatial Relationships

To make it easy to determine common spatial relationships, the OGC SFS defines a set of *named spatial relationship predicates*. PostGIS provides these as the functions ST_Contains, ST_Crosses, ST_Disjoint, ST_Equals, ST_Intersects, ST_Overlaps, ST_Touches, ST_Within. It also defines the non-standard relationship predicates ST_Covers, ST_CoveredBy, and ST_ContainsProperly.

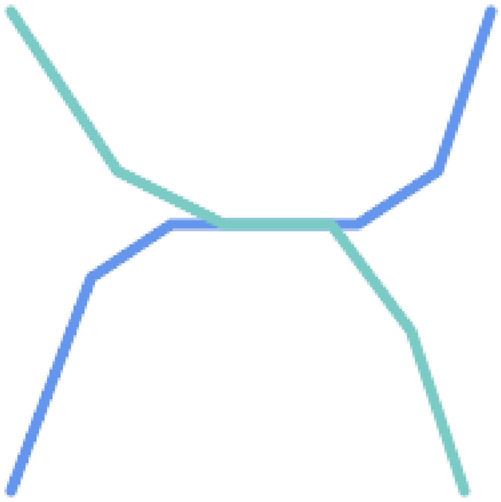
Spatial predicates are usually used as conditions in SQL `WHERE` or `JOIN` clauses. The named spatial predicates automatically use a spatial index if one is available, so there is no need to use the bounding box operator && as well. For example:

```
SELECT city.name, state.name, city.geom
FROM city JOIN state ON ST_Intersects(city.geom, state.geom);
```

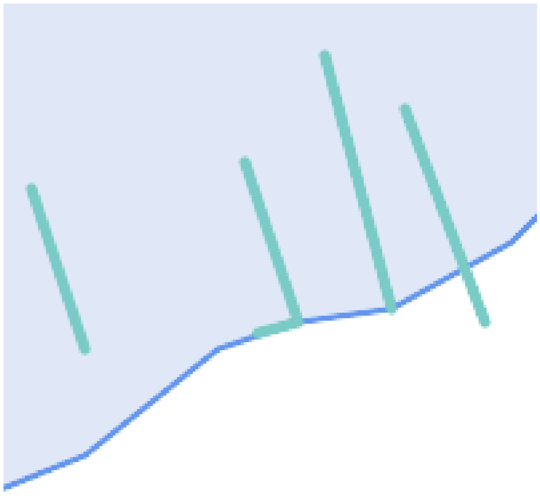
For more details and illustrations, see the PostGIS Workshop.

5.1.3 General Spatial Relationships

In some cases the named spatial relationships are insufficient to provide a desired spatial filter condition.



For example, consider a linear dataset representing a road network. It may be required to identify all road segments that cross each other, not at a point, but in a line (perhaps to validate some business rule). In this case ST_Crosses does not provide the necessary spatial filter, since for linear features it returns `true` only where they cross at a point.
A two-step solution would be to first compute the actual intersection (ST_Intersection) of pairs of road lines that spatially intersect (ST_Intersects), and then check if the intersection's ST_GeometryType is 'LINESTRING' (properly dealing with cases that return `GEOMETRYCOLLECTION`s of `[MULTI]POINT`s, `[MULTI]LINESTRING`s, etc.).
Clearly, a simpler and faster solution is desirable.



A second example is locating wharves that intersect a lake's boundary on a line and where one end of the wharf is up on shore. In other words, where a wharf is within but not completely contained by a lake, intersects the boundary of a lake on a line, and where exactly one of the wharf's endpoints is within or on the boundary of the lake. It is possible to use a combination of spatial predicates to find the required features:

- ST_Contains(lake, wharf) = TRUE
- ST_ContainsProperly(lake, wharf) = FALSE
- ST_GeometryType(ST_Intersection(wharf, lake)) = 'LINESTRING'
- ST_NumGeometries(ST_Multi(ST_Intersection(ST_Boundary(wharf), ST_Boundary(lake)))) = 1

  ... but needless to say, this is quite complicated.

These requirements can be met by computing the full DE-9IM intersection matrix. PostGIS provides the ST_Relate function to do this:

```
SELECT ST_Relate( 'LINESTRING (1 1, 5 5)',
                  'POLYGON ((3 3, 3 7, 7 7, 7 3, 3 3))' );
st_relate
-----------
1010F0212
```

To test a particular spatial relationship, an **intersection matrix pattern** is used. This is the matrix representation augmented with the additional symbols {T,*}:

- T => intersection dimension is non-empty; i.e. is in {0,1,2}
- * => don't care

Using intersection matrix patterns, specific spatial relationships can be evaluated in a more succinct way. The ST_Relate and the ST_RelateMatch functions can be used to test intersection matrix patterns. For the first example above, the intersection matrix pattern specifying two lines intersecting in a line is '**1*1***1****':

```
-- Find road segments that intersect in a line
SELECT a.id
```

```
FROM roads a, roads b
WHERE a.id != b.id
      AND a.geom && b.geom
      AND ST_Relate(a.geom, b.geom, '1*1***1**');
```

For the second example, the intersection matrix pattern specifying a line partly inside and partly outside a polygon is ’**102101FF2**’:

```
-- Find wharves partly on a lake's shoreline
SELECT a.lake_id, b.wharf_id
FROM lakes a, wharfs b
WHERE a.geom && b.geom
      AND ST_Relate(a.geom, b.geom, '102101FF2');
```

5.2 Using Spatial Indexes

When constructing queries using spatial conditions, for best performance it is important to ensure that a spatial index is used, if one exists (see Section 4.9). To do this, a spatial operator or index-aware function must be used in a `WHERE` or `ON` clause of the query.

Spatial operators include the bounding box operators (of which the most commonly used is &&; see Section 7.10.1 for the full list) and the distance operators used in nearest-neighbor queries (the most common being <->; see Section 7.10.2 for the full list.)

Index-aware functions automatically add a bounding box operator to the spatial condition. Index-aware functions include the named spatial relationship predicates ST_Contains, ST_ContainsProperly, ST_CoveredBy, ST_Covers, ST_Crosses, ST_Intersects, ST_Overlaps, ST_Touches, ST_Within, ST_Within, and ST_3DIntersects, and the distance predicates ST_DWithin, ST_DFullyWithin, ST_3DDFullyWithin, and ST_3DDWithin .)

Functions such as ST_Distance do *not* use indexes to optimize their operation. For example, the following query would be quite slow on a large table:

```
SELECT geom
FROM geom_table
WHERE ST_Distance( geom, 'SRID=312;POINT(100000 200000)' ) < 100
```

This query selects all the geometries in `geom_table` which are within 100 units of the point (100000, 200000). It will be slow because it is calculating the distance between each point in the table and the specified point, ie. one `ST_Distance()` calculation is computed for **every** row in the table.

The number of rows processed can be reduced substantially by using the index-aware function ST_DWithin:

```
SELECT geom
FROM geom_table
WHERE ST_DWithin( geom, 'SRID=312;POINT(100000 200000)', 100 )
```

This query selects the same geometries, but it does it in a more efficient way. This is enabled by `ST_DWithin()` using the && operator internally on an expanded bounding box of the query geometry. If there is a spatial index on `geom`, the query planner will recognize that it can use the index to reduce the number of rows scanned before calculating the distance. The spatial index allows retrieving only records with geometries whose bounding boxes overlap the expanded extent and hence which *might* be within the required distance. The actual distance is then computed to confirm whether to include the record in the result set.

For more information and examples see the PostGIS Workshop.

5.3 Examples of Spatial SQL

The examples in this section make use of a table of linear roads, and a table of polygonal municipality boundaries. The definition of the `bc_roads` table is:

```
Column    | Type              | Description
----------+-------------------+-------------------
gid       | integer           | Unique ID
name      | character varying | Road Name
geom      | geometry          | Location Geometry (Linestring)
```

The definition of the `bc_municipality` table is:

```
Column   | Type              | Description
---------+-------------------+-------------------
gid      | integer           | Unique ID
code     | integer           | Unique ID
name     | character varying | City / Town Name
geom     | geometry          | Location Geometry (Polygon)
```

1. *What is the total length of all roads, expressed in kilometers?*

   You can answer this question with a very simple piece of SQL:

   ```
   SELECT sum(ST_Length(geom))/1000 AS km_roads FROM bc_roads;

   km_roads
   ------------------
   70842.1243039643
   ```

2. *How large is the city of Prince George, in hectares?*

   This query combines an attribute condition (on the municipality name) with a spatial calculation (of the polygon area):

   ```
   SELECT
     ST_Area(geom)/10000 AS hectares
   FROM bc_municipality
   WHERE name = 'PRINCE GEORGE';

   hectares
   ------------------
   32657.9103824927
   ```

3. *What is the largest municipality in the province, by area?*

   This query uses a spatial measurement as an ordering value. There are several ways of approaching this problem, but the most efficient is below:

   ```
   SELECT
     name,
     ST_Area(geom)/10000 AS hectares
   FROM bc_municipality
   ORDER BY hectares DESC
   LIMIT 1;

   name           | hectares
   ---------------+-----------------
   TUMBLER RIDGE  | 155020.02556131
   ```

Note that in order to answer this query we have to calculate the area of every polygon. If we were doing this a lot it would make sense to add an area column to the table that could be indexed for performance. By ordering the results in a descending direction, and them using the PostgreSQL ”LIMIT” command we can easily select just the largest value without using an aggregate function like MAX().

4. *What is the length of roads fully contained within each municipality?*

   This is an example of a ”spatial join”, which brings together data from two tables (with a join) using a spatial interaction (”contained”) as the join condition (rather than the usual relational approach of joining on a common key):

```
SELECT
  m.name,
  sum(ST_Length(r.geom))/1000 as roads_km
FROM bc_roads AS r
JOIN bc_municipality AS m
  ON ST_Contains(m.geom, r.geom)
GROUP BY m.name
ORDER BY roads_km;

name                        | roads_km
----------------------------+------------------
SURREY                      | 1539.47553551242
VANCOUVER                   | 1450.33093486576
LANGLEY DISTRICT            | 833.793392535662
BURNABY                     | 773.769091404338
PRINCE GEORGE               | 694.37554369147
...
```

   This query takes a while, because every road in the table is summarized into the final result (about 250K roads for the example table). For smaller datasets (several thousand records on several hundred) the response can be very fast.

5. *Create a new table with all the roads within the city of Prince George.*

   This is an example of an ”overlay”, which takes in two tables and outputs a new table that consists of spatially clipped or cut resultants. Unlike the ”spatial join” demonstrated above, this query creates new geometries. An overlay is like a turbo-charged spatial join, and is useful for more exact analysis work:

```
CREATE TABLE pg_roads as
SELECT
  ST_Intersection(r.geom, m.geom) AS intersection_geom,
  ST_Length(r.geom) AS rd_orig_length,
  r.*
FROM bc_roads AS r
JOIN bc_municipality AS m
  ON ST_Intersects(r.geom, m.geom)
WHERE
  m.name = 'PRINCE GEORGE';
```

6. *What is the length in kilometers of ”Douglas St” in Victoria?*

```
SELECT
  sum(ST_Length(r.geom))/1000 AS kilometers
FROM bc_roads r
JOIN bc_municipality m
  ON ST_Intersects(m.geom, r.geom
WHERE
  r.name = 'Douglas St'
  AND m.name = 'VICTORIA';
```

```
kilometers
------------------
4.89151904172838
```

7. *What is the largest municipality polygon that has a hole?*

```
SELECT gid, name, ST_Area(geom) AS area
FROM bc_municipality
WHERE ST_NRings(geom)
> 1
ORDER BY area DESC LIMIT 1;

gid  | name         | area
-----+--------------+------------------
12   | SPALLUMCHEEN | 257374619.430216
```

Chapter 6

⊠⊠⊠⊠⊠⊠

6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

6.1.1 ⊠⊠⊠⊠⊠

⊠⊠ PostgreSQL (8.0 ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (optimizer) ⊠⊠ TOAST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TOAST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠” ⊠⊠⊠⊠ (extension room)” ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ the PostgreSQL Documentation for TOAST ⊠⊠⊠⊠⊠⊠⊠.

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⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ && ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠ 80 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GiST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, && ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ TOAST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

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and newer thread on PostGIS https://lists.osgeo.org/pipermail/postgis-devel/2017-June/026209.html

6.1.2 ⊠⊠⊠⊠

PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TOAST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

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⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠” ⊠⊠” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
SELECT AddGeometryColumn('myschema','mytable','bbox','4326','GEOMETRY','2');
UPDATE mytable SET bbox = ST_Envelope(ST_Force2D(geom));
```

⊠⊠ geom_column ⊠⊠ bbox ⊠⊠⊠ && ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
SELECT geom_column
FROM mytable
WHERE bbox && ST_SetSRID('BOX3D(0 0,1 1)'::box3d,4326);
```

⊠⊠, mytable ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, bbox ⊠" ⊠⊠⊠" ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (trigger) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ bbox ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ UPDATE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

6.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, PostgreSQL ⊠ CLUSTER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠, ⊠⊠⊠. ⊠⊠, ⊠⊠⊠. (⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠ CLUSTER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.)

⊠⊠⊠, ⊠⊠ PostgreSQL ⊠ PostGIS GiST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ GiST ⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
lwgeom=# CLUSTER my_geom_index ON my_table;
ERROR: cannot cluster when index access method does not handle null values
HINT: You may be able to work around this by marking column "geom" NOT NULL.
```

HINT ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠"not null" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
lwgeom=# ALTER TABLE my_table ALTER COLUMN geom SET not null;
ALTER TABLE
```

⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. "ALTER TABLE blubb ADD CHECK (geometry is not null);" ⊠⊠ CHECK ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

6.3 ⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3D ⊠⊠ 4D ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ OpenGIS ⊠⊠ ST_AsText() ⊠⊠ ST_AsBinary() ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force2D() ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
UPDATE mytable SET geom = ST_Force2D(geom);
VACUUM FULL ANALYZE mytable;
```

AddGeometryColumn() ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. geometry_columns ⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ WHERE ⊠⊠"VACUUM;" ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, "WHERE dimension(the_geom)>2" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Chapter 7

PostGIS Reference

⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL-MM-⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Spatial Type (ST) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

7.1 PostgreSQL PostGIS Geometry/Geography/Box ⊠⊠

7.1.1 box2d

box2d — The type representing a 2-dimensional bounding box.

⊠⊠

box3d ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ postgis ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_3DExtent ⊠ box3d ⊠⊠⊠⊠⊠⊠⊠⊠.

The representation contains the values `xmin, ymin, xmax, ymax`. These are the minimum and maximum values of the X and Y extents.

`box2d` objects have a text representation which looks like `BOX(1 2,5 6)`.

⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠	⊠⊠
box3d	⊠⊠⊠
geometry	⊠⊠⊠

⊠⊠

Section 13.7

7.1.2 box3d

box3d — The type representing a 3-dimensional bounding box.

⊠⊠

box3d ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ postgis ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_3DExtent ⊠ box3d ⊠⊠⊠⊠⊠⊠⊠⊠.

The representation contains the values `xmin, ymin, zmin, xmax, ymax, zmax`. These are the minimum and maximum values of the X, Y and Z extents.

`box3d` objects have a text representation which looks like `BOX3D(1 2 3,5 6 5)`.

⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠	⊠⊠
box	⊠⊠⊠
box2d	⊠⊠⊠
geometry	⊠⊠⊠

⊠⊠

Section 13.7

7.1.3 geometry

geometry — geography ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

geography ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

All spatial operations on geometry use the units of the Spatial Reference System the geometry is in.

⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠	⊠⊠
box	⊠⊠⊠
box2d	⊠⊠⊠
box3d	⊠⊠⊠
bytea	⊠⊠⊠

geography	⊠⊠⊠
text	⊠⊠⊠

⊠⊠

Section 4.1, Section 4.3

7.1.4 geometry_dump

geometry_dump — A composite type used to describe the parts of complex geometry.

⊠⊠

`geometry_dump` is a composite data type containing the fields:

- `geom` - a geometry representing a component of the dumped geometry. The geometry type depends on the originating function.
- `path[]` - an integer array that defines the navigation path within the dumped geometry to the `geom` component. The path array is 1-based (i.e. `path[1]` is the first element.)

It is used by the `ST_Dump*` family of functions as an output type to explode a complex geometry into its constituent parts.

⊠⊠

Section 13.6

7.1.5 geography

geography — The type representing spatial features with geodetic (ellipsoidal) coordinate systems.

⊠⊠

geography ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Spatial operations on the geography type provide more accurate results by taking the ellipsoidal model into account.

⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠	⊠⊠
geometry	⊠⊠⊠

⊠⊠

Section 4.3, Section 4.3

7.2 ⊠⊠⊠⊠

7.2.1 AddGeometryColumn

AddGeometryColumn — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **AddGeometryColumn**(varchar table_name, varchar column_name, integer srid, varchar type, integer dimension, boolean use_typmod=true);
text **AddGeometryColumn**(varchar schema_name, varchar table_name, varchar column_name, integer srid, varchar type, integer dimension, boolean use_typmod=true);
text **AddGeometryColumn**(varchar catalog_name, varchar schema_name, varchar table_name, varchar column_name, integer srid, varchar type, integer dimension, boolean use_typmod=true);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `schema_name` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `srid` ⊠⊠⊠⊠⊠⊠⊠⊠⊠ SPATIAL_REF_SYS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `type` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠'POLYGON' ⊠⊠'MULTILINESTRING' ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠ search_path ⊠⊠⊠⊠⊠⊠) ⊠⊠⊠ SRID, ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ WGS84 POINT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠: `ALTER TABLE some_table ADD COLUMN geom geometry(Point,4326);`
> ⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ `use_typmod` ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ typmod ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ typmod ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ typmod ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Section 4.6.3 ⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠⊠⊠: 2.0.0 ⊠⊠. use_typmod ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ typmod ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□

```
-- Create schema to hold data
CREATE SCHEMA my_schema;
-- Create a new simple PostgreSQL table
CREATE TABLE my_schema.my_spatial_table (id serial);

-- Describing the table shows a simple table with a single "id" column.
postgis=# \d my_schema.my_spatial_table
                                                         Table "my_schema.my_spatial_table"
 Column |  Type   |                                Modifiers
--------+---------+-------------------------------------------------------------------------

 id     | integer | not null default nextval('my_schema.my_spatial_table_id_seq'::regclass)

-- Add a spatial column to the table
SELECT AddGeometryColumn ('my_schema','my_spatial_table','geom',4326,'POINT',2);

-- Add a point using the old constraint based behavior
SELECT AddGeometryColumn ('my_schema','my_spatial_table','geom_c',4326,'POINT',2, false);

--Add a curvepolygon using old constraint behavior
SELECT AddGeometryColumn ('my_schema','my_spatial_table','geomcp_c',4326,'CURVEPOLYGON',2, false);

-- Describe the table again reveals the addition of a new geometry columns.
\d my_schema.my_spatial_table
                            addgeometrycolumn
-------------------------------------------------------------------------
 my_schema.my_spatial_table.geomcp_c SRID:4326 TYPE:CURVEPOLYGON DIMS:2
(1 row)

                                    Table "my_schema.my_spatial_table"
  Column  |         Type         |                                Modifiers
----------+----------------------+-------------------------------------------------------------------------

 id       | integer              | not null default nextval('my_schema.my_spatial_table_id_seq'::regclass)
 geom     | geometry(Point,4326) |
 geom_c   | geometry             |
 geomcp_c | geometry             |
Check constraints:
    "enforce_dims_geom_c" CHECK (st_ndims(geom_c) = 2)
    "enforce_dims_geomcp_c" CHECK (st_ndims(geomcp_c) = 2)
    "enforce_geotype_geom_c" CHECK (geometrytype(geom_c) = 'POINT'::text OR geom_c IS NULL)
    "enforce_geotype_geomcp_c" CHECK (geometrytype(geomcp_c) = 'CURVEPOLYGON'::text OR geomcp_c IS NULL)
    "enforce_srid_geom_c" CHECK (st_srid(geom_c) = 4326)
    "enforce_srid_geomcp_c" CHECK (st_srid(geomcp_c) = 4326)

-- geometry_columns view also registers the new columns --
SELECT f_geometry_column As col_name, type, srid, coord_dimension As ndims
    FROM geometry_columns
    WHERE f_table_name = 'my_spatial_table' AND f_table_schema = 'my_schema';

 col_name |     type     | srid | ndims
----------+--------------+------+-------
 geom     | Point        | 4326 |     2
 geom_c   | Point        | 4326 |     2
 geomcp_c | CurvePolygon | 4326 |     2
```

⊠⊠

DropGeometryColumn, DropGeometryTable, Section 4.6.2, Section 4.6.3

7.2.2 DropGeometryColumn

DropGeometryColumn — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **DropGeometryColumn**(varchar table_name, varchar column_name);
text **DropGeometryColumn**(varchar schema_name, varchar table_name, varchar column_name);
text **DropGeometryColumn**(varchar catalog_name, varchar schema_name, varchar table_name, varchar column_name);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. schema_name ⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ f_table_schema ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

> **Note**
> ⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ALTER TABLE ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT DropGeometryColumn ('my_schema','my_spatial_table','geom');
                        ----RESULT output ---
                                          dropgeometrycolumn
------------------------------------------------------
 my_schema.my_spatial_table.geom effectively removed.

-- In PostGIS 2.0+ the above is also equivalent to the standard
-- the standard alter table.  Both will deregister from geometry_columns
ALTER TABLE my_schema.my_spatial_table DROP column geom;
```

⊠⊠

AddGeometryColumn, DropGeometryTable, Section 4.6.2

7.2.3 DropGeometryTable

DropGeometryTable — ⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **DropGeometryTable**(varchar table_name);
boolean **DropGeometryTable**(varchar schema_name, varchar table_name);
boolean **DropGeometryTable**(varchar catalog_name, varchar schema_name, varchar table_name);

⊠⊠

⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ (schema-aware) pgSQL ⊠⊠⊠⊠⊠ current_schema() ⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ DROP TABLE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT DropGeometryTable ('my_schema','my_spatial_table');
----RESULT output ---
my_schema.my_spatial_table dropped.

-- The above is now equivalent to --
DROP TABLE my_schema.my_spatial_table;
```

⊠⊠

AddGeometryColumn, DropGeometryColumn, Section 4.6.2

7.2.4 Find_SRID

Find_SRID — Returns the SRID defined for a geometry column.

Synopsis

integer **Find_SRID**(varchar a_schema_name, varchar a_table_name, varchar a_geomfield_name);

⊠⊠

Returns the integer SRID of the specified geometry column by searching through the GEOMETRY_COLUMNS table. If the geometry column has not been properly added (e.g. with the AddGeometryColumn function), this function will not work.

⊠⊠

```
SELECT Find_SRID('public', 'tiger_us_state_2007', 'geom_4269');
find_srid
----------
4269
```

⊠⊠

ST_SRID

7.2.5 Populate_Geometry_Columns

Populate_Geometry_Columns — Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints.

Synopsis

text **Populate_Geometry_Columns**(boolean use_typmod=true);
int **Populate_Geometry_Columns**(oid relation_oid, boolean use_typmod=true);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `geometry_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ `use_typmod=false` ⊠⊠⊠⊠

⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, `use_typmod=false` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- `enforce_dims_the_geom` - ensures every geometry has the same dimension (see ST_NDims)
- `enforce_geotype_the_geom` - ensures every geometry is of the same type (see GeometryType)
- `enforce_srid_the_geom` - ensures every geometry is in the same projection (see ST_SRID)

`oid` ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`oid` ⊠⊠⊠⊠⊠⊠ `oid` ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ `geometry_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (truncate) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `geometry_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `geometry_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ `use_typmod` ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `use_typmod` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

☒☒

```
CREATE TABLE public.myspatial_table(gid serial, geom geometry);
INSERT INTO myspatial_table(geom) VALUES(ST_GeomFromText('LINESTRING(1 2, 3 4)',4326) );
-- This will now use typ modifiers.  For this to work, there must exist data
SELECT Populate_Geometry_Columns('public.myspatial_table'::regclass);

populate_geometry_columns
--------------------------
                        1


\d myspatial_table

                                   Table ”public.myspatial_table”
 Column |           Type            |                            Modifiers
--------+---------------------------+---------------------------------------------------------------

 gid    | integer                   | not null default nextval('myspatial_table_gid_seq':: ↵
    regclass)
 geom   | geometry(LineString,4326) |
```

```
-- This will change the geometry columns to use constraints if they are not typmod or have  ↵
   constraints already.
--For this to work, there must exist data
CREATE TABLE public.myspatial_table_cs(gid serial, geom geometry);
INSERT INTO myspatial_table_cs(geom) VALUES(ST_GeomFromText('LINESTRING(1 2, 3 4)',4326) );
SELECT Populate_Geometry_Columns('public.myspatial_table_cs'::regclass, false);
populate_geometry_columns
--------------------------
                        1
\d myspatial_table_cs

                          Table ”public.myspatial_table_cs”
 Column |   Type   |                            Modifiers
--------+----------+------------------------------------------------------------------
 gid    | integer  | not null default nextval('myspatial_table_cs_gid_seq'::regclass)
 geom   | geometry |
Check constraints:
    ”enforce_dims_geom” CHECK (st_ndims(geom) = 2)
    ”enforce_geotype_geom” CHECK (geometrytype(geom) = 'LINESTRING'::text OR geom IS NULL)
    ”enforce_srid_geom” CHECK (st_srid(geom) = 4326)
```

7.2.6 UpdateGeometrySRID

UpdateGeometrySRID — Updates the SRID of all features in a geometry column, and the table metadata.

Synopsis

text **UpdateGeometrySRID**(varchar table_name, varchar column_name, integer srid);
text **UpdateGeometrySRID**(varchar schema_name, varchar table_name, varchar column_name, integer srid);
text **UpdateGeometrySRID**(varchar catalog_name, varchar schema_name, varchar table_name, varchar column_name, integer srid);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠, geometry_columns ⊠⊠⊠⊠⊠⊠ srid ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠. ⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ schema-aware pgsql installations ⊠⊠⊠⊠⊠ current_schema() ⊠⊠

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

Insert geometries into roads table with a SRID set already using EWKT format:

```
COPY roads (geom) FROM STDIN;
SRID=4326;LINESTRING(0 0, 10 10)
SRID=4326;LINESTRING(10 10, 15 0)
\.
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠ SRID ⊠ 4326 ⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
SELECT UpdateGeometrySRID('roads','geom',4326);
```

⊠⊠⊠⊠⊠⊠⊠ DDL ⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
ALTER TABLE roads
  ALTER COLUMN geom TYPE geometry(MULTILINESTRING, 4326)
    USING ST_SetSRID(geom,4326);
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠'unknown' ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, DDL ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
ALTER TABLE roads
 ALTER COLUMN geom TYPE geometry(MULTILINESTRING, 3857) USING ST_Transform(ST_SetSRID(geom ↩
     ,4326),3857) ;
```

⊠⊠

UpdateRasterSRID, ST_SetSRID, ST_Transform

7.3 ⊠⊠⊠⊠⊠ (constructor)

7.3.1 ST_Collect

ST_Collect — Creates a GeometryCollection or Multi* geometry from a set of geometries.

Synopsis

geometry **ST_Collect**(geometry g1, geometry g2);
geometry **ST_Collect**(geometry[] g1_array);
geometry **ST_Collect**(geometry set g1field);

⊠⊠

Collects geometries into a geometry collection. The result is either a Multi* or a GeometryCollection, depending on whether the input geometries have the same or different types (homogeneous or heterogeneous). The input geometries are left unchanged within the collection.

Variant 1: accepts two input geometries

Variant 2: accepts an array of geometries

Variant 3: aggregate function accepting a rowset of geometries.

> **Note**
> If any of the input geometries are collections (Multi* or GeometryCollection) ST_Collect returns a GeometryCollection (since that is the only type which can contain nested collections). To prevent this, use ST_Dump in a subquery to expand the input collections to their atomic elements (see example below).

> **Note**
> ST_Collect and ST_Union appear similar, but in fact operate quite differently. ST_Collect aggregates geometries into a collection without changing them in any way. ST_Union geometrically merges geometries where they overlap, and splits linestrings at intersections. It may return single geometries when it dissolves boundaries.

1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_MakeLine ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_MakeLine ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠: XLink ⊠⊠

Collect 2D points.

```
SELECT ST_AsText( ST_Collect( ST_GeomFromText('POINT(1 2)'),
        ST_GeomFromText('POINT(-2 3)') ));

st_astext
----------
MULTIPOINT((1 2),(-2 3))
```

Collect 3D points.

```
SELECT ST_AsEWKT( ST_Collect( ST_GeomFromEWKT('POINT(1 2 3)'),
                ST_GeomFromEWKT('POINT(1 2 4)') ) );

                st_asewkt
-------------------------
 MULTIPOINT(1 2 3,1 2 4)
```

Collect curves.

```
SELECT ST_AsText( ST_Collect( 'CIRCULARSTRING(220268 150415,220227 150505,220227 150406)',
                'CIRCULARSTRING(220227 150406,2220227 150407,220227 150406)'));

                st_astext
------------------------------------------------------------------------------------
MULTICURVE(CIRCULARSTRING(220268 150415,220227 150505,220227 150406),
 CIRCULARSTRING(220227 150406,2220227 150407,220227 150406))
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠

Using an array constructor for a subquery.

```
SELECT ST_Collect( ARRAY( SELECT geom FROM sometable ) );
```

Using an array constructor for values.

```
SELECT ST_AsText(  ST_Collect(
                ARRAY[ ST_GeomFromText('LINESTRING(1 2, 3 4)'),
                        ST_GeomFromText('LINESTRING(3 4, 4 5)') ] )) As wktcollect;

--wkt collect --
MULTILINESTRING((1 2,3 4),(3 4,4 5))
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠

Creating multiple collections by grouping geometries in a table.

```
SELECT stusps, ST_Collect(f.geom) as geom
         FROM (SELECT stusps, (ST_Dump(geom)).geom As geom
                                FROM
                                somestatetable ) As f
        GROUP BY stusps
```

⊠⊠

ST_Dump, ST_AsBinary

7.3.2 ST_LineFromMultiPoint

ST_LineFromMultiPoint — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_LineFromMultiPoint**(geometry aMultiPoint);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Use ST_MakeLine to create lines from Point or LineString inputs.

This function supports 3d and will not drop the z-index.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AsEWKT(  ST_LineFromMultiPoint('MULTIPOINT(1 2 3, 4 5 6, 7 8 9)')  ));

--result--
LINESTRING(1 2 3,4 5 6,7 8 9)
```

⊠⊠

ST_AsEWKT, ST_AsKML

7.3.3 ST_MakeEnvelope

ST_MakeEnvelope — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠ SRS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_MakeEnvelope**(float xmin, float ymin, float xmax, float ymax, integer srid=unknown);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠ SRS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0 ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (envelope) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsText( ST_MakeEnvelope(10, 10, 11, 11, 4326) );

st_asewkt
-----------
POLYGON((10 10, 10 11, 11 11, 11 10, 10 10))
```

⊠⊠

ST_MakePoint, ST_MakePoint, ST_Point, ST_SRID

7.3.4 ST_MakeLine

ST_MakeLine — ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_MakeLine**(geometry geom1, geometry geom2);
geometry **ST_MakeLine**(geometry[] geoms_array);
geometry **ST_MakeLine**(geometry set geoms);

⊠⊠

Creates a LineString containing the points of Point, MultiPoint, or LineString geometries. Other geometry types cause an error.

Variant 1: accepts two input geometries

Variant 2: accepts an array of geometries

Variant 3: aggregate function accepting a rowset of geometries. To ensure the order of the input geometries use `ORDER BY` in the function call, or a subquery with an `ORDER BY` clause.

Repeated nodes at the beginning of input LineStrings are collapsed to a single point. Repeated points in Point and MultiPoint inputs are not collapsed. ST_RemoveRepeatedPoints can be used to collapse repeated points from the output LineString.

This function supports 3d and will not drop the z-index.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_MakeLine ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_MakeLine ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠

Create a line composed of two points.

```
SELECT ST_AsText( ST_MakeLine(ST_Point(1,2), ST_Point(3,4)) );

          st_astext
---------------------
 LINESTRING(1 2,3 4)
```

⊠⊠⊠ 3D ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠ BOX3D ⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AsEWKT( ST_MakeLine(ST_MakePoint(1,2,3), ST_MakePoint(3,4,5) ));

                st_asewkt
-------------------------
 LINESTRING(1 2 3,3 4 5)
```

⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
select ST_AsText( ST_MakeLine( 'LINESTRING(0 0, 1 1)', 'LINESTRING(2 2, 3 3)' ) );

          st_astext
-----------------------------
 LINESTRING(0 0,1 1,2 2,3 3)
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

Create a line from an array formed by a subquery with ordering.

```
SELECT ST_MakeLine( ARRAY( SELECT ST_Centroid(geom) FROM visit_locations ORDER BY ↩
   visit_time) );
```

Create a 3D line from an array of 3D points

```
SELECT ST_AsEWKT( ST_MakeLine(
          ARRAY[ ST_MakePoint(1,2,3), ST_MakePoint(3,4,5), ST_MakePoint(6,6,6) ]  ));

                st_asewkt
-------------------------
LINESTRING(1 2 3,3 4 5,6 6 6)
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠ GPS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GPS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GPS ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Using aggregate `ORDER BY` provides a correctly-ordered LineString.

```
SELECT gps.track_id, ST_MakeLine(gps.geom ORDER BY gps_time) As geom
        FROM gps_points As gps
        GROUP BY track_id;
```

Prior to PostgreSQL 9, ordering in a subquery can be used. However, sometimes the query plan may not respect the order of the subquery.

```
SELECT gps.track_id, ST_MakeLine(gps.geom) As geom
        FROM ( SELECT track_id, gps_time, geom
                        FROM gps_points ORDER BY track_id, gps_time ) As gps
        GROUP BY track_id;
```

⊠⊠

ST_RemoveRepeatedPoints, ST_AsText, ST_GeomFromText, ST_MakePoint

7.3.5 ST_MakePoint

ST_MakePoint — Creates a 2D, 3DZ or 4D Point.

Synopsis

geometry **ST_MakePoint**(float x, float y);

geometry **ST_MakePoint**(float x, float y, float z);

geometry **ST_MakePoint**(float x, float y, float z, float m);

⊠⊠

Creates a 2D XY, 3D XYZ or 4D XYZM Point geometry. Use ST_MakePointM to make points with XYM coordinates.

Use ST_SetSRID to specify a SRID for the created point.

While not OGC-compliant, `ST_MakePoint` is faster and more precise than ST_GeomFromText and ST_PointFromText. It is also easier to use for numeric coordinate values.

Note
For geodetic coordinates, X is longitude and Y is latitude

Note
The functions ST_Point, ST_PointZ, ST_PointM, and ST_PointZM can be used to create points with a given SRID.

This function supports 3d and will not drop the z-index.

⊠⊠

```
-- Create a point with unknown SRID
SELECT ST_MakePoint(-71.1043443253471, 42.3150676015829);

-- Create a point in the WGS 84 geodetic CRS
SELECT ST_SetSRID(ST_MakePoint(-71.1043443253471, 42.3150676015829),4326);

-- Create a 3D point (e.g. has altitude)
SELECT ST_MakePoint(1, 2,1.5);

-- Get z of point
SELECT ST_Z(ST_MakePoint(1, 2,1.5));
result
-------
1.5
```

⊠⊠

ST_GeomFromText, ST_PointFromText, ST_SetSRID, ST_MakePointM, ST_Point, ST_PointZ, ST_PointM, ST_PointZM

7.3.6 ST_MakePointM

ST_MakePointM — x, y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_MakePointM**(float x, float y, float m);

⊠⊠

Creates a point with X, Y and M (measure) ordinates. Use ST_MakePoint to make points with XY, XYZ, or XYZM coordinates.

Use ST_SetSRID to specify a SRID for the created point.

Note
For geodetic coordinates, X is longitude and Y is latitude

Note
The functions ST_PointM, and ST_PointZM can be used to create points with an M value and a given SRID.

⊠⊠

Note
ST_AsEWKT is used for text output because ST_AsText does not support M values.

Create point with unknown SRID.

```
SELECT ST_AsEWKT(  ST_MakePointM(-71.1043443253471, 42.3150676015829, 10)  );

                                   st_asewkt
-----------------------------------------------
 POINTM(-71.1043443253471 42.3150676015829 10)
```

x, y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AsEWKT( ST_SetSRID(  ST_MakePointM(-71.104, 42.315, 10),  4326));

                                                st_asewkt
---------------------------------------------------------
SRID=4326;POINTM(-71.104 42.315 10)
```

Get measure of created point.

```
SELECT ST_M(  ST_MakePointM(-71.104, 42.315, 10)  );

result
-------
10
```

⊠⊠

ST_MakePoint, ST_SetSRID, ST_PointM, ST_PointZM

7.3.7 ST_MakePolygon

ST_MakePolygon — Creates a Polygon from a shell and optional list of holes.

Synopsis

geometry **ST_MakePolygon**(geometry linestring);

geometry **ST_MakePolygon**(geometry outerlinestring, geometry[] interiorlinestrings);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠ (shell) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Variant 1: Accepts one shell LineString.

Variant 2: Accepts a shell LineString and an array of inner (hole) LineStrings. A geometry array can be constructed using the PostgreSQL array_agg(), ARRAY[] or ARRAY() constructs.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_LineMerge ⊠⊠ ST_Dump ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_MakePolygon( ST_GeomFromText('LINESTRING(75 29,77 29,77 29, 75 29)'));
```

Create a Polygon from an open LineString, using ST_StartPoint and ST_AddPoint to close it.

```
SELECT ST_MakePolygon( ST_AddPoint(foo.open_line, ST_StartPoint(foo.open_line)) )
FROM (
  SELECT ST_GeomFromText('LINESTRING(75 29,77 29,77 29, 75 29)') As open_line) As foo;
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AsEWKT( ST_MakePolygon( 'LINESTRING(75.15 29.53 1,77 29 1,77.6 29.5 1, 75.15 ↩
    29.53 1)'));

st_asewkt
-----------
POLYGON((75.15 29.53 1,77 29 1,77.6 29.5 1,75.15 29.53 1))
```

Create a Polygon from a LineString with measures

```
SELECT ST_AsEWKT( ST_MakePolygon( 'LINESTRINGM(75.15 29.53 1,77 29 1,77.6 29.5 2, 75.15 ↩
    29.53 2)' ));

st_asewkt
----------
POLYGONM((75.15 29.53 1,77 29 1,77.6 29.5 2,75.15 29.53 2))
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_MakePolygon( ST_ExteriorRing( ST_Buffer(ring.line,10)),
        ARRAY[  ST_Translate(ring.line, 1, 1),
                ST_ExteriorRing(ST_Buffer(ST_Point(20,20),1)) ]
        )
FROM (SELECT ST_ExteriorRing(
        ST_Buffer(ST_Point(10,10),10,10)) AS line ) AS ring;
```

Create a set of province boundaries with holes representing lakes. The input is a table of province Polygons/MultiPolygons and a table of water linestrings. Lines forming lakes are determined by using ST_IsClosed. The province linework is extracted by using ST_Boundary. As required by `ST_MakePolygon`, the boundary is forced to be a single LineString by using ST_LineMerge. (However, note that if a province has more than one region or has islands this will produce an invalid polygon.) Using a LEFT JOIN ensures all provinces are included even if they have no lakes.

> **Note**
> NULL ⊠⊠⊠ ST_MakePolygon ⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠ CASE ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT p.gid, p.province_name,
        CASE WHEN array_agg(w.geom) IS NULL
        THEN p.geom
        ELSE  ST_MakePolygon( ST_LineMerge(ST_Boundary(p.geom)),
                        array_agg(w.geom)) END
FROM
        provinces p LEFT JOIN waterlines w
                ON (ST_Within(w.geom, p.geom) AND ST_IsClosed(w.geom))
GROUP BY p.gid, p.province_name, p.geom;
```

Another technique is to utilize a correlated subquery and the ARRAY() constructor that converts a row set to an array.

```
SELECT p.gid,  p.province_name,
    CASE WHEN EXISTS( SELECT w.geom
        FROM waterlines w
        WHERE ST_Within(w.geom, p.geom)
        AND ST_IsClosed(w.geom))
    THEN ST_MakePolygon(
        ST_LineMerge(ST_Boundary(p.geom)),
        ARRAY( SELECT w.geom
            FROM waterlines w
            WHERE ST_Within(w.geom, p.geom)
            AND ST_IsClosed(w.geom)))
    ELSE p.geom
    END AS geom
FROM provinces p;
```

⊠⊠

ST_BuildArea ST_Polygon

7.3.8 ST_Point

ST_Point — Creates a Point with X, Y and SRID values.

Synopsis

geometry **ST_Point**(float x, float y);

geometry **ST_Point**(float x, float y, integer srid=unknown);

⊠⊠

Returns a Point with the given X and Y coordinate values. This is the SQL-MM equivalent for ST_MakePoint that takes just X and Y.

> **Note**
> For geodetic coordinates, X is longitude and Y is latitude

Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry.

This method implements the SQL/MM specification. SQL-MM 3: 6.1.2

⊠⊠: ⊠⊠

```
SELECT ST_Point( -71.104, 42.315);
```

Creating a point with SRID specified:

```
SELECT ST_Point( -71.104, 42.315, 4326);
```

Alternative way of specifying SRID:

```
SELECT ST_SetSRID( ST_Point( -71.104, 42.315), 4326);
```

⊠⊠: ⊠⊠⊠

Create geography points using the `::` cast syntax:

```
SELECT ST_Point( -71.104, 42.315, 4326)::geography;
```

Pre-PostGIS 3.2 code, using CAST:

```
SELECT CAST( ST_SetSRID(ST_Point( -71.104, 42.315), 4326) AS geography);
```

If the point coordinates are not in a geodetic coordinate system (such as WGS84), then they must be reprojected before casting to a geography. In this example a point in Pennsylvania State Plane feet (SRID 2273) is projected to WGS84 (SRID 4326).

```
SELECT ST_Transform( ST_Point( 3637510, 3014852, 2273), 4326)::geography;
```

⊠⊠

ST_MakePoint, ST_PointZ, ST_PointM, ST_PointZM, ST_SetSRID, ST_Transform

7.3.9 ST_PointZ

ST_PointZ — Creates a Point with X, Y, Z and SRID values.

Synopsis

geometry **ST_PointZ**(float x, float y, float z, integer srid=unknown);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Point ⊠⊠⊠⊠⊠⊠. ST_MakePoint ⊠⊠⊠⊠ OGC ⊠⊠⊠⊠⊠.

Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry.

⊠⊠

```
SELECT ST_PointZ(-71.104, 42.315, 3.4, 4326)
```

```
SELECT ST_PointZ(-71.104, 42.315, 3.4, srid => 4326)
```

```
SELECT ST_PointZ(-71.104, 42.315, 3.4)
```

⊠⊠

ST_MakePoint, ST_PointFromText, ST_SetSRID, ST_MakePointM

7.3.10 ST_PointM

ST_PointM — Creates a Point with X, Y, M and SRID values.

Synopsis

geometry **ST_PointM**(float x, float y, float m, integer srid=unknown);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Point ⊠⊠⊠⊠⊠⊠. ST_MakePoint ⊠⊠⊠⊠ OGC ⊠⊠⊠⊠⊠.

Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry.

⊠⊠

```
SELECT ST_PointM(-71.104, 42.315, 3.4, 4326)
```

```
SELECT ST_PointM(-71.104, 42.315, 3.4, srid => 4326)
```

```
SELECT ST_PointM(-71.104, 42.315, 3.4)
```

☒☒

ST_MakePoint, ST_PointFromText, ST_SetSRID, ST_MakePointM

7.3.11 ST_PointZM

ST_PointZM — Creates a Point with X, Y, Z, M and SRID values.

Synopsis

geometry **ST_PointZM**(float x, float y, float z, float m, integer srid=unknown);

☒☒

☒☒☒☒☒☒☒☒☒ ST_Point ☒☒☒☒☒☒. ST_MakePoint ☒☒☒☒ OGC ☒☒☒☒☒.

Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry.

☒☒

```
SELECT ST_PointZM(-71.104, 42.315, 3.4, 4.5, 4326)
```

```
SELECT ST_PointZM(-71.104, 42.315, 3.4, 4.5, srid => 4326)
```

```
SELECT ST_PointZM(-71.104, 42.315, 3.4, 4.5)
```

☒☒

ST_MakePoint, ST_Point, ST_PointM, ST_PointZ, ST_SetSRID

7.3.12 ST_Polygon

ST_Polygon — Creates a Polygon from a LineString with a specified SRID.

Synopsis

geometry **ST_Polygon**(geometry lineString, integer srid);

☒☒

Returns a polygon built from the given LineString and sets the spatial reference system from the `srid`.

ST_Polygon is similar to ST_MakePolygon Variant 1 with the addition of setting the SRID.

, ST_MakePoint, ST_SetSRID

> **Note**
> □□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□ ST_LineMerge □□ ST_Dump □□□□□□□.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 8.3.2

This function supports 3d and will not drop the z-index.

□□

Create a 2D polygon.

```
SELECT ST_AsText( ST_Polygon('LINESTRING(75 29, 77 29, 77 29, 75 29)'::geometry, 4326) );

-- result --
POLYGON((75 29, 77 29, 77 29, 75 29))
```

Create a 3D polygon.

```
SELECT ST_AsEWKT( ST_Polygon( ST_GeomFromEWKT('LINESTRING(75 29 1, 77 29 2, 77 29 3, 75 29 ↩
    1)'), 4326) );

-- result --
SRID=4326;POLYGON((75 29 1, 77 29 2, 77 29 3, 75 29 1))
```

□□

ST_AsEWKT, ST_AsText, ST_GeomFromEWKT, ST_GeomFromText, ST_LineMerge, ST_MakePolygon

7.3.13 ST_TileEnvelope

ST_TileEnvelope — Creates a rectangular Polygon in Web Mercator (SRID:3857) using the XYZ tile system.

Synopsis

geometry **ST_TileEnvelope**(integer tileZoom, integer tileX, integer tileY, geometry bounds=SRID=3857;LI
20037508.342789 -20037508.342789,20037508.342789 20037508.342789), float margin=0.0);

□□

Creates a rectangular Polygon giving the extent of a tile in the XYZ tile system. The tile is specified by the zoom level Z and the XY index of the tile in the grid at that level. Can be used to define the tile bounds required by ST_AsMVTGeom to convert geometry into the MVT tile coordinate space.

By default, the tile envelope is in the Web Mercator coordinate system (SRID:3857) using the standard range of the Web Mercator system (-20037508.342789, 20037508.342789). This is the most common coordinate system used for MVT tiles. The optional `bounds` parameter can be used to generate tiles in any coordinate system. It is a geometry that has the SRID and extent of the "Zoom Level zero" square within which the XYZ tile system is inscribed.

The optional `margin` parameter can be used to expand a tile by the given percentage. E.g. `margin=0.125` expands the tile by 12.5%, which is equivalent to buffer=512 when the tile extent size is 4096, as used in ST_AsMVTGeom. This is useful to create a tile buffer to include data lying outside of the tile's visible area, but whose existence affects the tile rendering. For example, a city name (a point) could be near an edge of a tile, so its label should be rendered on two tiles, even though the point is located in the visible area of just one tile. Using expanded tiles in a query will include the city point in both tiles. Use a negative value to shrink the tile instead. Values less than -0.5 are prohibited because that would eliminate the tile completely. Do not specify a margin when using with `ST_AsMVTGeom`. See the example for ST_AsMVT.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsText( ST_TileEnvelope(2, 1, 1) );

 st_astext
------------------------------
 POLYGON((-10018754.1713945 0,-10018754.1713945 10018754.1713945,0 10018754.1713945,0  ↩
    0,-10018754.1713945 0))

SELECT ST_AsText( ST_TileEnvelope(3, 1, 1, ST_MakeEnvelope(-180, -90, 180, 90, 4326) ) );

                      st_astext
------------------------------------------------------
 POLYGON((-135 45,-135 67.5,-90 67.5,-90 45,-135 45))
```

⊠⊠

ST_MakeEnvelope

7.3.14 ST_HexagonGrid

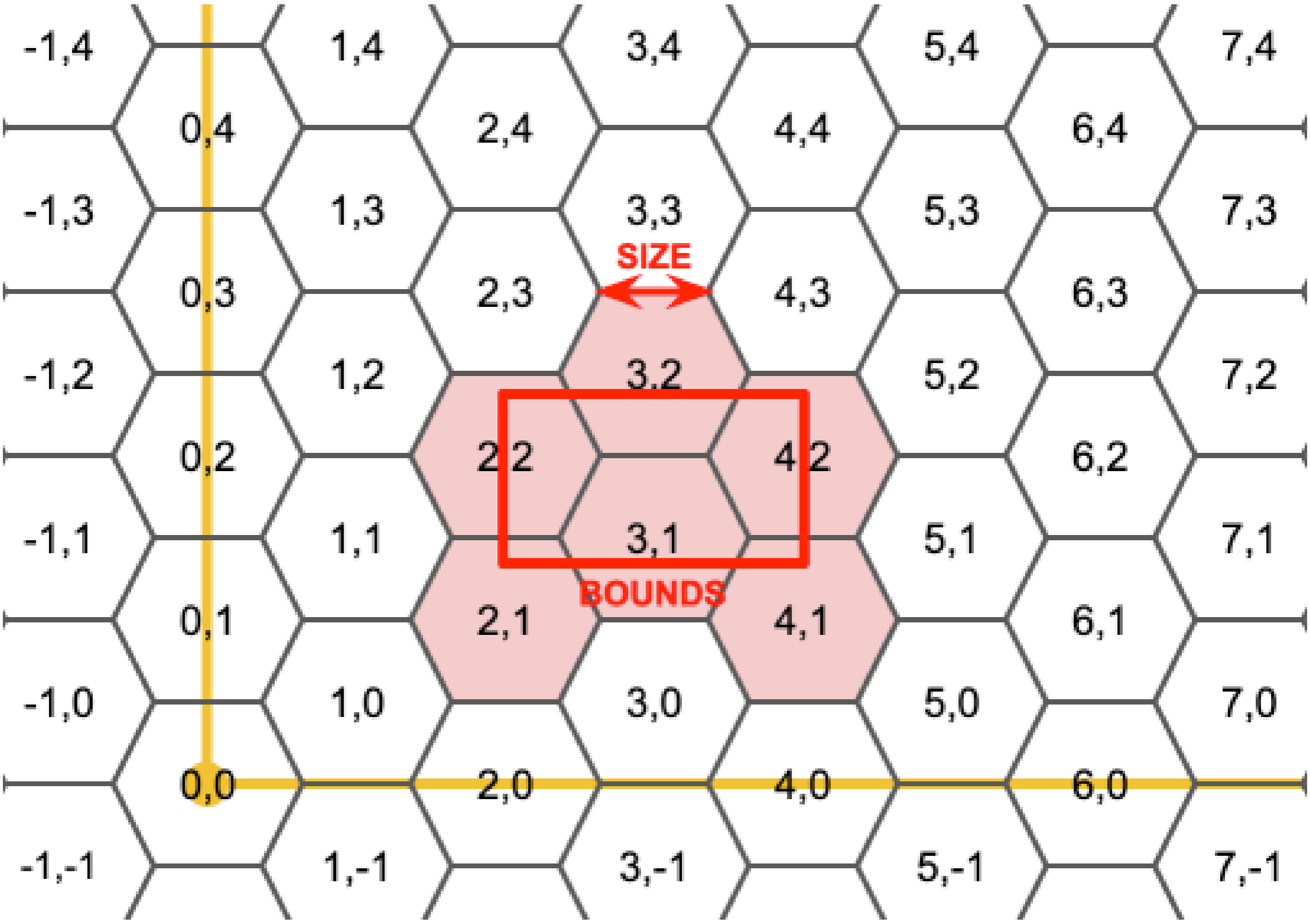
ST_HexagonGrid — Returns a set of hexagons and cell indices that completely cover the bounds of the geometry argument.

Synopsis

setof record **ST_HexagonGrid**(float8 size, geometry bounds);

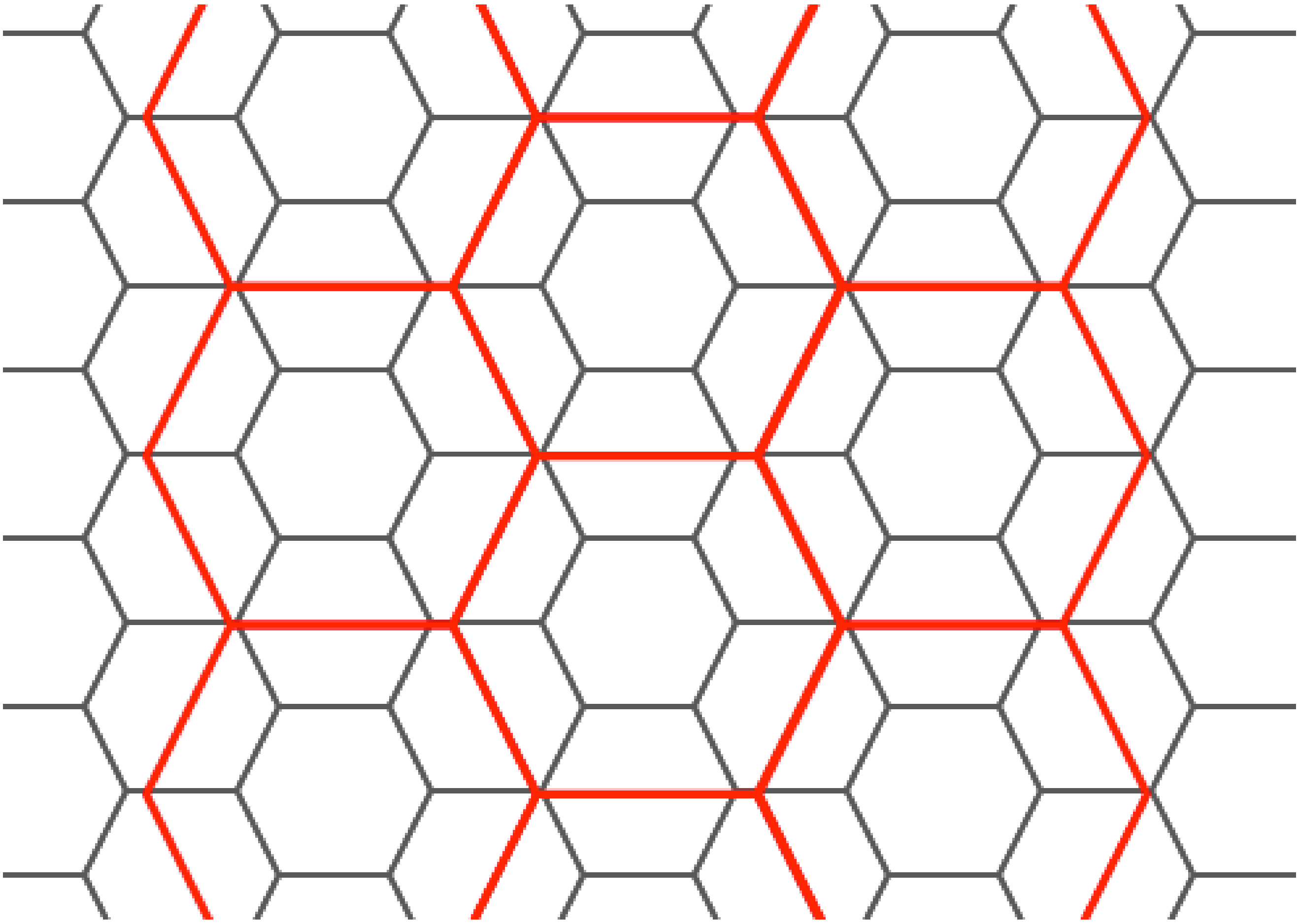
⊠⊠

Starts with the concept of a hexagon tiling of the plane. (Not a hexagon tiling of the globe, this is not the H3 tiling scheme.) For a given planar SRS, and a given edge size, starting at the origin of the SRS, there is one unique hexagonal tiling of the plane, Tiling(SRS, Size). This function answers the question: what hexagons in a given Tiling(SRS, Size) overlap with a given bounds.



The SRS for the output hexagons is the SRS provided by the bounds geometry.

Doubling or tripling the edge size of the hexagon generates a new parent tiling that fits with the origin tiling. Unfortunately, it is not possible to generate parent hexagon tilings that the child tiles perfectly fit inside.



2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

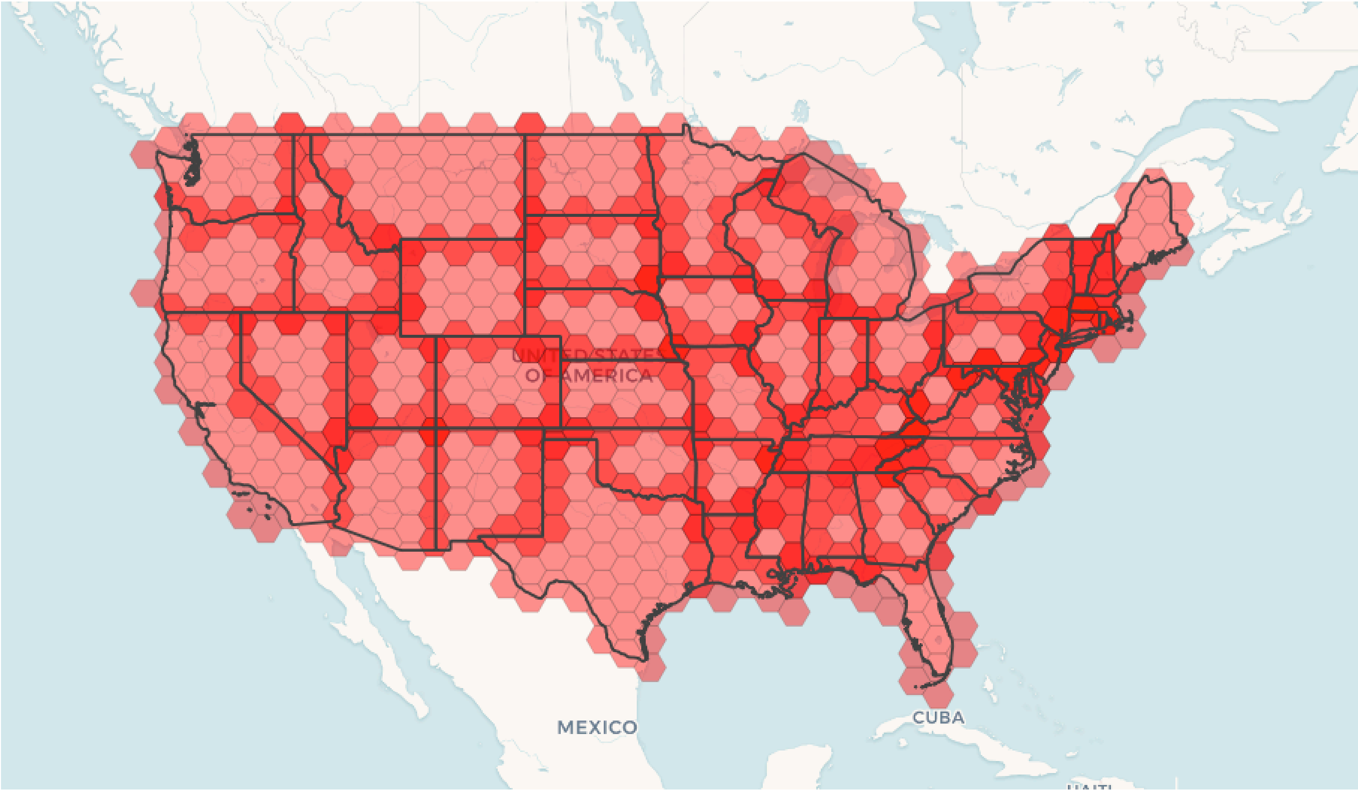
⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠

To do a point summary against a hexagonal tiling, generate a hexagon grid using the extent of the points as the bounds, then spatially join to that grid.

```
SELECT COUNT(*), hexes.geom
FROM
    ST_HexagonGrid(
        10000,
        ST_SetSRID(ST_EstimatedExtent('pointtable', 'geom'), 3857)
    ) AS hexes
    INNER JOIN
    pointtable AS pts
    ON ST_Intersects(pts.geom, hexes.geom)
GROUP BY hexes.geom;
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

If we generate a set of hexagons for each polygon boundary and filter out those that do not intersect their hexagons, we end up with a tiling for each polygon.



Tiling states results in a hexagon coverage of each state, and multiple hexagons overlapping at the borders between states.

> **Note**
> The LATERAL keyword is implied for set-returning functions when referring to a prior table in the FROM list. So CROSS JOIN LATERAL, CROSS JOIN, or just plain , are equivalent constructs for this example.

```
SELECT admin1.gid, hex.geom
FROM
    admin1
    CROSS JOIN
    ST_HexagonGrid(100000, admin1.geom) AS hex
WHERE
    adm0_a3 = 'USA'
    AND
    ST_Intersects(admin1.geom, hex.geom)
```

⊠⊠

ST_EstimatedExtent, ST_MakePoint, ST_Point, ST_SRID

7.3.15 ST_Hexagon

ST_Hexagon — Returns a single hexagon, using the provided edge size and cell coordinate within the hexagon grid space.

Synopsis

geometry **ST_Hexagon**(float8 size, integer cell_i, integer cell_j, geometry origin);

⊠⊠

Uses the same hexagon tiling concept as ST_HexagonGrid, but generates just one hexagon at the desired cell coordinate. Optionally, can adjust origin coordinate of the tiling, the default origin is at 0,0.

Hexagons are generated with no SRID set, so use ST_SetSRID to set the SRID to the one you expect.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Example: Creating a hexagon at the origin

```
SELECT ST_AsText(ST_SetSRID(ST_Hexagon(1.0, 0, 0), 3857));

POLYGON((-1 0,-0.5
         -0.866025403784439,0.5
         -0.866025403784439,1
         0,0.5
         0.866025403784439,-0.5
         0.866025403784439,-1 0))
```

⊠⊠

ST_TileEnvelope, ST_MakePoint, ST_SetSRID

7.3.16 ST_SquareGrid

ST_SquareGrid — Returns a set of grid squares and cell indices that completely cover the bounds of the geometry argument.

Synopsis

setof record **ST_SquareGrid**(float8 size, geometry bounds);

⊠⊠

Starts with the concept of a square tiling of the plane. For a given planar SRS, and a given edge size, starting at the origin of the SRS, there is one unique square tiling of the plane, Tiling(SRS, Size). This function answers the question: what grids in a given Tiling(SRS, Size) overlap with a given bounds.

The SRS for the output squares is the SRS provided by the bounds geometry.

Doubling or edge size of the square generates a new parent tiling that perfectly fits with the original tiling. Standard web map tilings in mercator are just powers-of-two square grids in the mercator plane.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

The grid will fill the whole bounds of the country, so if you want just squares that touch the country you will have to filter afterwards with ST_Intersects.

```
WITH grid AS (
SELECT (ST_SquareGrid(1, ST_Transform(geom,4326))).*
FROM admin0 WHERE name = 'Canada'
)
  SELEcT ST_AsText(geom)
  FROM grid
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠

To do a point summary against a square tiling, generate a square grid using the extent of the points as the bounds, then spatially join to that grid. Note the estimated extent might be off from actual extent, so be cautious and at very least make sure you've analyzed your table.

```
SELECT COUNT(*), squares.geom
    FROM
    pointtable AS pts
    INNER JOIN
    ST_SquareGrid(
        1000,
        ST_SetSRID(ST_EstimatedExtent('pointtable', 'geom'), 3857)
    ) AS squares
    ON ST_Intersects(pts.geom, squares.geom)
    GROUP BY squares.geom
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠

This yields the same result as the first example but will be slower for a large number of points

```
SELECT COUNT(*), squares.geom
    FROM
    pointtable AS pts
    INNER JOIN
    ST_SquareGrid(
        1000,
       pts.geom
    ) AS squares
    ON ST_Intersects(pts.geom, squares.geom)
    GROUP BY squares.geom
```

⊠⊠

ST_TileEnvelope, ST_Point, ST_SetSRID, ST_SRID

7.3.17 ST_Square

ST_Square — Returns a single square, using the provided edge size and cell coordinate within the square grid space.

Synopsis

geometry **ST_Square**(float8 size, integer cell_i, integer cell_j, geometry origin);

□□

Uses the same square tiling concept as ST_SquareGrid, but generates just one square at the desired cell coordinate. Optionally, can adjust origin coordinate of the tiling, the default origin is at 0,0.

Squares are generated with no SRID set, so use ST_SetSRID to set the SRID to the one you expect.

2.1.0 □□□□□□□□□□□□.

Example: Creating a square at the origin

```
SELECT ST_AsText(ST_SetSRID(ST_Square(1.0, 0, 0), 3857));

 POLYGON((0 0,0 1,1 1,1 0,0 0))
```

□□

ST_TileEnvelope, ST_MakeLine, ST_MakePolygon

7.3.18 ST_Letters

ST_Letters — Returns the input letters rendered as geometry with a default start position at the origin and default text height of 100.

Synopsis

geometry **ST_Letters**(text letters, json font);

□□

Uses a built-in font to render out a string as a multipolygon geometry. The default text height is 100.0, the distance from the bottom of a descender to the top of a capital. The default start position places the start of the baseline at the origin. Over-riding the font involves passing in a json map, with a character as the key, and base64 encoded TWKB for the font shape, with the fonts having a height of 1000 units from the bottom of the descenders to the tops of the capitals.

The text is generated at the origin by default, so to reposition and resize the text, first apply the `ST_Scale` function and then apply the `ST_Translate` function.

Availability: 3.3.0

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsText(ST_Letters('Yo'), 1);
```

Letters generated by ST_Letters

Example: Scaling and moving words

```
SELECT ST_Translate(ST_Scale(ST_Letters('Yo'), 10, 10), 100,100);
```

⊠⊠

ST_AsTWKB, ST_Scale, ST_Translate

7.4 ⊠⊠⊠⊠⊠ (accessor)

7.4.1 GeometryType

GeometryType — ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **GeometryType**(geometry geomA);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: 'LINESTRING', 'POLYGON', 'MULTIPOINT' ⊠⊠.

OGC ⊠⊠ s2.1.1.1 - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

> **Note**
> ⊠⊠⊠⊠’POINTM’ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method supports Circular Strings and Curves.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT GeometryType(ST_GeomFromText('LINESTRING(77.29 29.07,77.42 29.26,77.27 29.31,77.29 ↩
    29.07)'));
 geometrytype
--------------
 LINESTRING
```

```
SELECT ST_GeometryType(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 ↩
    0 0)),
                ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0) ↩
                    ),
                ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
                ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1) ↩
                    ) )'));
                        --result
                        POLYHEDRALSURFACE
```

```
SELECT GeometryType(geom) as result
  FROM
    (SELECT
       ST_GeomFromEWKT('TIN (((
                0 0 0,
                0 0 1,
                0 1 0,
                0 0 0
            )), ((
                0 0 0,
                0 1 0,
                1 1 0,
                0 0 0
            ))
            )')  AS geom
    ) AS g;
 result
--------
 TIN
```

⊠⊠

ST_GeometryType

7.4.2 ST_Boundary

ST_Boundary — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Boundary**(geometry geomA);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (closure) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ (combinatorial boundary) ⊠ OGC ⊠⊠⊠⊠ 3.12.3.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ (位相的) ⊠⊠⊠⊠⊠⊠⊠⊠⊠, OGC ⊠⊠⊠ 3.12.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (primitive) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

GEOS ⊠⊠⊠⊠⊠

> **Note**
> 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GEOMETRYCOLLECTION ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) NULL ⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. OGC SPEC s2.1.1.1

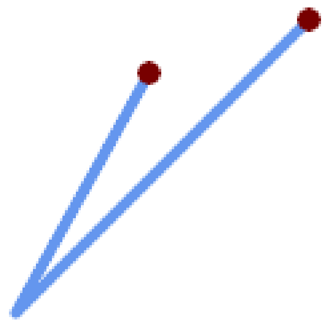
This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1.17

This function supports 3d and will not drop the z-index.

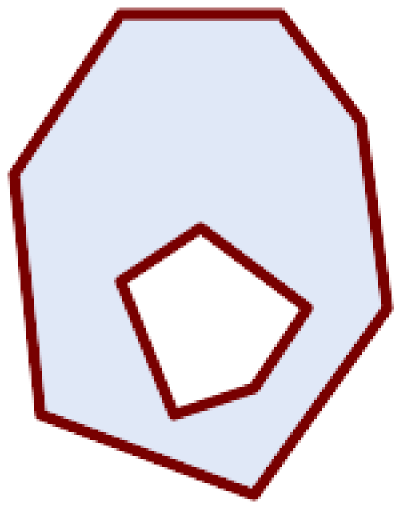
⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Changed: 3.2.0 support for TIN, does not use geos, does not linearize curves

⊠⊠



```
SELECT ST_Boundary(geom)
FROM (SELECT 'LINESTRING(100 150,50 60, 70 80, 160 170)'::geometry As geom) As f;

ST_AsText output

MULTIPOINT((100 150),(160 170))
```



```
SELECT ST_Boundary(geom)
FROM (SELECT
'POLYGON (( 10 130, 50 190, 110 190, 140 150, 150 80, 100 10, 20 40, 10 130 ),
        ( 70 40, 100 50, 120 80, 80 110, 50 90, 70 40 ))'::geometry As geom) As f;

ST_AsText output

MULTILINESTRING((10 130,50 190,110 190,140 150,150 80,100 10,20 40,10 130),
        (70 40,100 50,120 80,80 110,50 90,70 40))
```

```
SELECT ST_AsText(ST_Boundary(ST_GeomFromText('LINESTRING(1 1,0 0, -1 1)')));
st_astext
-----------
MULTIPOINT((1 1),(-1 1))

SELECT ST_AsText(ST_Boundary(ST_GeomFromText('POLYGON((1 1,0 0, -1 1, 1 1))')));
st_astext
----------
LINESTRING(1 1,0 0,-1 1,1 1)

--Using a 3d polygon
SELECT ST_AsEWKT(ST_Boundary(ST_GeomFromEWKT('POLYGON((1 1 1,0 0 1, -1 1 1, 1 1 1))')));

st_asewkt
-----------------------------------
LINESTRING(1 1 1,0 0 1,-1 1 1,1 1 1)

--Using a 3d multilinestring
SELECT ST_AsEWKT(ST_Boundary(ST_GeomFromEWKT('MULTILINESTRING((1 1 1,0 0 0.5, -1 1 1),(1 1 0.5,0 0 0.5, -1 1 0.5, 1 1 0.5) )')));

st_asewkt
----------
```

```
MULTIPOINT((-1 1 1),(1 1 0.75))
```

⊠⊠

ST_AsText, ST_ExteriorRing, ST_MakePolygon

7.4.3 ST_BoundingDiagonal

ST_BoundingDiagonal — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_BoundingDiagonal**(geometry geom, boolean fits=false);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`fits` ⊠⊠⊠⊠⊠⊠⊠⊠ (best fit) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

⊠⊠

```
-- Get the minimum X in a buffer around a point
SELECT ST_X(ST_StartPoint(ST_BoundingDiagonal(
  ST_Buffer(ST_Point(0,0),10)
)));
 st_x
------
  -10
```

⊠⊠

ST_StartPoint, ST_EndPoint, ST_X, ST_Y, ST_Z, ST_M, &&&

7.4.4 ST_CoordDim

ST_CoordDim — ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_CoordDim**(geometry geomA);

⊠⊠

ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
⊠⊠⊠⊠ MM ⊠⊠⊠⊠⊠, ST_NDims ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.3

This method supports Circular Strings and Curves.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT ST_CoordDim('CIRCULARSTRING(1 2 3, 1 3 4, 5 6 7, 8 9 10, 11 12 13)');
                        ---result--
                                3

                                SELECT ST_CoordDim(ST_Point(1,2));
                        --result--
                                2
```

⊠⊠

ST_NDims

7.4.5 ST_Dimension

ST_Dimension — ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_Dimension**(geometry g);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. OGC ⊠⊠⊠ s2.1.1.1 ⊠⊠⊠⊠⊠⊠ `POINT` ⊠ 0, `LINESTRING` ⊠ 1, `POLYGON` ⊠ 2, ⊠⊠⊠ `GEOMETRYCOLLECTION` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠) ⊠⊠⊠⊠⊠⊠ null ⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.2

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT ST_Dimension('GEOMETRYCOLLECTION(LINESTRING(1 1,0 0),POINT(0 0))');
ST_Dimension
-----------
1
```

⊠⊠

ST_NDims

7.4.6 ST_Dump

ST_Dump — Returns a set of `geometry_dump` rows for the components of a geometry.

Synopsis

geometry_dump[] **ST_Dump**(geometry g1);

⊠⊠

A set-returning function (SRF) that extracts the components of a geometry. It returns a set of geometry_dump rows, each containing a geometry (*geom* field) and an array of integers (*path* field).

For an atomic geometry type (POINT,LINESTRING,POLYGON) a single record is returned with an empty *path* array and the input geometry as *geom*. For a collection or multi-geometry a record is returned for each of the collection components, and the *path* denotes the position of the component inside the collection.

ST_Dump is useful for expanding geometries. It is the inverse of a ST_Collect / GROUP BY, in that it creates new rows. For example it can be use to expand MULTIPOLYGONS into POLYGONS.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: PostGIS 1.0.0RC1. Requires PostgreSQL 7.3 or higher.

> **Note**
> 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

⊠⊠⊠⊠

```
SELECT sometable.field1, sometable.field1,
      (ST_Dump(sometable.geom)).geom AS geom
FROM sometable;

-- Break a compound curve into its constituent linestrings and circularstrings
SELECT ST_AsEWKT(a.geom), ST_HasArc(a.geom)
  FROM ( SELECT (ST_Dump(p_geom)).geom AS geom
         FROM (SELECT ST_GeomFromEWKT('COMPOUNDCURVE(CIRCULARSTRING(0 0, 1 1, 1 0),(1 0, 0 1))') AS p_geom) AS b
        ) AS a;
          st_asewkt          | st_hasarc
-----------------------------+----------
 CIRCULARSTRING(0 0,1 1,1 0) | t
 LINESTRING(1 0,0 1)         | f
(2 rows)
```

⊠⊠⊠⊠⊠, TIN ⊠⊠⊠⊠⊠⊠⊠

```
-- Polyhedral surface example
-- Break a Polyhedral surface into its faces
SELECT (a.p_geom).path[1] As path, ST_AsEWKT((a.p_geom).geom) As geom_ewkt
  FROM (SELECT ST_Dump(ST_GeomFromEWKT('POLYHEDRALSURFACE(
((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),  ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),  ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1))
)') ) AS p_geom )  AS a;

 path |                geom_ewkt
------+------------------------------------------
    1 | POLYGON((0 0 0,0 0 1,0 1 1,0 1 0,0 0 0))
    2 | POLYGON((0 0 0,0 1 0,1 1 0,1 0 0,0 0 0))
    3 | POLYGON((0 0 0,1 0 0,1 0 1,0 0 1,0 0 0))
    4 | POLYGON((1 1 0,1 1 1,1 0 1,1 0 0,1 1 0))
    5 | POLYGON((0 1 0,0 1 1,1 1 1,1 1 0,0 1 0))
    6 | POLYGON((0 0 1,1 0 1,1 1 1,0 1 1,0 0 1))
```

```
-- TIN --
SELECT (g.gdump).path, ST_AsEWKT((g.gdump).geom) as wkt
  FROM
```

```
    (SELECT
       ST_Dump( ST_GeomFromEWKT('TIN (((
                0 0 0,
                0 0 1,
                0 1 0,
                0 0 0
            )), ((
                0 0 0,
                0 1 0,
                1 1 0,
                0 0 0
            ))
            )') ) AS gdump
    ) AS g;
-- result --
 path |                 wkt
------+----------------------------------
 {1}  | TRIANGLE((0 0 0,0 0 1,0 1 0,0 0 0))
 {2}  | TRIANGLE((0 0 0,0 1 0,1 1 0,0 0 0))
```

⊠⊠

geometry_dump, ST_GeomFromEWKT, ST_Dump, ST_GeometryN, ST_NumGeometries

7.4.7 ST_DumpPoints

ST_DumpPoints — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry_dump[] **ST_DumpPoints**(geometry geom);

⊠⊠

A set-returning function (SRF) that extracts the coordinates (vertices) of a geometry. It returns a set of geometry_dump rows, each containing a geometry (*geom* field) and an array of integers (*path* field).

- the *geom* field `POINT`s represent the coordinates of the supplied geometry.
- the *path* field (an `integer[]`) is an index enumerating the coordinate positions in the elements of the supplied geometry. The indices are 1-based. For example, for a `LINESTRING` the paths are `{i}` where `i` is the `nth` coordinate in the `LINESTRING`. For a `POLYGON` the paths are `{i,j}` where `i` is the ring number (1 is outer; inner rings follow) and `j` is the coordinate position in the ring.

To obtain a single geometry containing the coordinates use ST_Points.

Enhanced: 2.1.0 Faster speed. Reimplemented as native-C.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

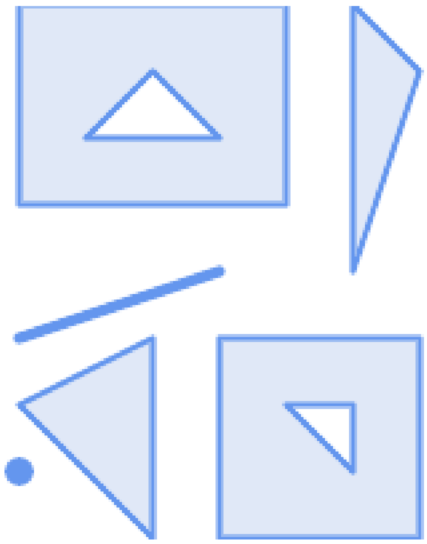
This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

Classic Explode a Table of LineStrings into nodes

```
SELECT edge_id, (dp).path[1] As index, ST_AsText((dp).geom) As wktnode
FROM (SELECT 1 As edge_id
        , ST_DumpPoints(ST_GeomFromText('LINESTRING(1 2, 3 4, 10 10)')) AS dp
     UNION ALL
     SELECT 2 As edge_id
        , ST_DumpPoints(ST_GeomFromText('LINESTRING(3 5, 5 6, 9 10)')) AS dp
   ) As foo;
 edge_id | index |    wktnode
---------+-------+--------------
       1 |     1 | POINT(1 2)
       1 |     2 | POINT(3 4)
       1 |     3 | POINT(10 10)
       2 |     1 | POINT(3 5)
       2 |     2 | POINT(5 6)
       2 |     3 | POINT(9 10)
```

☒☒☒☒



```
SELECT path, ST_AsText(geom)
FROM (
  SELECT (ST_DumpPoints(g.geom)).*
  FROM
    (SELECT
       'GEOMETRYCOLLECTION(
          POINT ( 0 1 ),
          LINESTRING ( 0 3, 3 4 ),
          POLYGON (( 2 0, 2 3, 0 2, 2 0 )),
          POLYGON (( 3 0, 3 3, 6 3, 6 0, 3 0 ),
                   ( 5 1, 4 2, 5 2, 5 1 )),
          MULTIPOLYGON (
                  (( 0 5, 0 8, 4 8, 4 5, 0 5 ),
                   ( 1 6, 3 6, 2 7, 1 6 )),
```

```
                  (( 5 4, 5 8, 6 7, 5 4 ))
          )
        )'::geometry AS geom
    ) AS g
  ) j;

   path    | st_astext
-----------+------------
 {1,1}     | POINT(0 1)
 {2,1}     | POINT(0 3)
 {2,2}     | POINT(3 4)
 {3,1,1}   | POINT(2 0)
 {3,1,2}   | POINT(2 3)
 {3,1,3}   | POINT(0 2)
 {3,1,4}   | POINT(2 0)
 {4,1,1}   | POINT(3 0)
 {4,1,2}   | POINT(3 3)
 {4,1,3}   | POINT(6 3)
 {4,1,4}   | POINT(6 0)
 {4,1,5}   | POINT(3 0)
 {4,2,1}   | POINT(5 1)
 {4,2,2}   | POINT(4 2)
 {4,2,3}   | POINT(5 2)
 {4,2,4}   | POINT(5 1)
 {5,1,1,1} | POINT(0 5)
 {5,1,1,2} | POINT(0 8)
 {5,1,1,3} | POINT(4 8)
 {5,1,1,4} | POINT(4 5)
 {5,1,1,5} | POINT(0 5)
 {5,1,2,1} | POINT(1 6)
 {5,1,2,2} | POINT(3 6)
 {5,1,2,3} | POINT(2 7)
 {5,1,2,4} | POINT(1 6)
 {5,2,1,1} | POINT(5 4)
 {5,2,1,2} | POINT(5 8)
 {5,2,1,3} | POINT(6 7)
 {5,2,1,4} | POINT(5 4)
(29 rows)
```

□□□□□, TIN □□□□□□

```
-- Polyhedral surface cube --
SELECT (g.gdump).path, ST_AsEWKT((g.gdump).geom) as wkt
  FROM
    (SELECT
       ST_DumpPoints(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0  ↩
           0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )') ) AS gdump
    ) AS g;
-- result --
  path   |     wkt
---------+--------------
 {1,1,1} | POINT(0 0 0)
 {1,1,2} | POINT(0 0 1)
 {1,1,3} | POINT(0 1 1)
 {1,1,4} | POINT(0 1 0)
 {1,1,5} | POINT(0 0 0)
 {2,1,1} | POINT(0 0 0)
```

```
 {2,1,2} | POINT(0 1 0)
 {2,1,3} | POINT(1 1 0)
 {2,1,4} | POINT(1 0 0)
 {2,1,5} | POINT(0 0 0)
 {3,1,1} | POINT(0 0 0)
 {3,1,2} | POINT(1 0 0)
 {3,1,3} | POINT(1 0 1)
 {3,1,4} | POINT(0 0 1)
 {3,1,5} | POINT(0 0 0)
 {4,1,1} | POINT(1 1 0)
 {4,1,2} | POINT(1 1 1)
 {4,1,3} | POINT(1 0 1)
 {4,1,4} | POINT(1 0 0)
 {4,1,5} | POINT(1 1 0)
 {5,1,1} | POINT(0 1 0)
 {5,1,2} | POINT(0 1 1)
 {5,1,3} | POINT(1 1 1)
 {5,1,4} | POINT(1 1 0)
 {5,1,5} | POINT(0 1 0)
 {6,1,1} | POINT(0 0 1)
 {6,1,2} | POINT(1 0 1)
 {6,1,3} | POINT(1 1 1)
 {6,1,4} | POINT(0 1 1)
 {6,1,5} | POINT(0 0 1)
(30 rows)
```

```
-- Triangle --
SELECT (g.gdump).path, ST_AsText((g.gdump).geom) as wkt
  FROM
    (SELECT
       ST_DumpPoints( ST_GeomFromEWKT('TRIANGLE ((
                0 0,
                0 9,
                9 0,
                0 0
            ))') ) AS gdump
    ) AS g;
-- result --
 path |    wkt
------+------------
 {1}  | POINT(0 0)
 {2}  | POINT(0 9)
 {3}  | POINT(9 0)
 {4}  | POINT(0 0)
```

```
-- TIN --
SELECT (g.gdump).path, ST_AsEWKT((g.gdump).geom) as wkt
  FROM
    (SELECT
       ST_DumpPoints( ST_GeomFromEWKT('TIN (((
                0 0 0,
                0 0 1,
                0 1 0,
                0 0 0
            )), ((
                0 0 0,
                0 1 0,
                1 1 0,
                0 0 0
            ))
            )') ) AS gdump
```

```
    ) AS g;
-- result --
  path   |     wkt
---------+--------------
 {1,1,1} | POINT(0 0 0)
 {1,1,2} | POINT(0 0 1)
 {1,1,3} | POINT(0 1 0)
 {1,1,4} | POINT(0 0 0)
 {2,1,1} | POINT(0 0 0)
 {2,1,2} | POINT(0 1 0)
 {2,1,3} | POINT(1 1 0)
 {2,1,4} | POINT(0 0 0)
(8 rows)
```

⊠⊠

geometry_dump, ST_GeomFromEWKT, ST_Dump, ST_GeometryN, ST_NumGeometries

7.4.8 ST_DumpSegments

ST_DumpSegments — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry_dump[] **ST_DumpSegments**(geometry geom);

⊠⊠

A set-returning function (SRF) that extracts the segments of a geometry. It returns a set of geometry_dump rows, each containing a geometry (*geom* field) and an array of integers (*path* field).

- the *geom* field `LINESTRING`s represent the linear segments of the supplied geometry, while the `CIRCULARSTRING`s represent the arc segments.
- the *path* field (an `integer[]`) is an index enumerating the segment start point positions in the elements of the supplied geometry. The indices are 1-based. For example, for a `LINESTRING` the paths are `{i}` where `i` is the `nth` segment start point in the `LINESTRING`. For a `POLYGON` the paths are `{i,j}` where `i` is the ring number (1 is outer; inner rings follow) and `j` is the segment start point position in the ring.

Availability: 3.2.0

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

⊠⊠⊠⊠

```
SELECT path, ST_AsText(geom)
FROM (
    SELECT (ST_DumpSegments(g.geom)).*
    FROM (SELECT 'GEOMETRYCOLLECTION(
    LINESTRING(1 1, 3 3, 4 4),
    POLYGON((5 5, 6 6, 7 7, 5 5))
)'::geometry AS geom
        ) AS g
) j;

  path   b''|b''      st_astext
---------------------------------
 {1,1}   b''|b'' LINESTRING(1 1,3 3)
 {1,2}   b''|b'' LINESTRING(3 3,4 4)
 {2,1,1} b''|b'' LINESTRING(5 5,6 6)
 {2,1,2} b''|b'' LINESTRING(6 6,7 7)
 {2,1,3} b''|b'' LINESTRING(7 7,5 5)
(5 rows)
```

□□□□□, TIN □□□□□□

```
-- Triangle --
SELECT path, ST_AsText(geom)
FROM (
    SELECT (ST_DumpSegments(g.geom)).*
    FROM (SELECT 'TRIANGLE((
        0 0,
        0 9,
        9 0,
        0 0
    ))'::geometry AS geom
        ) AS g
) j;

 path  b''|b''      st_astext
 ---------------------------------
 {1,1} b''|b'' LINESTRING(0 0,0 9)
 {1,2} b''|b'' LINESTRING(0 9,9 0)
 {1,3} b''|b'' LINESTRING(9 0,0 0)
(3 rows)
```

```
-- TIN --
SELECT path, ST_AsEWKT(geom)
FROM (
    SELECT (ST_DumpSegments(g.geom)).*
    FROM (SELECT 'TIN(((
        0 0 0,
        0 0 1,
        0 1 0,
        0 0 0
    )), ((
        0 0 0,
        0 1 0,
        1 1 0,
        0 0 0
    ))
    )'::geometry AS geom
        ) AS g
```

```
) j;

  path   b''|b''        st_asewkt
  ---------------------------------
 {1,1,1} b''|b'' LINESTRING(0 0 0,0 0 1)
 {1,1,2} b''|b'' LINESTRING(0 0 1,0 1 0)
 {1,1,3} b''|b'' LINESTRING(0 1 0,0 0 0)
 {2,1,1} b''|b'' LINESTRING(0 0 0,0 1 0)
 {2,1,2} b''|b'' LINESTRING(0 1 0,1 1 0)
 {2,1,3} b''|b'' LINESTRING(1 1 0,0 0 0)
(6 rows)
```

⊠⊠

geometry_dump, ST_Collect, ST_Dump, ST_NumInteriorRing,

7.4.9 ST_DumpRings

ST_DumpRings — Returns a set of `geometry_dump` rows for the exterior and interior rings of a Polygon.

Synopsis

geometry_dump[] **ST_DumpRings**(geometry a_polygon);

⊠⊠

A set-returning function (SRF) that extracts the rings of a polygon. It returns a set of geometry_dump rows, each containing a geometry (*geom* field) and an array of integers (*path* field).

The *geom* field contains each ring as a POLYGON. The *path* field is an integer array of length 1 containing the polygon ring index. The exterior ring (shell) has index 0. The interior rings (holes) have indices of 1 and higher.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Dump ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: PostGIS 1.1.3. Requires PostgreSQL 7.3 or higher.

This function supports 3d and will not drop the z-index.

⊠⊠

General form of query.

```
SELECT polyTable.field1, polyTable.field1,
          (ST_DumpRings(polyTable.geom)).geom As geom
FROM polyTable;
```

A polygon with a single hole.

```
SELECT path, ST_AsEWKT(geom) As geom
        FROM ST_DumpRings(
                ST_GeomFromEWKT('POLYGON((-8149064 5133092 1,-8149064 5132986 1,-8148996 ↩
                    5132839 1,-8148972 5132767 1,-8148958 5132508 1,-8148941 5132466 ↩
                    1,-8148924 5132394 1,
                -8148903 5132210 1,-8148930 5131967 1,-8148992 5131978 1,-8149237 5132093 ↩
                    1,-8149404 5132211 1,-8149647 5132310 1,-8149757 5132394 1,
                -8150305 5132788 1,-8149064 5133092 1),
                (-8149362 5132394 1,-8149446 5132501 1,-8149548 5132597 1,-8149695 5132675 ↩
                    1,-8149362 5132394 1))')
                )  as foo;
 path |                                            geom
----------------------------------------------------------------------------------------------------

  {0} | POLYGON((-8149064 5133092 1,-8149064 5132986 1,-8148996 5132839 1,-8148972 5132767 ↩
      1,-8148958 5132508 1,
          |          -8148941 5132466 1,-8148924 5132394 1,
          |          -8148903 5132210 1,-8148930 5131967 1,
          |          -8148992 5131978 1,-8149237 5132093 1,
          |          -8149404 5132211 1,-8149647 5132310 1,-8149757 5132394 1,-8150305 ↩
              5132788 1,-8149064 5133092 1))
  {1} | POLYGON((-8149362 5132394 1,-8149446 5132501 1,
          |          -8149548 5132597 1,-8149695 5132675 1,-8149362 5132394 1))
```

☒☒

geometry_dump, ST_GeomFromEWKT, ST_Dump, ST_GeometryN, ST_NumGeometries

7.4.10 ST_EndPoint

ST_EndPoint — ST_LineString ☒☒ ST_CircularString ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_EndPoint**(geometry g);

☒☒

LINESTRING ☒☒ CIRCULARLINESTRING ☒☒☒☒☒☒☒☒☒☒☒ POINT ☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒ LINESTRING ☒☒ CIRCULARLINESTRING ☒☒☒☒☒ NULL ☒☒☒☒☒☒.

This method implements the SQL/MM specification. SQL-MM 3: 7.1.4

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

> **Note**
> ☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. PostGIS ☒☒☒. 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ NULL ☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ 2.0 ☒☒☒☒☒ NULL ☒☒☒☒☒☒☒☒☒☒☒.

⊠⊠

End point of a LineString

```
postgis=# SELECT ST_AsText(ST_EndPoint('LINESTRING(1 1, 2 2, 3 3)'::geometry));
 st_astext
------------
 POINT(3 3)
```

End point of a non-LineString is NULL

```
SELECT ST_EndPoint('POINT(1 1)'::geometry) IS NULL AS is_null;
  is_null
----------
 t
```

End point of a 3D LineString

```
--3d endpoint
SELECT ST_AsEWKT(ST_EndPoint('LINESTRING(1 1 2, 1 2 3, 0 0 5)'));
  st_asewkt
--------------
 POINT(0 0 5)
```

ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AsText(ST_EndPoint('CIRCULARSTRING(5 2,-3 1.999999, -2 1, -4 2, 6 3)'::geometry)) ↩
    ;
 st_astext
------------
 POINT(6 3)
```

⊠⊠

ST_PointN, ST_StartPoint

7.4.11 ST_Envelope

ST_Envelope — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (double precision; float8) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Envelope**(geometry g1);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ float8 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ ((MINX, MINY), (MINX, MAXY), (MAXX, MAXY), (MAXX, MINY), (MINX, MINY)). (PostGIS ⊠ ZMIN/ZMAX ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.)

⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠, ⊠⊠⊠) ⊠⊠ POLYGON ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ POINT ⊠⊠ LINESTRING ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.

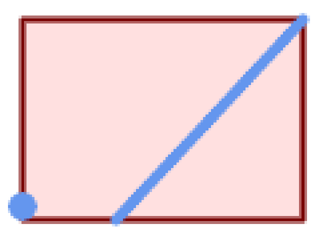
1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, float4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.1

This method implements the SQL/MM specification. SQL-MM 3: 5.1.19

⊠⊠

```
SELECT ST_AsText(ST_Envelope('POINT(1 3)'::geometry));
 st_astext
------------
 POINT(1 3)
(1 row)


SELECT ST_AsText(ST_Envelope('LINESTRING(0 0, 1 3)'::geometry));
                   st_astext
--------------------------------
 POLYGON((0 0,0 3,1 3,1 0,0 0))
(1 row)


SELECT ST_AsText(ST_Envelope('POLYGON((0 0, 0 1, 1.0000001 1, 1.0000001 0, 0 0))'::geometry));
                                                  st_astext
--------------------------------------------------------------
 POLYGON((0 0,0 1,1.00000011920929 1,1.00000011920929 0,0 0))
(1 row)
SELECT ST_AsText(ST_Envelope('POLYGON((0 0, 0 1, 1.0000000001 1, 1.0000000001 0, 0 0))'::geometry));
                                                  st_astext
--------------------------------------------------------------
 POLYGON((0 0,0 1,1.00000011920929 1,1.00000011920929 0,0 0))
(1 row)

SELECT Box3D(geom), Box2D(geom), ST_AsText(ST_Envelope(geom)) As envelopewkt
        FROM (SELECT 'POLYGON((0 0, 0 1000012333334.34545678, 1.0000001 1, 1.0000001 0, 0 0))'::geometry As geom) As foo;
```



Envelope of a point and linestring.

```
SELECT ST_AsText(ST_Envelope(
                ST_Collect(
                        ST_GeomFromText('LINESTRING(55 75,125 150)'),
                                ST_Point(20, 80))
```

```
                                )) As wktenv;
wktenv
-----------
POLYGON((20 75,20 150,125 150,125 75,20 75))
```

⊠⊠

Box2D, Box3D, ST_OrientedEnvelope

7.4.12 ST_ExteriorRing

ST_ExteriorRing — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_ExteriorRing**(geometry a_polygon);

⊠⊠

POLYGON ⊠⊠⊠⊠⊠⊠⊠ (exterior ring) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Dump ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. 2.1.5.1

This method implements the SQL/MM specification. SQL-MM 3: 8.2.3, 8.3.3

This function supports 3d and will not drop the z-index.

⊠⊠

```
--If you have a table of polygons
SELECT gid, ST_ExteriorRing(geom) AS ering
FROM sometable;

--If you have a table of MULTIPOLYGONs
--and want to return a MULTILINESTRING composed of the exterior rings of each polygon
SELECT gid, ST_Collect(ST_ExteriorRing(geom)) AS erings
        FROM (SELECT gid, (ST_Dump(geom)).geom As geom
                        FROM sometable) As foo
GROUP BY gid;

--3d Example
SELECT ST_AsEWKT(
        ST_ExteriorRing(
        ST_GeomFromEWKT('POLYGON((0 0 1, 1 1 1, 1 2 1, 1 1 1, 0 0 1))')
```

```
        )
);

st_asewkt
---------
LINESTRING(0 0 1,1 1 1,1 2 1,1 1 1,0 0 1)
```

⊠⊠

ST_InteriorRingN, ST_Boundary, ST_NumInteriorRings

7.4.13 ST_GeometryN

ST_GeometryN — ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeometryN**(geometry geomA, integer n);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, (⊠⊠) ⊠⊠⊠⊠, (⊠⊠) ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ (multicurve) ⊠⊠ (⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠ 1-⊠⊠ N ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> 0.8.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ OGC ⊠⊠⊠⊠⊠ 1-⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ 0-⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Dump ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.0.0 ⊠⊠⊠⊠ ST_GeometryN(..,1) ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 9.1.5

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

□□□□

```
--Extracting a subset of points from a 3d multipoint
SELECT n, ST_AsEWKT(ST_GeometryN(geom, n)) As geomewkt
FROM (
VALUES (ST_GeomFromEWKT('MULTIPOINT((1 2 7), (3 4 7), (5 6 7), (8 9 10))') ),
( ST_GeomFromEWKT('MULTICURVE(CIRCULARSTRING(2.5 2.5,4.5 2.5, 3.5 3.5), (10 11, 12 11))') )
        )As foo(geom)
        CROSS JOIN generate_series(1,100) n
WHERE n <= ST_NumGeometries(geom);

 n |               geomewkt
---+-----------------------------------------
 1 | POINT(1 2 7)
 2 | POINT(3 4 7)
 3 | POINT(5 6 7)
 4 | POINT(8 9 10)
 1 | CIRCULARSTRING(2.5 2.5,4.5 2.5,3.5 3.5)
 2 | LINESTRING(10 11,12 11)


--Extracting all geometries (useful when you want to assign an id)
SELECT gid, n, ST_GeometryN(geom, n)
FROM sometable CROSS JOIN generate_series(1,100) n
WHERE n <= ST_NumGeometries(geom);
```

□□□□□, TIN □□□□□□

```
-- Polyhedral surface example
-- Break a Polyhedral surface into its faces
SELECT ST_AsEWKT(ST_GeometryN(p_geom,3)) As geom_ewkt
  FROM (SELECT ST_GeomFromEWKT('POLYHEDRALSURFACE(
((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1))
)')  AS p_geom )  AS a;

                geom_ewkt
------------------------------------------
 POLYGON((0 0 0,1 0 0,1 0 1,0 0 1,0 0 0))
```

```
-- TIN --
SELECT ST_AsEWKT(ST_GeometryN(geom,2)) as wkt
  FROM
    (SELECT
       ST_GeomFromEWKT('TIN (((
                0 0 0,
                0 0 1,
                0 1 0,
                0 0 0
            )), ((
                0 0 0,
                0 1 0,
                1 1 0,
                0 0 0
            ))
```

```
            )')  AS geom
    ) AS g;
-- result --
                 wkt
-------------------------------------
 TRIANGLE((0 0 0,0 1 0,1 1 0,0 0 0))
```

⊠⊠

ST_Dump, ST_NumGeometries

7.4.14 ST_GeometryType

ST_GeometryType — ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_GeometryType**(geometry g1);

⊠⊠

⊠⊠⊠⊠⊠⊠'ST_LineString', 'ST_Polygon', 'ST_MultiPolygon' ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GeometryType(geometry) ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.4

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_GeometryType(ST_GeomFromText('LINESTRING(77.29 29.07,77.42 29.26,77.27 ↩
    29.31,77.29 29.07)'));
                        --result
                        ST_LineString
```

```
SELECT ST_GeometryType(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 ↩
    0 0)),
                ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0) ↩
                    ),
                ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
                ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1) ↩
                    ) )'));
                        --result
                        ST_PolyhedralSurface
```

```
SELECT ST_GeometryType(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 ↩
    0 0)),
                ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0) ↩
                    ),
                ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
                ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1) ↩
                    ) )'));
                        --result
                        ST_PolyhedralSurface
```

```
SELECT ST_GeometryType(geom) as result
  FROM
    (SELECT
       ST_GeomFromEWKT('TIN (((
                0 0 0,
                0 0 1,
                0 1 0,
                0 0 0
            )), ((
                0 0 0,
                0 1 0,
                1 1 0,
                0 0 0
            ))
            )')  AS geom
    ) AS g;
 result
--------
 ST_Tin
```

□□

GeometryType

7.4.15 ST_HasArc

ST_HasArc — Tests if a geometry contains a circular arc

Synopsis

boolean **ST_HasArc**(geometry geomA);

□□

□□□□□□□□□□□, □□□, □□□□□□□□ TRUE □□□□□□.

1.2.2 □□□□□□□□□□□□.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

□□

```
SELECT ST_HasArc(ST_Collect('LINESTRING(1 2, 3 4, 5 6)', 'CIRCULARSTRING(1 1, 2 3, 4 5, 6 ↩
    7, 5 6)'));
                st_hasarc
                --------
                t
```

□□

ST_CurveToLine, ST_PointN

7.4.16 ST_InteriorRingN

ST_InteriorRingN — □□□□□□□□□□□□□□□□□□□.

Synopsis

geometry **ST_InteriorRingN**(geometry a_polygon, integer n);

□□

□□□□□□□ N □□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□ N □□□ (range) □□□ □□□ NULL □□□□□□.

> **Note**
> □□□□□□□□□□□□□□□□□□. □□□□□□□□ ST_Dump □□□□□□□□□□□□□.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 8.2.6, 8.3.5

This function supports 3d and will not drop the z-index.

□□

```
SELECT ST_AsText(ST_InteriorRingN(geom, 1)) As geom
FROM (SELECT ST_BuildArea(
                ST_Collect(ST_Buffer(ST_Point(1,2), 20,3),
                        ST_Buffer(ST_Point(1, 2), 10,3))) As geom
                )  as foo;
```

□□

ST_ExteriorRing, ST_M, ST_X, ST_Y, ST_ZMax, ST_ZMin

7.4.17 ST_NumCurves

ST_NumCurves — Return the number of component curves in a CompoundCurve.

Synopsis

integer **ST_NumCurves**(geometry a_compoundcurve);

⊠⊠

Return the number of component curves in a CompoundCurve, zero for an empty CompoundCurve, or NULL for a non-CompoundCurve input.

This method implements the SQL/MM specification. SQL-MM 3: 8.2.6, 8.3.5

This function supports 3d and will not drop the z-index.

⊠⊠

```
-- Returns 3
SELECT ST_NumCurves('COMPOUNDCURVE(
    (2 2, 2.5 2.5),
    CIRCULARSTRING(2.5 2.5, 4.5 2.5, 3.5 3.5),
    (3.5 3.5, 2.5 4.5, 3 5, 2 2)
  )');

-- Returns 0
SELECT ST_NumCurves('COMPOUNDCURVE EMPTY');
```

⊠⊠

ST_CurveN, ST_Dump, ST_ExteriorRing, ST_NumInteriorRings, ST_NumGeometries

7.4.18 ST_CurveN

ST_CurveN — Returns the Nth component curve geometry of a CompoundCurve.

Synopsis

geometry **ST_CurveN**(geometry a_compoundcurve, integer index);

⊠⊠

Returns the Nth component curve geometry of a CompoundCurve. The index starts at 1. Returns NULL if the geometry is not a CompoundCurve or the index is out of range.

This method implements the SQL/MM specification. SQL-MM 3: 8.2.6, 8.3.5

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_AsText(ST_CurveN('COMPOUNDCURVE(
    (2 2, 2.5 2.5),
    CIRCULARSTRING(2.5 2.5, 4.5 2.5, 3.5 3.5),
    (3.5 3.5, 2.5 4.5, 3 5, 2 2)
  )', 1));
```

⊠⊠

ST_NumCurves, ST_Dump, ST_ExteriorRing, ST_NumInteriorRings, ST_NumGeometries

7.4.19 ST_IsClosed

ST_IsClosed — LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_IsClosed**(geometry g);

⊠⊠

LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 7.1.5, 9.3.3

Note
SQL-MM defines the result of `ST_IsClosed(NULL)` to be 0, while PostGIS returns `NULL`.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

This function supports Polyhedral surfaces.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
postgis=# SELECT ST_IsClosed('LINESTRING(0 0, 1 1)'::geometry);
 st_isclosed
-------------
 f
(1 row)

postgis=# SELECT ST_IsClosed('LINESTRING(0 0, 0 1, 1 1, 0 0)'::geometry);
 st_isclosed
-------------
 t
(1 row)

postgis=# SELECT ST_IsClosed('MULTILINESTRING((0 0, 0 1, 1 1, 0 0),(0 0, 1 1))'::geometry);
 st_isclosed
-------------
 f
(1 row)

postgis=# SELECT ST_IsClosed('POINT(0 0)'::geometry);
 st_isclosed
-------------
 t
(1 row)

postgis=# SELECT ST_IsClosed('MULTIPOINT((0 0), (1 1))'::geometry);
 st_isclosed
-------------
 t
(1 row)
```

□□□□□□□□

```
-- A cube --
                SELECT ST_IsClosed(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1  ↩
                    1, 0 1 0, 0 0 0)),
                ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0) ↩
                    ),
                ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
                ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1) ↩
                    ) )'));

 st_isclosed
-------------
 t


 -- Same as cube but missing a side --
 SELECT ST_IsClosed(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0  ↩
     0)),
                ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0) ↩
                    ),
                ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
                ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)) )'));

 st_isclosed
-------------
 f
```

⊠⊠

ST_IsRing

7.4.20 ST_IsCollection

ST_IsCollection — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_IsCollection**(geometry g);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠:

- GEOMETRYCOLLECTION
- MULTI{POINT,POLYGON,LINESTRING,CURVE,SURFACE}
- COMPOUNDCURVE

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
postgis=# SELECT ST_IsCollection('LINESTRING(0 0, 1 1)'::geometry);
 st_iscollection
-------------
 f
(1 row)

postgis=# SELECT ST_IsCollection('MULTIPOINT EMPTY'::geometry);
 st_iscollection
-------------
 t
(1 row)

postgis=# SELECT ST_IsCollection('MULTIPOINT((0 0))'::geometry);
 st_iscollection
-------------
 t
(1 row)

postgis=# SELECT ST_IsCollection('MULTIPOINT((0 0), (42 42))'::geometry);
 st_iscollection
```

```
-------------
 t
(1 row)

postgis=# SELECT ST_IsCollection('GEOMETRYCOLLECTION(POINT(0 0))'::geometry);
 st_iscollection
-------------
 t
(1 row)
```

⊠⊠

ST_NumGeometries

7.4.21 ST_IsEmpty

ST_IsEmpty — Tests if a geometry is empty.

Synopsis

boolean **ST_IsEmpty**(geometry geomA);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. TRUE ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

Note
SQL-MM ⊠ ST_IsEmpty(NULL) ⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠, PostGIS ⊠ NULL ⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.1

This method implements the SQL/MM specification. SQL-MM 3: 5.1.7

This method supports Circular Strings and Curves.

Warning
⊠⊠⊠⊠: PostGIS 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromText('GEOMETRYCOLLECTION(EMPTY)') ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 2.0.0 ⊠⊠⊠⊠, SQL/MM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

⊠⊠

```
SELECT ST_IsEmpty(ST_GeomFromText('GEOMETRYCOLLECTION EMPTY'));
 st_isempty
------------
 t
(1 row)

 SELECT ST_IsEmpty(ST_GeomFromText('POLYGON EMPTY'));
 st_isempty
------------
 t
(1 row)

SELECT ST_IsEmpty(ST_GeomFromText('POLYGON((1 2, 3 4, 5 6, 1 2))'));

 st_isempty
------------
 f
(1 row)

 SELECT ST_IsEmpty(ST_GeomFromText('POLYGON((1 2, 3 4, 5 6, 1 2))')) = false;
 ?column?
----------
 t
(1 row)

 SELECT ST_IsEmpty(ST_GeomFromText('CIRCULARSTRING EMPTY'));
  st_isempty
------------
 t
(1 row)
```

7.4.22 ST_IsPolygonCCW

ST_IsPolygonCCW — Tests if Polygons have exterior rings oriented counter-clockwise and interior rings oriented clockwise.

Synopsis

boolean **ST_IsPolygonCCW** (geometry geom);

⊠⊠

Returns true if all polygonal components of the input geometry use a counter-clockwise orientation for their exterior ring, and a clockwise direction for all interior rings.

Returns true if the geometry has no polygonal components.

> **Note**
> Closed linestrings are not considered polygonal components, so you would still get a true return by passing a single closed linestring no matter its orientation.

> **Note**
> If a polygonal geometry does not use reversed orientation for interior rings (i.e., if one or more interior rings are oriented in the same direction as an exterior ring) then both ST_IsPolygonCW and ST_IsPolygonCCW will return false.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

⊠⊠

ST_ForcePolygonCW , ST_ForcePolygonCCW , ST_IsPolygonCW

7.4.23 ST_IsPolygonCW

ST_IsPolygonCW — Tests if Polygons have exterior rings oriented clockwise and interior rings oriented counter-clockwise.

Synopsis

boolean **ST_IsPolygonCW** (geometry geom);

⊠⊠

Returns true if all polygonal components of the input geometry use a clockwise orientation for their exterior ring, and a counter-clockwise direction for all interior rings.

Returns true if the geometry has no polygonal components.

> **Note**
> Closed linestrings are not considered polygonal components, so you would still get a true return by passing a single closed linestring no matter its orientation.

> **Note**
> If a polygonal geometry does not use reversed orientation for interior rings (i.e., if one or more interior rings are oriented in the same direction as an exterior ring) then both ST_IsPolygonCW and ST_IsPolygonCCW will return false.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

☒☒

ST_ForcePolygonCW , ST_ForcePolygonCCW , ST_IsPolygonCW

7.4.24 ST_IsRing

ST_IsRing — Tests if a LineString is closed and simple.

Synopsis

boolean **ST_IsRing**(geometry g);

☒☒

Returns TRUE if this LINESTRING is both ST_IsClosed (ST_StartPoint(g) ~= ST_Endpoint(g)) and ST_IsSimple (does not self intersect).

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. 2.1.5.1

This method implements the SQL/MM specification. SQL-MM 3: 7.1.6

Note
SQL-MM defines the result of ST_IsRing(NULL) to be 0, while PostGIS returns NULL.

☒☒

```
SELECT ST_IsRing(geom), ST_IsClosed(geom), ST_IsSimple(geom)
FROM (SELECT 'LINESTRING(0 0, 0 1, 1 1, 1 0, 0 0)'::geometry AS geom) AS foo;
 st_isring | st_isclosed | st_issimple
-----------+-------------+-------------
 t         | t           | t
(1 row)

SELECT ST_IsRing(geom), ST_IsClosed(geom), ST_IsSimple(geom)
FROM (SELECT 'LINESTRING(0 0, 0 1, 1 0, 1 1, 0 0)'::geometry AS geom) AS foo;
 st_isring | st_isclosed | st_issimple
-----------+-------------+-------------
 f         | t           | f
(1 row)
```

☒☒

ST_IsClosed, ST_IsSimple, ST_StartPoint, ST_EndPoint

7.4.25 ST_IsSimple

ST_IsSimple — ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ TRUE ☒☒☒☒☒☒.

Synopsis

boolean **ST_IsSimple**(geometry geomA);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ OGC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ”OpenGIS ⊠⊠⊠⊠⊠⊠⊠⊠ (Ensuring OpenGIS compliance of geometries)” ⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> SQL-MM ⊠ ST_IsSimple(NULL) ⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠, PostGIS ⊠ NULL ⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.1

This method implements the SQL/MM specification. SQL-MM 3: 5.1.8

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_IsSimple(ST_GeomFromText('POLYGON((1 2, 3 4, 5 6, 1 2))'));
 st_issimple
-------------
 f
(1 row)

 SELECT ST_IsSimple(ST_GeomFromText('LINESTRING(1 1,2 2,2 3.5,1 3,1 2,2 1)'));
 st_issimple
-------------
 f
(1 row)
```

⊠⊠

ST_IsValid

7.4.26 ST_M

ST_M — Returns the M coordinate of a Point.

Synopsis

float **ST_M**(geometry a_point);

⊠⊠

⊠⊠⊠⊠ M ⊠⊠⊠⊠⊠⊠⊠⊠. M ⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠ (⊠⊠) OGC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (extractor) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification.

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_M(ST_GeomFromEWKT('POINT(1 2 3 4)'));
 st_m
------
        4
(1 row)
```

⊠⊠

ST_GeomFromEWKT, ST_X, ST_Y, ST_Z

7.4.27 ST_MemSize

ST_MemSize — ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_MemSize**(geometry geomA);

⊠⊠

ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This complements the PostgreSQL built-in database object functions pg_column_size, pg_size_pretty, pg_relation_size, pg_total_relation_size.

> **Note**
> pg_relation_size which gives the byte size of a table may return byte size lower than ST_MemSize. This is because pg_relation_size does not add toasted table contribution and large geometries are stored in TOAST tables.
> pg_total_relation_size ⊠⊠⊠⊠⊠⊠, TOAST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
> pg_column_size returns how much space a geometry would take in a column considering compression, so may be lower than ST_MemSize

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Changed: 2.2.0 name changed to ST_MemSize to follow naming convention.

⊠⊠

```
--Return how much byte space Boston takes up  in our Mass data set
SELECT pg_size_pretty(SUM(ST_MemSize(geom))) as totgeomsum,
pg_size_pretty(SUM(CASE WHEN town = 'BOSTON' THEN ST_MemSize(geom) ELSE 0 END)) As bossum,
CAST(SUM(CASE WHEN town = 'BOSTON' THEN ST_MemSize(geom) ELSE 0 END)*1.00 /
                SUM(ST_MemSize(geom))*100 As numeric(10,2)) As perbos
FROM towns;

totgeomsum        bossum        perbos
----------        ------        ------
1522 kB               30 kB        1.99


SELECT ST_MemSize(ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 150505,220227 150406)'));

---
73

--What percentage of our table is taken up by just the geometry
SELECT pg_total_relation_size('public.neighborhoods') As fulltable_size, sum(ST_MemSize(geom)) As geomsize,
sum(ST_MemSize(geom))*1.00/pg_total_relation_size('public.neighborhoods')*100 As pergeom
FROM neighborhoods;
fulltable_size geomsize  pergeom
------------------------------------------------
262144         96238         36.71188354492187500000
```

7.4.28 ST_NDims

ST_NDims — ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NDims**(geometry g1);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠ 2 - 2 ⊠⊠ (x,y), 3 - 3 ⊠⊠ (x,y,z), 3 - ⊠⊠⊠⊠⊠ 2 ⊠⊠ (x,y,m), ⊠⊠⊠ 4 - ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (x,y,z,m) ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_NDims(ST_GeomFromText('POINT(1 1)')) As d2point,
        ST_NDims(ST_GeomFromEWKT('POINT(1 1 2)')) As d3point,
        ST_NDims(ST_GeomFromEWKT('POINTM(1 1 0.5)')) As d2pointm;

         d2point | d3point | d2pointm
---------+---------+----------
           2 |       3 |        3
```

⊠⊠

ST_CoordDim, ST_Dimension, ST_GeomFromEWKT

7.4.29 ST_NPoints

ST_NPoints — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NPoints**(geometry g1);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

Note

1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_NPoints(ST_GeomFromText('LINESTRING(77.29 29.07,77.42 29.26,77.27 29.31,77.29 ↩
    29.07)'));
--result
4

--Polygon in 3D space
SELECT ST_NPoints(ST_GeomFromEWKT('LINESTRING(77.29 29.07 1,77.42 29.26 0,77.27 29.31 ↩
    -1,77.29 29.07 3)'))
--result
4
```

⊠⊠

ST_NumPoints

7.4.30 ST_NRings

ST_NRings — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NRings**(geometry geomA);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NumInteriorRings ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_NRings(geom) As Nrings, ST_NumInteriorRings(geom) As ninterrings
                                        FROM (SELECT ST_GeomFromText('POLYGON((1 2, 3 4, 5 ↩
                                            6, 1 2))') As geom) As foo;
         nrings | ninterrings
--------+-------------
          1 |           0
(1 row)
```

⊠⊠

ST_NumInteriorRings

7.4.31 ST_NumGeometries

ST_NumGeometries — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NumGeometries**(geometry geom);

⊠⊠

Returns the number of elements in a geometry collection (GEOMETRYCOLLECTION or MULTI*). For non-empty atomic geometries returns 1. For empty geometries returns 0.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠. 2.0.0 ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM 3: 9.1.4

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
--Prior versions would have returned NULL for this -- in 2.0.0 this returns 1
SELECT ST_NumGeometries(ST_GeomFromText('LINESTRING(77.29 29.07,77.42 29.26,77.27 ↩
    29.31,77.29 29.07)'));
--result
1

--Geometry Collection Example - multis count as one geom in a collection
SELECT ST_NumGeometries(ST_GeomFromEWKT('GEOMETRYCOLLECTION(MULTIPOINT((-2 3),(-2 2)),
LINESTRING(5 5 ,10 10),
POLYGON((-7 4.2,-7.1 5,-7.1 4.3,-7 4.2)))'));
--result
3
```

⊠⊠

ST_GeometryN, ST_Multi

7.4.32 ST_NumInteriorRings

ST_NumInteriorRings — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NumInteriorRings**(geometry a_polygon);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM 3: 8.2.5

⊠⊠⊠⊠: 2.0.0 ⊠⊠.

⊠⊠

```
--If you have a regular polygon
SELECT gid, field1, field2, ST_NumInteriorRings(geom) AS numholes
FROM sometable;

--If you have multipolygons
--And you want to know the total number of interior rings in the MULTIPOLYGON
SELECT gid, field1, field2, SUM(ST_NumInteriorRings(geom)) AS numholes
FROM (SELECT gid, field1, field2, (ST_Dump(geom)).geom As geom
        FROM sometable) As foo
GROUP BY gid, field1,field2;
```

⊠⊠

ST_NumInteriorRing, ST_PointN

7.4.33 ST_NumInteriorRing

ST_NumInteriorRing — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_NumInteriorRings ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NumInteriorRing**(geometry a_polygon);

⊠⊠

ST_NumInteriorRings, ST_PointN

7.4.34 ST_NumPatches

ST_NumPatches — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NumPatches**(geometry g1);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_NumGeometries ⊠⊠⊠⊠⊠⊠ MM ⊠⊠⊠⊠⊠⊠⊠⊠⊠. MM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_NumGeometries ⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM ISO/IEC 13249-3: 8.5

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_NumPatches(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 ↩
    0)),
                ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0) ↩
                    ),
                ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
                ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1) ↩
                    ) )'));
                --result
                6
```

⊠⊠

ST_GeomFromEWKT, ST_NumGeometries

7.4.35 ST_NumPoints

ST_NumPoints — ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NumPoints**(geometry g1);

⊠⊠

ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_NPoints ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_NPoints ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 7.2.4

⊠⊠

```
SELECT ST_NumPoints(ST_GeomFromText('LINESTRING(77.29 29.07,77.42 29.26,77.27 29.31,77.29 ↩
    29.07)'));
                --result
                4
```

⊠⊠

ST_NPoints

7.4.36 ST_PatchN

ST_PatchN — ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_PatchN**(geometry geomA, integer n);

⊠⊠

⊠⊠⊠ POLYHEDRALSURFACE, POLYHEDRALSURFACEM ⊠⊠⊠ 1-⊠⊠ N ⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_GeometryN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_GeometryN ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠ 1-⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Dump ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM ISO/IEC 13249-3: 8.5

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

⊠⊠

```
--Extract the 2nd face of the polyhedral surface
SELECT ST_AsEWKT(ST_PatchN(geom, 2)) As geomewkt
FROM (
VALUES (ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
        ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
        ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
        ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )')) ) ↩
            As foo(geom);

              geomewkt
---+-----------------------------------------
 POLYGON((0 0 0,0 1 0,1 1 0,1 0 0,0 0 0))
```

⊠⊠

ST_AsEWKT, ST_GeomFromEWKT, ST_Dump, ST_GeometryN, ST_NumGeometries

7.4.37 ST_PointN

ST_PointN — ST_LineString □□ ST_CircularString □□□□□□□□□□□□□□□□.

Synopsis

geometry **ST_PointN**(geometry a_linestring, integer n);

□□

□□□□□□□□□□□□□□□□□□□□□□□ N □□□□□□□□□□□. □□□□□□□□□□□□□□□ □□□□□□□□□□, -1 □□□□□□□□□□. □□□□□□□□□□□□□□ NULL □□□□□□.

Note
0.8.0 □□□□□□□□ OGC □□□□□□ 1-□□□□□. OGC □□□□□□□□ (□□□□□) □□□□ □□□□□. □□□□□□□ 0-□□□□□□□□□□□□.

Note
□□□□□□□□□□□□□□□□□□ N □□□□□□□□□□□□, □□□□ ST_Dump □□□□□ □□□□□□□□.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 7.2.5, 7.3.5

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

Note
□□□□: 2.0.0 □□□□□□□□□□□□□□□□□□□□□□□□□. PostGIS □□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□. 2.0.0 □□□□□□□□□□□□□□□□ NULL □□□□□□□□.
□□□□: 2.3.0 □□□□□□□□□ (-1 □□□□□□□) □□□□□□□□□.

□□

```
-- Extract all POINTs from a LINESTRING
SELECT ST_AsText(
   ST_PointN(
          column1,
          generate_series(1, ST_NPoints(column1))
   ))
FROM ( VALUES ('LINESTRING(0 0, 1 1, 2 2)'::geometry) ) AS foo;

 st_astext
------------
 POINT(0 0)
```

```
 POINT(1 1)
 POINT(2 2)
(3 rows)

--Example circular string
SELECT ST_AsText(ST_PointN(ST_GeomFromText('CIRCULARSTRING(1 2, 3 2, 1 2)'), 2));

 st_astext
------------
 POINT(3 2)
(1 row)

SELECT ST_AsText(f)
FROM ST_GeomFromText('LINESTRING(0 0 0, 1 1 1, 2 2 2)') AS g
  ,ST_PointN(g, -2) AS f; -- 1 based index

    st_astext
-----------------
 POINT Z (1 1 1)
(1 row)
```

⊠⊠

ST_NPoints

7.4.38 ST_Points

ST_Points — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Points**(geometry geom);

⊠⊠

Returns a MultiPoint containing all the coordinates of a geometry. Duplicate points are preserved, including the start and end points of ring geometries. (If desired, duplicate points can be removed by calling ST_RemoveRepeatedPoints on the result).

To obtain information about the position of each coordinate in the parent geometry use ST_DumpPoints.

M and Z coordinates are preserved if present.

This method supports Circular Strings and Curves.

This function supports 3d and will not drop the z-index.

2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_AsText(ST_Points('POLYGON Z ((30 10 4,10 30 5,40 40 6, 30 10))'));

--result
MULTIPOINT Z ((30 10 4),(10 30 5),(40 40 6),(30 10 4))
```

□□

ST_RemoveRepeatedPoints, ST_PointN

7.4.39 ST_StartPoint

ST_StartPoint — Returns the first point of a LineString.

Synopsis

geometry **ST_StartPoint**(geometry geomA);

□□

LINESTRING □□ CIRCULARLINESTRING □□□□□□□□□□ POINT □□□□□□. □□□□□□□ LINESTRING □□ CIRCULARLINESTRING □□□□□ NULL □□□□□□.

This method implements the SQL/MM specification. SQL-MM 3: 7.1.3

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

> **Note**
> Enhanced: 3.2.0 returns a point for all geometries. Prior behavior returns NULLs if input was not a LineString.
> □□□□: 2.0.0 □□□□□□□□□□□□□□□□□□□□□□□□. PostGIS □□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□. 2.0.0 □□□□□□□□□□□□□□□□ NULL □□□□□□□□. □□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□ 2.0 □□□□ NULL □□□□□□□□□□.

□□

Start point of a LineString

```
SELECT ST_AsText(ST_StartPoint('LINESTRING(0 1, 0 2)'::geometry));
 st_astext
------------
 POINT(0 1)
```

Start point of a non-LineString is NULL

```
SELECT ST_StartPoint('POINT(0 1)'::geometry) IS NULL AS is_null;
  is_null
----------
 t
```

Start point of a 3D LineString

```
SELECT ST_AsEWKT(ST_StartPoint('LINESTRING(0 1 1, 0 2 2)'::geometry));
 st_asewkt
------------
 POINT(0 1 1)
```

ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AsText(ST_StartPoint('CIRCULARSTRING(5 2,-3 1.999999, -2 1, -4 2, 6 3)'::geometry ↩
    ));
 st_astext
------------
 POINT(5 2)
```

⊠⊠

ST_EndPoint, ST_PointN

7.4.40 ST_Summary

ST_Summary — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_Summary**(geometry g);
text **ST_Summary**(geography g);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- M: M ⊠⊠⊠⊠⊠⊠⊠⊠.
- Z: Z ⊠⊠⊠⊠⊠⊠⊠⊠.
- B: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- G: ⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠.
- S: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

1.2.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ S ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□

```
=# SELECT ST_Summary(ST_GeomFromText('LINESTRING(0 0, 1 1)')) as geom,
        ST_Summary(ST_GeogFromText('POLYGON((0 0, 1 1, 1 2, 1 1, 0 0))')) geog;
            geom             |          geog
-----------------------------+--------------------------
 LineString[B] with 2 points | Polygon[BGS] with 1 rings
                             | ring 0 has 5 points
                             :
(1 row)


=# SELECT ST_Summary(ST_GeogFromText('LINESTRING(0 0 1, 1 1 1)')) As geog_line,
        ST_Summary(ST_GeomFromText('SRID=4326;POLYGON((0 0 1, 1 1 2, 1 2 3, 1 1 1, 0 0 1)) ↩
            ')) As geom_poly;
;
           geog_line             |        geom_poly
-------------------------------- +--------------------------
 LineString[ZBGS] with 2 points | Polygon[ZBS] with 1 rings
                                :    ring 0 has 5 points
                                :
(1 row)
```

□□

PostGIS_DropBBox, PostGIS_AddBBox, ST_Force3DM, ST_Force3DZ, ST_Force2D, geography
ST_IsValid, ST_IsValid, ST_IsValidReason, ST_IsValidDetail

7.4.41 ST_X

ST_X — Returns the X coordinate of a Point.

Synopsis

float **ST_X**(geometry a_point);

□□

□□□□ X □□□□□□□□. X □□□□□□□ NULL □□□□□□. □□□□□□□□□□□□□.

> **Note**
> To get the minimum and maximum X value of geometry coordinates use the functions ST_XMin and ST_XMax.

This method implements the SQL/MM specification. SQL-MM 3: 6.1.3

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_X(ST_GeomFromEWKT('POINT(1 2 3 4)'));
 st_x
------
       1
(1 row)

SELECT ST_Y(ST_Centroid(ST_GeomFromEWKT('LINESTRING(1 2 3 4, 1 1 1 1)')));
 st_y
------
  1.5
(1 row)
```

⊠⊠

ST_Centroid, ST_GeomFromEWKT, ST_M, ST_XMax, ST_XMin, ST_Y, ST_Z

7.4.42 ST_Y

ST_Y — Returns the Y coordinate of a Point.

Synopsis

float **ST_Y**(geometry a_point);

⊠⊠

⊠⊠⊠⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠. Y ⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> To get the minimum and maximum Y value of geometry coordinates use the functions ST_YMin and ST_YMax.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 6.1.4

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_Y(ST_GeomFromEWKT('POINT(1 2 3 4)'));
 st_y
------
       2
(1 row)
```

```
SELECT ST_Y(ST_Centroid(ST_GeomFromEWKT('LINESTRING(1 2 3 4, 1 1 1 1)')));
 st_y
------
  1.5
(1 row)
```

⊠⊠

ST_Centroid, ST_GeomFromEWKT, ST_M, ST_X, ST_YMax, ST_YMin, ST_Z

7.4.43 ST_Z

ST_Z — Returns the Z coordinate of a Point.

Synopsis

float **ST_Z**(geometry a_point);

⊠⊠

⊠⊠⊠⊠ Z ⊠⊠⊠⊠⊠⊠⊠⊠. Z ⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> To get the minimum and maximum Z value of geometry coordinates use the functions ST_ZMin and ST_ZMax.

This method implements the SQL/MM specification.

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_Z(ST_GeomFromEWKT('POINT(1 2 3 4)'));
 st_z
------
        3
(1 row)
```

⊠⊠

ST_GeomFromEWKT, ST_M, ST_X, ST_Y, ST_ZMax, ST_ZMin

7.4.44 ST_Zmflag

ST_Zmflag — ST_Geometry □□□□□□□□□□□□.

Synopsis

smallint **ST_Zmflag**(geometry geomA);

□□

ST_Geometry □□□□□□□□□□□□.

Values are: 0 = 2D, 1 = 3D-M, 2 = 3D-Z, 3 = 4D.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

□□

```
SELECT ST_Zmflag(ST_GeomFromEWKT('LINESTRING(1 2, 3 4)'));
 st_zmflag
-----------
                 0

SELECT ST_Zmflag(ST_GeomFromEWKT('LINESTRINGM(1 2 3, 3 4 3)'));
 st_zmflag
-----------
                 1

SELECT ST_Zmflag(ST_GeomFromEWKT('CIRCULARSTRING(1 2 3, 3 4 3, 5 6 3)'));
 st_zmflag
-----------
                 2
SELECT ST_Zmflag(ST_GeomFromEWKT('POINT(1 2 3 4)'));
 st_zmflag
-----------
                 3
```

□□

ST_CoordDim, ST_NDims, ST_Dimension

7.4.45 ST_HasZ

ST_HasZ — Checks if a geometry has a Z dimension.

Synopsis

boolean **ST_HasZ**(geometry geom);

☒☒

Checks if the input geometry has a Z dimension and returns a boolean value. If the geometry has a Z dimension, it returns true; otherwise, it returns false.

Geometry objects with a Z dimension typically represent three-dimensional (3D) geometries, while those without it are two-dimensional (2D) geometries.

This function is useful for determining if a geometry has elevation or height information.

Availability: 3.5.0

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

☒☒

```
SELECT ST_HasZ(ST_GeomFromText('POINT(1 2 3)'));
 --result
 true
```

```
SELECT ST_HasZ(ST_GeomFromText('LINESTRING(0 0, 1 1)'));
 --result
 false
```

☒☒

ST_Zmflag

ST_HasM

7.4.46 ST_HasM

ST_HasM — Checks if a geometry has an M (measure) dimension.

Synopsis

boolean **ST_HasM**(geometry geom);

☒☒

Checks if the input geometry has an M (measure) dimension and returns a boolean value. If the geometry has an M dimension, it returns true; otherwise, it returns false.

Geometry objects with an M dimension typically represent measurements or additional data associated with spatial features.

This function is useful for determining if a geometry includes measure information.

Availability: 3.5.0

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

⊠⊠

```
SELECT ST_HasM(ST_GeomFromText('POINTM(1 2 3)'));
 --result
 true
```

```
SELECT ST_HasM(ST_GeomFromText('LINESTRING(0 0, 1 1)'));
 --result
 false
```

⊠⊠

ST_Zmflag

ST_HasZ

7.5 ⊠⊠⊠⊠⊠ (editor)

7.5.1 ST_AddPoint

ST_AddPoint — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_AddPoint**(geometry linestring, geometry point);

geometry **ST_AddPoint**(geometry linestring, geometry point, integer position = -1);

⊠⊠

Adds a point to a LineString before the index *position* (using a 0-based index). If the *position* parameter is omitted or is -1 the point is appended to the end of the LineString.

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

Add a point to the end of a 3D line

```
SELECT ST_AsEWKT(ST_AddPoint('LINESTRING(0 0 1, 1 1 1)', ST_MakePoint(1, 2, 3)));

    st_asewkt
    ----------
    LINESTRING(0 0 1,1 1 1,1 2 3)
```

Guarantee all lines in a table are closed by adding the start point of each line to the end of the line only for those that are not closed.

```
UPDATE sometable
SET geom = ST_AddPoint(geom, ST_StartPoint(geom))
FROM sometable
WHERE ST_IsClosed(geom) = false;
```

⊠⊠

ST_RemovePoint, ST_SetPoint

7.5.2 ST_CollectionExtract

ST_CollectionExtract — Given a geometry collection, returns a multi-geometry containing only elements of a specified type.

Synopsis

geometry **ST_CollectionExtract**(geometry collection);

geometry **ST_CollectionExtract**(geometry collection, integer type);

⊠⊠

Given a geometry collection, returns a homogeneous multi-geometry.

If the *type* is not specified, returns a multi-geometry containing only geometries of the highest dimension. So polygons are preferred over lines, which are preferred over points.

If the *type* is specified, returns a multi-geometry containing only that type. If there are no sub-geometries of the right type, an EMPTY geometry is returned. Only points, lines and polygons are supported. The type numbers are:

- 1 == POINT
- 2 == LINESTRING
- 3 == POLYGON

For atomic geometry inputs, the geometry is returned unchanged if the input type matches the requested type. Otherwise, the result is an EMPTY geometry of the specified type. If required, these can be converted to multi-geometries using ST_Multi.

> **Warning**
> MultiPolygon results are not checked for validity. If the polygon components are adjacent or overlapping the result will be invalid. (For example, this can occur when applying this function to an ST_Split result.) This situation can be checked with ST_IsValid and repaired with ST_MakeValid.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> Prior to 1.5.3 this function returned atomic inputs unchanged, no matter type. In 1.5.3 non-matching single geometries returned a NULL result. In 2.0.0 non-matching single geometries return an EMPTY result of the requested type.

□□

Extract highest-dimension type:

```
SELECT ST_AsText(ST_CollectionExtract(
        'GEOMETRYCOLLECTION( POINT(0 0), LINESTRING(1 1, 2 2) )'));
    st_astext
    ---------------
    MULTILINESTRING((1 1, 2 2))
```

Extract points (type 1 == POINT):

```
SELECT ST_AsText(ST_CollectionExtract(
        'GEOMETRYCOLLECTION(GEOMETRYCOLLECTION(POINT(0 0)))',
        1 ));
    st_astext
    ---------------
    MULTIPOINT((0 0))
```

Extract lines (type 2 == LINESTRING):

```
SELECT ST_AsText(ST_CollectionExtract(
        'GEOMETRYCOLLECTION(GEOMETRYCOLLECTION(LINESTRING(0 0, 1 1)),LINESTRING(2 2, 3 3)) ↩
            ',
        2 ));
    st_astext
    ---------------
    MULTILINESTRING((0 0, 1 1), (2 2, 3 3))
```

□□

ST_CollectionHomogenize, ST_Multi, ST_IsValid, ST_MakeValid

7.5.3 ST_CollectionHomogenize

ST_CollectionHomogenize — Returns the simplest representation of a geometry collection.

Synopsis

geometry **ST_CollectionHomogenize**(geometry collection);

□□

□□□□□□□□□□□□□□” □□□□□” □□□□□□□□□.

- Homogeneous (uniform) collections are returned as the appropriate multi-geometry.
- Heterogeneous (mixed) collections are flattened into a single GeometryCollection.
- Collections containing a single atomic element are returned as that element.
- Atomic geometries are returned unchanged. If required, these can be converted to a multi-geometry using ST_Multi.

Warning
This function does not ensure that the result is valid. In particular, a collection containing adjacent or overlapping Polygons will create an invalid MultiPolygon. This situation can be checked with ST_IsValid and repaired with ST_MakeValid.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

Single-element collection converted to an atomic geometry

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(POINT(0 0))'));

        st_astext
        ------------
        POINT(0 0)
```

Nested single-element collection converted to an atomic geometry:

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(MULTIPOINT((0 0)))'));

        st_astext
        ------------
        POINT(0 0)
```

Collection converted to a multi-geometry:

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(POINT(0 0),POINT(1 1))'));

        st_astext
        ---------------------
        MULTIPOINT((0 0),(1 1))
```

Nested heterogeneous collection flattened to a GeometryCollection:

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(POINT(0 0), GEOMETRYCOLLECTION
    ( LINESTRING(1 1, 2 2)))'));

        st_astext
        ---------------------
        GEOMETRYCOLLECTION(POINT(0 0),LINESTRING(1 1,2 2))
```

Collection of Polygons converted to an (invalid) MultiPolygon:

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION (POLYGON ((10 50, 50 50, 50
    10, 10 10, 10 50)), POLYGON ((90 50, 90 10, 50 10, 50 50, 90 50)))'));

        st_astext
        ---------------------
        MULTIPOLYGON(((10 50,50 50,50 10,10 10,10 50)),((90 50,90 10,50 10,50 50,90 50)))
```

⊠⊠

ST_CollectionExtract, ST_Multi, ST_IsValid, ST_MakeValid

7.5.4 ST_CurveToLine

ST_CurveToLine — Converts a geometry containing curves to a linear geometry.

Synopsis

geometry **ST_CurveToLine**(geometry curveGeom, float tolerance, integer tolerance_type, integer flags);

⊠⊠

Converts a CIRCULAR STRING to regular LINESTRING or CURVEPOLYGON to POLYGON or MULTISURFACE to MULTIPOLYGON. Useful for outputting to devices that can't support CIRCULARSTRING geometry types

Converts a given geometry to a linear geometry. Each curved geometry or segment is converted into a linear approximation using the given `tolerance` and options (32 segments per quadrant and no options by default).

The 'tolerance_type' argument determines interpretation of the `tolerance` argument. It can take the following values:

- 0 (default): Tolerance is max segments per quadrant.
- 1: Tolerance is max-deviation of line from curve, in source units.
- 2: Tolerance is max-angle, in radians, between generating radii.

The 'flags' argument is a bitfield. 0 by default. Supported bits are:

- 1: Symmetric (orientation idependent) output.
- 2: Retain angle, avoids reducing angles (segment lengths) when producing symmetric output. Has no effect when Symmetric flag is off.

Availability: 1.3.0

Enhanced: 2.4.0 added support for max-deviation and max-angle tolerance, and for symmetric output.

Enhanced: 3.0.0 implemented a minimum number of segments per linearized arc to prevent topological collapse.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 7.1.7

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

□□

```
SELECT ST_AsText(ST_CurveToLine(ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 150505,220227 150406)')));

--Result --
 LINESTRING(220268 150415,220269.95064912 150416.539364228,220271.823415575 150418.17258804,220273.613787707 150419.895736857,
 220275.317452352 150421.704659462,220276.930305234 150423.594998003,220278.448460847 150425.562198489,
 220279.868261823 150427.60152176,220281.186287736 150429.708054909,220282.399363347 150431.876723113,
 220283.50456625 150434.10230186,220284.499233914 150436.379429536,220285.380970099 150438.702620341,220286.147650624 150441.066277505,
 220286.797428488 150443.464706771,220287.328738321 150445.892130112,220287.740300149 150448.342699654,
 220288.031122486 150450.810511759,220288.200504713 150453.289621251,220288.248038775 150455.77405574,
 220288.173610157 150458.257830005,220287.977398166 150460.734960415,220287.659875492 150463.199479347,
 220287.221807076 150465.64544956,220286.664248262 150468.066978495,220285.988542259 150470.458232479,220285.196316903 150472.81345077,
 220284.289480732 150475.126959442,220283.270218395 150477.39318505,220282.140985384 150479.606668057,
 220280.90450212 150481.762075989,220279.5637474 150483.85421628,220278.12195122 150485.87804878,
 220276.582586992 150487.828697901,220274.949363179 150489.701464356,220273.226214362 150491.491836488,
 220271.417291757 150493.195501133,220269.526953216 150494.808354014,220267.559752731 150496.326509628,
 220265.520429459 150497.746310603,220263.41389631 150499.064336517,220261.245228106 150500.277412127,
 220259.019649359 150501.38261503,220256.742521683 150502.377282695,220254.419330878 150503.259018879,
 220252.055673714 150504.025699404,220249.657244448 150504.675477269,220247.229821107 150505.206787101,
 220244.779251566 150505.61834893,220242.311439461 150505.909171266,220239.832329968 150506.078553494,
 220237.347895479 150506.126087555,220234.864121215 150506.051658938,220232.386990804 150505.855446946,
 220229.922471872 150505.537924272,220227.47650166 150505.099855856,220225.054972724 150504.542297043,
 220222.663718741 150503.86659104,220220.308500449 150503.074365683,
 220217.994991777 150502.167529512,220215.72876617 150501.148267175,
 220213.515283163 150500.019034164,220211.35987523 150498.7825509,
 220209.267734939 150497.441796181,220207.243902439 150496,
 220205.293253319 150494.460635772,220203.420486864 150492.82741196,220201.630114732 150491.104263143,
 220199.926450087 150489.295340538,220198.313597205 150487.405001997,220196.795441592 150485.437801511,
 220195.375640616 150483.39847824,220194.057614703 150481.291945091,220192.844539092 150479.123276887,220191.739336189 150476.89769814,
 220190.744668525 150474.620570464,220189.86293234 150472.297379659,220189.096251815 150469.933722495,
 220188.446473951 150467.535293229,220187.915164118 150465.107869888,220187.50360229 150462.657300346,
 220187.212779953 150460.189488241,220187.043397726 150457.710378749,220186.995863664 150455.22594426,
 220187.070292282 150452.742169995,220187.266504273 150450.265039585,220187.584026947 150447.800520653,
 220188.022095363 150445.35455044,220188.579654177 150442.933021505,220189.25536018 150440.541767521,
```

```
 220190.047585536 150438.18654923,220190.954421707 150435.873040558,220191.973684044 ↩
     150433.60681495,
 220193.102917055 150431.393331943,220194.339400319 150429.237924011,220195.680155039 ↩
     150427.14578372,220197.12195122 150425.12195122,
 220198.661315447 150423.171302099,220200.29453926 150421.298535644,220202.017688077 ↩
     150419.508163512,220203.826610682 150417.804498867,
 220205.716949223 150416.191645986,220207.684149708 150414.673490372,220209.72347298 ↩
     150413.253689397,220211.830006129 150411.935663483,
 220213.998674333 150410.722587873,220216.22425308 150409.61738497,220218.501380756 ↩
     150408.622717305,220220.824571561 150407.740981121,
 220223.188228725 150406.974300596,220225.586657991 150406.324522731,220227 150406)

--3d example
SELECT ST_AsEWKT(ST_CurveToLine(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 ↩
    150505 2,220227 150406 3)')));
Output
------
 LINESTRING(220268 150415 1,220269.95064912 150416.539364228 1.0181172856673,
 220271.823415575 150418.17258804 1.03623457133459,220273.613787707 150419.895736857 ↩
     1.05435185700189,....AD INFINITUM ....
    220225.586657991 150406.324522731 1.32611114201132,220227 150406 3)

--use only 2 segments to approximate quarter circle
SELECT ST_AsText(ST_CurveToLine(ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 ↩
    150505,220227 150406)'),2));
st_astext
------------------------------
 LINESTRING(220268 150415,220287.740300149 150448.342699654,220278.12195122 ↩
     150485.87804878,
 220244.779251566 150505.61834893,220207.243902439 150496,220187.50360229 150462.657300346,
 220197.12195122 150425.12195122,220227 150406)

-- Ensure approximated line is no further than 20 units away from
-- original curve, and make the result direction-neutral
SELECT ST_AsText(ST_CurveToLine(
 'CIRCULARSTRING(0 0,100 -100,200 0)'::geometry,
    20, -- Tolerance
    1, -- Above is max distance between curve and line
    1  -- Symmetric flag
));
st_astext
-------------------------------------------------------------------------------------------
 LINESTRING(0 0,50 -86.6025403784438,150 -86.6025403784439,200 -1.1331077795296e-13,200 0)
```

□□

ST_LineToCurve

7.5.5 ST_Scroll

ST_Scroll — Change start point of a closed LineString.

Synopsis

geometry **ST_Scroll**(geometry linestring, geometry point);

⊠⊠

Changes the start/end point of a closed LineString to the given vertex *point*.

Availability: 3.2.0

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

⊠⊠

Make e closed line start at its 3rd vertex

```
SELECT ST_AsEWKT(ST_Scroll('SRID=4326;LINESTRING(0 0 0 1, 10 0 2 0, 5 5 4 2,0 0 0 1)', ' ↩
    POINT(5 5 4 2)'));

st_asewkt
----------
SRID=4326;LINESTRING(5 5 4 2,0 0 0 1,10 0 2 0,5 5 4 2)
```

⊠⊠

ST_Normalize

7.5.6 ST_FlipCoordinates

ST_FlipCoordinates — Returns a version of a geometry with X and Y axis flipped.

Synopsis

geometry **ST_FlipCoordinates**(geometry geom);

⊠⊠

Returns a version of the given geometry with X and Y axis flipped. Useful for fixing geometries which contain coordinates expressed as latitude/longitude (Y,X).

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT ST_AsEWKT(ST_FlipCoordinates(GeomFromEWKT('POINT(1 2)')));
 st_asewkt
------------
POINT(2 1)
```

⊠⊠

ST_SwapOrdinates

7.5.7 ST_Force2D

ST_Force2D — ⊠⊠⊠"2 ⊠⊠⊠⊠" ⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Force2D**(geometry geomA);

⊠⊠

⊠⊠⊠"2 ⊠⊠⊠⊠" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X ⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ (OGC ⊠⊠⊠⊠ 2 ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠) OGC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_2D ⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_AsEWKT(ST_Force2D(ST_GeomFromEWKT('CIRCULARSTRING(1 1 2, 2 3 2, 4 5 2, 6 7 2, 5 6 ↩
     2)')));
                st_asewkt
-------------------------------------
CIRCULARSTRING(1 1,2 3,4 5,6 7,5 6)

SELECT  ST_AsEWKT(ST_Force2D('POLYGON((0 0 2,0 5 2,5 0 2,0 0 2),(1 1 2,3 1 2,1 3 2,1 1 2)) ↩
    '));

                                  st_asewkt
----------------------------------------------
 POLYGON((0 0,0 5,5 0,0 0),(1 1,3 1,1 3,1 1))
```

⊠⊠

ST_Force3D

7.5.8 ST_Force3D

ST_Force3D — ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠. ST_Force3DZ ⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Force3D**(geometry geomA, float Zvalue = 0.0);

⊠⊠

Forces the geometries into XYZ mode. This is an alias for ST_Force3DZ. If a geometry has no Z component, then a *Zvalue* Z coordinate is tacked on.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_3D ⊠⊠⊠⊠.

Changed: 3.1.0. Added support for supplying a non-zero Z value.

This function supports Polyhedral surfaces.

This method supports Circular Strings and Curves.

This function supports 3d and will not drop the z-index.

⊠⊠

```
--Nothing happens to an already 3D geometry
                SELECT ST_AsEWKT(ST_Force3D(ST_GeomFromEWKT('CIRCULARSTRING(1 1 2, 2 3 2, 4 ←
                    5 2, 6 7 2, 5 6 2)')));
                                   st_asewkt
-----------------------------------------------
 CIRCULARSTRING(1 1 2,2 3 2,4 5 2,6 7 2,5 6 2)


SELECT  ST_AsEWKT(ST_Force3D('POLYGON((0 0,0 5,5 0,0 0),(1 1,3 1,1 3,1 1))'));

                                                 st_asewkt
--------------------------------------------------------------
 POLYGON((0 0 0,0 5 0,5 0 0,0 0 0),(1 1 0,3 1 0,1 3 0,1 1 0))
```

⊠⊠

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3DZ

7.5.9 ST_Force3DZ

ST_Force3DZ — ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Force3DZ**(geometry geomA, float Zvalue = 0.0);

⊠⊠

Forces the geometries into XYZ mode. If a geometry has no Z component, then a *Zvalue* Z coordinate is tacked on.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_3DZ ⊠⊠⊠⊠.

Changed: 3.1.0. Added support for supplying a non-zero Z value.

This function supports Polyhedral surfaces.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
--Nothing happens to an already 3D geometry
SELECT ST_AsEWKT(ST_Force3DZ(ST_GeomFromEWKT('CIRCULARSTRING(1 1 2, 2 3 2, 4 5 2, 6 7 2, 5 ↩
    6 2)')));
                                   st_asewkt
-----------------------------------------------
 CIRCULARSTRING(1 1 2,2 3 2,4 5 2,6 7 2,5 6 2)


SELECT  ST_AsEWKT(ST_Force3DZ('POLYGON((0 0,0 5,5 0,0 0),(1 1,3 1,1 3,1 1))'));

                                                 st_asewkt
--------------------------------------------------------------
 POLYGON((0 0 0,0 5 0,5 0 0,0 0 0),(1 1 0,3 1 0,1 3 0,1 1 0))
```

⊠⊠

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3D

7.5.10 ST_Force3DM

ST_Force3DM — ⊠⊠⊠ XYM ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Force3DM**(geometry geomA, float Mvalue = 0.0);

⊠⊠

Forces the geometries into XYM mode. If a geometry has no M component, then a *Mvalue* M coordinate is tacked on. If it has a Z component, then Z is removed

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_3DM ⊠⊠⊠⊠⊠.

Changed: 3.1.0. Added support for supplying a non-zero M value.

This method supports Circular Strings and Curves.

⊠⊠

```
--Nothing happens to an already 3D geometry
SELECT ST_AsEWKT(ST_Force3DM(ST_GeomFromEWKT('CIRCULARSTRING(1 1 2, 2 3 2, 4 5 2, 6 7 2, 5 ↩
    6 2)')));
                                   st_asewkt
------------------------------------------------
 CIRCULARSTRINGM(1 1 0,2 3 0,4 5 0,6 7 0,5 6 0)


SELECT  ST_AsEWKT(ST_Force3DM('POLYGON((0 0 1,0 5 1,5 0 1,0 0 1),(1 1 1,3 1 1,1 3 1,1 1 1)) ↩
    '));

                                                  st_asewkt
---------------------------------------------------------------
 POLYGONM((0 0 0,0 5 0,5 0 0,0 0 0),(1 1 0,3 1 0,1 3 0,1 1 0))
```

⊠⊠

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3D, ST_GeomFromEWKT

7.5.11 ST_Force4D

ST_Force4D — ⊠⊠⊠ XYZM ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Force4D**(geometry geomA, float Zvalue = 0.0, float Mvalue = 0.0);

⊠⊠

Forces the geometries into XYZM mode. *Zvalue* and *Mvalue* is tacked on for missing Z and M dimensions, respectively.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_4D ⊠⊠⊠⊠.

Changed: 3.1.0. Added support for supplying non-zero Z and M values.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
--Nothing happens to an already 3D geometry
SELECT ST_AsEWKT(ST_Force4D(ST_GeomFromEWKT('CIRCULARSTRING(1 1 2, 2 3 2, 4 5 2, 6 7 2, 5 6 ↩
     2)')));
                                                st_asewkt
---------------------------------------------------------
 CIRCULARSTRING(1 1 2 0,2 3 2 0,4 5 2 0,6 7 2 0,5 6 2 0)



SELECT  ST_AsEWKT(ST_Force4D('MULTILINESTRINGM((0 0 1,0 5 2,5 0 3,0 0 4),(1 1 1,3 1 1,1 3  ↩
    1,1 1 1))'));

                                                                          st_asewkt
--------------------------------------------------------------------------------------
 MULTILINESTRING((0 0 0 1,0 5 0 2,5 0 0 3,0 0 0 4),(1 1 0 1,3 1 0 1,1 3 0 1,1 1 0 1))
```

⊠⊠

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3D

7.5.12 ST_ForceCollection

ST_ForceCollection — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_ForceCollection**(geometry geomA);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ WKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

1.2.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_Collection ⊠⊠⊠⊠⊠.

This function supports Polyhedral surfaces.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT  ST_AsEWKT(ST_ForceCollection('POLYGON((0 0 1,0 5 1,5 0 1,0 0 1),(1 1 1,3 1 1,1 3 ↩
    1,1 1 1))'));

                                                                   st_asewkt
----------------------------------------------------------------------------------
 GEOMETRYCOLLECTION(POLYGON((0 0 1,0 5 1,5 0 1,0 0 1),(1 1 1,3 1 1,1 3 1,1 1 1)))


  SELECT ST_AsText(ST_ForceCollection('CIRCULARSTRING(220227 150406,2220227 150407,220227 ↩
      150406)'));
                                                                   st_astext
--------------------------------------------------------------------------------
 GEOMETRYCOLLECTION(CIRCULARSTRING(220227 150406,2220227 150407,220227 150406))
(1 row)
```

```
-- POLYHEDRAL example --
SELECT ST_AsEWKT(ST_ForceCollection('POLYHEDRALSURFACE(((0 0 0,0 0 1,0 1 1,0 1 0,0 0 0)),
 ((0 0 0,0 1 0,1 1 0,1 0 0,0 0 0)),
 ((0 0 0,1 0 0,1 0 1,0 0 1,0 0 0)),
 ((1 1 0,1 1 1,1 0 1,1 0 0,1 1 0)),
 ((0 1 0,0 1 1,1 1 1,1 1 0,0 1 0)),
 ((0 0 1,1 0 1,1 1 1,0 1 1,0 0 1)))'))

                                                                   st_asewkt
----------------------------------------------------------------------------------
GEOMETRYCOLLECTION(
  POLYGON((0 0 0,0 0 1,0 1 1,0 1 0,0 0 0)),
  POLYGON((0 0 0,0 1 0,1 1 0,1 0 0,0 0 0)),
  POLYGON((0 0 0,1 0 0,1 0 1,0 0 1,0 0 0)),
  POLYGON((1 1 0,1 1 1,1 0 1,1 0 0,1 1 0)),
  POLYGON((0 1 0,0 1 1,1 1 1,1 1 0,0 1 0)),
  POLYGON((0 0 1,1 0 1,1 1 1,0 1 1,0 0 1))
)
```

⊠⊠

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3D, ST_GeomFromEWKT

7.5.13 ST_ForceCurve

ST_ForceCurve — ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (upcast) ⊠⊠⊠.

Synopsis

geometry **ST_ForceCurve**(geometry g);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ (compoundcurve) ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (multisurface) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_AsText(
  ST_ForceCurve(
        'POLYGON((0 0 2, 5 0 2, 0 5 2, 0 0 2),(1 1 2, 1 3 2, 3 1 2, 1 1 2))'::geometry
  )
);
                              st_astext
----------------------------------------------------------------------
 CURVEPOLYGON Z ((0 0 2,5 0 2,0 5 2,0 0 2),(1 1 2,1 3 2,3 1 2,1 1 2))
(1 row)
```

⊠⊠

ST_LineToCurve

7.5.14 ST_ForcePolygonCCW

ST_ForcePolygonCCW — Orients all exterior rings counter-clockwise and all interior rings clockwise.

Synopsis

geometry **ST_ForcePolygonCCW** (geometry geom);

⊠⊠

Forces (Multi)Polygons to use a counter-clockwise orientation for their exterior ring, and a clockwise orientation for their interior rings. Non-polygonal geometries are returned unchanged.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

⊠⊠

ST_ForcePolygonCW , ST_IsPolygonCCW , ST_IsPolygonCW

7.5.15 ST_ForcePolygonCW

ST_ForcePolygonCW — Orients all exterior rings clockwise and all interior rings counter-clockwise.

Synopsis

geometry **ST_ForcePolygonCW** (geometry geom);

⊠⊠

Forces (Multi)Polygons to use a clockwise orientation for their exterior ring, and a counter-clockwise orientation for their interior rings. Non-polygonal geometries are returned unchanged.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

⊠⊠

ST_ForcePolygonCCW , ST_IsPolygonCCW , ST_IsPolygonCW

7.5.16 ST_ForceSFS

ST_ForceSFS — ⊠⊠⊠ SFS 1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_ForceSFS**(geometry geomA);
geometry **ST_ForceSFS**(geometry geomA, text version);

⊠⊠

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This method supports Circular Strings and Curves.

This function supports 3d and will not drop the z-index.

7.5.17 ST_ForceRHR

ST_ForceRHR — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠ (Right-Hand Rule) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_ForceRHR**(geometry g);

⊠⊠

Forces the orientation of the vertices in a polygon to follow a Right-Hand-Rule, in which the area that is bounded by the polygon is to the right of the boundary. In particular, the exterior ring is orientated in a clockwise direction and the interior rings in a counter-clockwise direction. This function is a synonym for ST_ForcePolygonCW

> **Note**
> The above definition of the Right-Hand-Rule conflicts with definitions used in other contexts. To avoid confusion, it is recommended to use ST_ForcePolygonCW.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_AsEWKT(
  ST_ForceRHR(
        'POLYGON((0 0 2, 5 0 2, 0 5 2, 0 0 2),(1 1 2, 1 3 2, 3 1 2, 1 1 2))'
  )
);
                                                  st_asewkt
--------------------------------------------------------------
 POLYGON((0 0 2,0 5 2,5 0 2,0 0 2),(1 1 2,3 1 2,1 3 2,1 1 2))
(1 row)
```

⊠⊠

ST_ForcePolygonCCW , ST_ForcePolygonCW , ST_IsPolygonCCW , ST_IsPolygonCW , ST_BuildArea, ST_Polygonize, ST_Reverse

7.5.18 ST_LineExtend

ST_LineExtend — Returns a line extended forwards and backwards by specified distances.

Synopsis

geometry **ST_LineExtend**(geometry line, float distance_forward, float distance_backward=0.0);

⊠⊠

Returns a line extended forwards and backwards by adding new start (and end) points at the given distance(s). A distance of zero does not add a point. Only non-negative distances are allowed. The direction(s) of the added point(s) is determined by the first (and last) two distinct points of the line. Duplicate points are ignored.

Availability: 3.4.0

Example: Extends a line 5 units forward and 6 units backward

```
SELECT ST_AsText(ST_LineExtend('LINESTRING(0 0, 0 10)'::geometry, 5, 6));
--------------------------------------------
LINESTRING(0 -6,0 0,0 10,0 15)
```

⊠⊠

ST_LineSubstring, ST_LocateAlong, ST_Project

7.5.19 ST_LineToCurve

ST_LineToCurve — Converts a linear geometry to a curved geometry.

Synopsis

geometry **ST_LineToCurve**(geometry geomANoncircular);

⊠⊠

Converts plain LINESTRING/POLYGON to CIRCULAR STRINGs and Curved Polygons. Note much fewer points are needed to describe the curved equivalent.

> **Note**
> If the input LINESTRING/POLYGON is not curved enough to clearly represent a curve, the function will return the same input geometry.

Availability: 1.3.0

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
-- 2D Example
SELECT ST_AsText(ST_LineToCurve(foo.geom)) As curvedastext,ST_AsText(foo.geom) As ↩
    non_curvedastext
    FROM (SELECT ST_Buffer('POINT(1 3)'::geometry, 3) As geom) As foo;

curvedatext                                                          non_curvedastext
--------------------------------------------------------------------|------------------------------

CURVEPOLYGON(CIRCULARSTRING(4 3,3.12132034355964 0.878679656440359, | POLYGON((4 ↩
    3,3.94235584120969 2.41472903395162,3.77163859753386 1.85194970290473,
1 0,-1.12132034355965 5.12132034355963,4 3))                        |  3.49440883690764 ↩
    1.33328930094119,3.12132034355964 0.878679656440359,
                                                                    |  2.66671069905881 ↩
                                                                       0.505591163092366,2.14805029
                                                                        0.228361402466141,
```

```
                                                                     |  1.58527096604839  ↩
                                                                        0.0576441587903094,1 ↩
                                                                         0,
                                                                     |  0.414729033951621  ↩
                                                                        0.0576441587903077,-0.1480502
                                                                         0.228361402466137,
                                                                     |  -0.666710699058802  ↩
                                                                        0.505591163092361,-1.1213203
                                                                         0.878679656440353,
                                                                     |  -1.49440883690763  ↩
                                                                        1.33328930094119,-1.7716385
                                                                         1.85194970290472
                                                                     |  --ETC--  ↩
                                                                        ,3.94235584120969  ↩
                                                                        3.58527096604839,4  ↩
                                                                        3))

--3D example
SELECT ST_AsText(ST_LineToCurve(geom)) As curved, ST_AsText(geom) AS not_curved
FROM (SELECT ST_Translate(ST_Force3D(ST_Boundary(ST_Buffer(ST_Point(1,3), 2,2))),0,0,3) AS  ↩
    geom) AS foo;

                        curved                        |               not_curved
------------------------------------------------------+---------------------------------------------

 CIRCULARSTRING Z (3 3 3,-1 2.99999999999999 3,3 3 3) | LINESTRING Z (3 3 3,2.4142135623731 ↩
      1.58578643762691 3,1 1 3,
                                                      | -0.414213562373092 1.5857864376269  ↩
                                                         3,-1 2.99999999999999 3,
                                                      | -0.414213562373101 4.41421356237309 ↩
                                                          3,
                                                      | 0.999999999999991 5  ↩
                                                         3,2.41421356237309 4.4142135623731 ↩
                                                          3,3 3 3)
(1 row)
```

□□

ST_CurveToLine

7.5.20 ST_Multi

ST_Multi — □□□□□□□□□□□□□□□□□□□□□□□□.

Synopsis

geometry **ST_Multi**(geometry geom);

□□

Returns the geometry as a MULTI* geometry collection. If the geometry is already a collection, it is returned unchanged.

⊠⊠

```
SELECT ST_AsText(ST_Multi('POLYGON ((10 30, 30 30, 30 10, 10 10, 10 30))'));
                    st_astext
    -------------------------------------------------
    MULTIPOLYGON(((10 30,30 30,30 10,10 10,10 30)))
```

⊠⊠

ST_AsText

7.5.21 ST_Normalize

ST_Normalize — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Normalize**(geometry geom);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠).

2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_AsText(ST_Normalize(ST_GeomFromText(
  'GEOMETRYCOLLECTION(
    POINT(2 3),
    MULTILINESTRING((0 0, 1 1),(2 2, 3 3)),
    POLYGON(
      (0 10,0 0,10 0,10 10,0 10),
      (4 2,2 2,2 4,4 4,4 2),
      (6 8,8 8,8 6,6 6,6 8)
    )
  )'
)));
                                                                     st_astext
------------------------------------------------------------------------------------------------------------

 GEOMETRYCOLLECTION(POLYGON((0 0,0 10,10 10,10 0,0 0),(6 6,8 6,8 8,6 8,6 6),(2 2,4 2,4 4,2 ↩
    4,2 2)),MULTILINESTRING((2 2,3 3),(0 0,1 1)),POINT(2 3))
(1 row)
```

⊠⊠

ST_Equals,

7.5.22 ST_Project

ST_Project — Returns a point projected from a start point by a distance and bearing (azimuth).

Synopsis

geometry **ST_Project**(geometry g1, float distance, float azimuth);
geometry **ST_Project**(geometry g1, geometry g2, float distance);
geography **ST_Project**(geography g1, float distance, float azimuth);
geography **ST_Project**(geography g1, geography g2, float distance);

☒☒

Returns a point projected from a point along a geodesic using a given distance and azimuth (bearing). This is known as the direct geodesic problem.

The two-point version uses the path from the first to the second point to implicitly define the azimuth and uses the distance as before.

The distance is given in meters. Negative values are supported.

The azimuth (also known as heading or bearing) is given in radians. It is measured clockwise from true north.

- North is azimuth zero (0 degrees)
- East is azimuth π/2 (90 degrees)
- South is azimuth π (180 degrees)
- West is azimuth 3π/2 (270 degrees)

Negative azimuth values and values greater than 2π (360 degrees) are supported.

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒.

Enhanced: 2.4.0 Allow negative distance and non-normalized azimuth.

Enhanced: 3.4.0 Allow geometry arguments and two-point form omitting azimuth.

Example: Projected point at 100,000 meters and bearing 45 degrees

```
SELECT ST_AsText(ST_Project('POINT(0 0)'::geography, 100000, radians(45.0)));
--------------------------------------------
 POINT(0.635231029125537 0.639472334729198)
```

☒☒

ST_Azimuth, ST_Distance, PostgreSQL function radians()

7.5.23 ST_QuantizeCoordinates

ST_QuantizeCoordinates — Sets least significant bits of coordinates to zero

Synopsis

geometry **ST_QuantizeCoordinates** (geometry g , int prec_x , int prec_y , int prec_z , int prec_m);

⊠⊠

`ST_QuantizeCoordinates` determines the number of bits (`N`) required to represent a coordinate value with a specified number of digits after the decimal point, and then sets all but the `N` most significant bits to zero. The resulting coordinate value will still round to the original value, but will have improved compressiblity. This can result in a significant disk usage reduction provided that the geometry column is using a compressible storage type. The function allows specification of a different number of digits after the decimal point in each dimension; unspecified dimensions are assumed to have the precision of the `x` dimension. Negative digits are interpreted to refer digits to the left of the decimal point, (i.e., `prec_x=-2` will preserve coordinate values to the nearest 100.

The coordinates produced by `ST_QuantizeCoordinates` are independent of the geometry that contains those coordinates and the relative position of those coordinates within the geometry. As a result, existing topological relationships between geometries are unaffected by use of this function. The function may produce invalid geometry when it is called with a number of digits lower than the intrinsic precision of the geometry.

Availability: 2.5.0

Technical Background

PostGIS stores all coordinate values as double-precision floating point integers, which can reliably represent 15 significant digits. However, PostGIS may be used to manage data that intrinsically has fewer than 15 significant digits. An example is TIGER data, which is provided as geographic coordinates with six digits of precision after the decimal point (thus requiring only nine significant digits of longitude and eight significant digits of latitude.)

When 15 significant digits are available, there are many possible representations of a number with 9 significant digits. A double precision floating point number uses 52 explicit bits to represent the significand (mantissa) of the coordinate. Only 30 bits are needed to represent a mantissa with 9 significant digits, leaving 22 insignificant bits; we can set their value to anything we like and still end up with a number that rounds to our input value. For example, the value 100.123456 can be represented by the floating point numbers closest to 100.123456000000, 100.123456000001, and 100.123456432199. All are equally valid, in that `ST_AsText(geom, 6)` will return the same result with any of these inputs. As we can set these bits to any value, `ST_QuantizeCoordinates` sets the 22 insignificant bits to zero. For a long coordinate sequence this creates a pattern of blocks of consecutive zeros that is compressed by PostgreSQL more efficiently.

> **Note**
> Only the on-disk size of the geometry is potentially affected by `ST_QuantizeCoordinates`. ST_MemSize, which reports the in-memory usage of the geometry, will return the the same value regardless of the disk space used by a geometry.

⊠⊠

```
SELECT ST_AsText(ST_QuantizeCoordinates('POINT (100.123456 0)'::geometry, 4));
st_astext
-------------------------
POINT(100.123455047607 0)
```

```
WITH test AS (SELECT 'POINT (123.456789123456 123.456789123456)'::geometry AS geom)
SELECT
  digits,
  encode(ST_QuantizeCoordinates(geom, digits), 'hex'),
  ST_AsText(ST_QuantizeCoordinates(geom, digits))
FROM test, generate_series(15, -15, -1) AS digits;

digits  |                   encode                   |               st_astext
--------+--------------------------------------------+------------------------------------------ ↩


15      | 01010000005f9a72083cdd5e405f9a72083cdd5e40 | POINT(123.456789123456  ↩
    123.456789123456)
14      | 01010000005f9a72083cdd5e405f9a72083cdd5e40 | POINT(123.456789123456  ↩
    123.456789123456)
13      | 01010000005f9a72083cdd5e405f9a72083cdd5e40 | POINT(123.456789123456  ↩
    123.456789123456)
12      | 01010000005c9a72083cdd5e405c9a72083cdd5e40 | POINT(123.456789123456  ↩
    123.456789123456)
11      | 0101000000409a72083cdd5e40409a72083cdd5e40 | POINT(123.456789123456  ↩
    123.456789123456)
10      | 0101000000009a72083cdd5e40009a72083cdd5e40 | POINT(123.456789123455  ↩
    123.456789123455)
9       | 0101000000009072083cdd5e40009072083cdd5e40 | POINT(123.456789123418  ↩
    123.456789123418)
8       | 0101000000008072083cdd5e40008072083cdd5e40 | POINT(123.45678912336  ↩
    123.45678912336)
7       | 0101000000000070083cdd5e40000070083cdd5e40 | POINT(123.456789121032  ↩
    123.456789121032)
6       | 0101000000000040083cdd5e40000040083cdd5e40 | POINT(123.456789076328  ↩
    123.456789076328)
5       | 0101000000000000083cdd5e40000000083cdd5e40 | POINT(123.456789016724  ↩
    123.456789016724)
4       | 0101000000000000003cdd5e40000000003cdd5e40 | POINT(123.456787109375  ↩
    123.456787109375)
3       | 0101000000000000003cdd5e40000000003cdd5e40 | POINT(123.456787109375  ↩
    123.456787109375)
2       | 01010000000000000038dd5e400000000038dd5e40 | POINT(123.45654296875  ↩
    123.45654296875)
1       | 01010000000000000000dd5e400000000000dd5e40 | POINT(123.453125 123.453125)
0       | 01010000000000000000dc5e400000000000dc5e40 | POINT(123.4375 123.4375)
-1      | 01010000000000000000c05e400000000000c05e40 | POINT(123 123)
-2      | 01010000000000000000005e400000000000005e40 | POINT(120 120)
-3      | 010100000000000000000058400000000000005840 | POINT(96 96)
-4      | 010100000000000000000058400000000000005840 | POINT(96 96)
-5      | 010100000000000000000058400000000000005840 | POINT(96 96)
-6      | 010100000000000000000058400000000000005840 | POINT(96 96)
-7      | 010100000000000000000058400000000000005840 | POINT(96 96)
-8      | 010100000000000000000058400000000000005840 | POINT(96 96)
-9      | 010100000000000000000058400000000000005840 | POINT(96 96)
-10     | 010100000000000000000058400000000000005840 | POINT(96 96)
-11     | 010100000000000000000058400000000000005840 | POINT(96 96)
-12     | 010100000000000000000058400000000000005840 | POINT(96 96)
-13     | 010100000000000000000058400000000000005840 | POINT(96 96)
-14     | 010100000000000000000058400000000000005840 | POINT(96 96)
-15     | 010100000000000000000058400000000000005840 | POINT(96 96)
```

⊠⊠

ST_SnapToGrid

7.5.24 ST_RemovePoint

ST_RemovePoint — Remove a point from a linestring.

Synopsis

geometry **ST_RemovePoint**(geometry linestring, integer offset);

⊠⊠

Removes a point from a LineString, given its index (0-based). Useful for turning a closed line (ring) into an open linestring.

Enhanced: 3.2.0

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

Guarantees no lines are closed by removing the end point of closed lines (rings). Assumes geom is of type LINESTRING

```
UPDATE sometable
	SET geom = ST_RemovePoint(geom, ST_NPoints(geom) - 1)
	FROM sometable
	WHERE ST_IsClosed(geom);
```

⊠⊠

ST_AddPoint, ST_NPoints, ST_NumPoints

7.5.25 ST_RemoveRepeatedPoints

ST_RemoveRepeatedPoints — Returns a version of a geometry with duplicate points removed.

Synopsis

geometry **ST_RemoveRepeatedPoints**(geometry geom, float8 tolerance);

⊠⊠

Returns a version of the given geometry with duplicate consecutive points removed. The function processes only (Multi)LineStrings, (Multi)Polygons and MultiPoints but it can be called with any kind of geometry. Elements of GeometryCollections are processed individually. The endpoints of LineStrings are preserved.

If the *tolerance* parameter is provided, vertices within the tolerance distance of one another are considered to be duplicates.

Enhanced: 3.2.0

2.2.0 □□□□□□□□□□□□□.

This function supports Polyhedral surfaces.

This function supports 3d and will not drop the z-index.

□□

```
SELECT ST_AsText( ST_RemoveRepeatedPoints( 'MULTIPOINT ((1 1), (2 2), (3 3), (2 2))'));
-------------------------
 MULTIPOINT(1 1,2 2,3 3)
```

```
SELECT ST_AsText( ST_RemoveRepeatedPoints( 'LINESTRING (0 0, 0 0, 1 1, 0 0, 1 1, 2 2)'));
---------------------------------
 LINESTRING(0 0,1 1,0 0,1 1,2 2)
```

Example: Collection elements are processed individually.

```
SELECT ST_AsText( ST_RemoveRepeatedPoints( 'GEOMETRYCOLLECTION (LINESTRING (1 1, 2 2, 2 2, 3 3), POINT (4 4), POINT (4 4), POINT (5 5))'));
------------------------------------------------------------------------------
 GEOMETRYCOLLECTION(LINESTRING(1 1,2 2,3 3),POINT(4 4),POINT(4 4),POINT(5 5))
```

Example: Repeated point removal with a distance tolerance.

```
SELECT ST_AsText( ST_RemoveRepeatedPoints( 'LINESTRING (0 0, 0 0, 1 1, 5 5, 1 1, 2 2)', 2));
-------------------------
 LINESTRING(0 0,5 5,2 2)
```

□□

ST_Simplify

7.5.26 ST_RemoveIrrelevantPointsForView

ST_RemoveIrrelevantPointsForView — Removes points that are irrelevant for rendering a specific rectangluar view of a geometry.

Synopsis

geometry **ST_RemoveIrrelevantPointsForView**(geometry geom, box2d bounds, boolean cartesian_hint = false);

□□

Returns a geometry without points being irrelevant for rendering the geometry within a given rectangular view.

This function can be used to quickly preprocess geometries that should be rendered only within certain bounds.

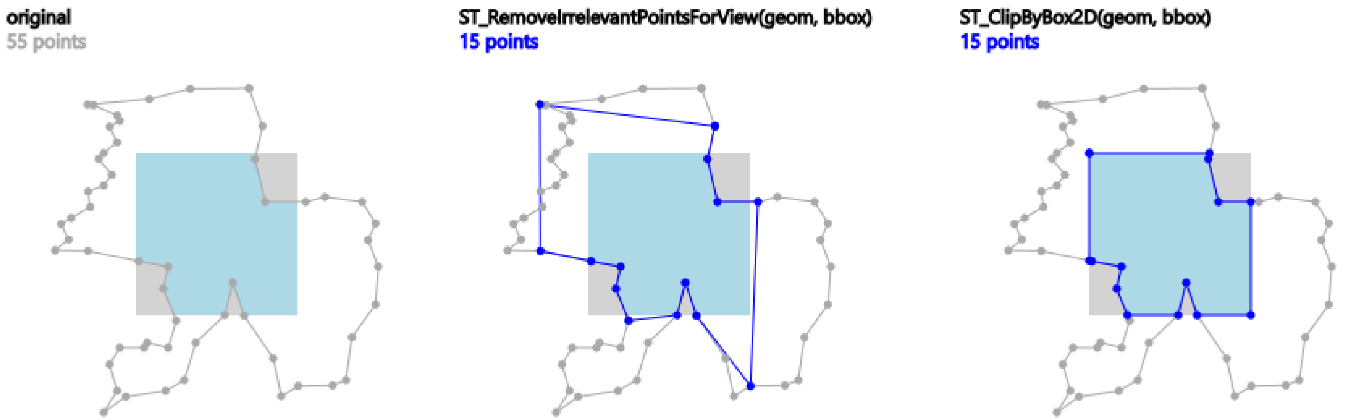
Only geometries of type (MULTI)POLYGON and (MULTI)LINESTRING are evaluated. Other geometries keep unchanged.

In contrast to `ST_ClipByBox2D()` this function

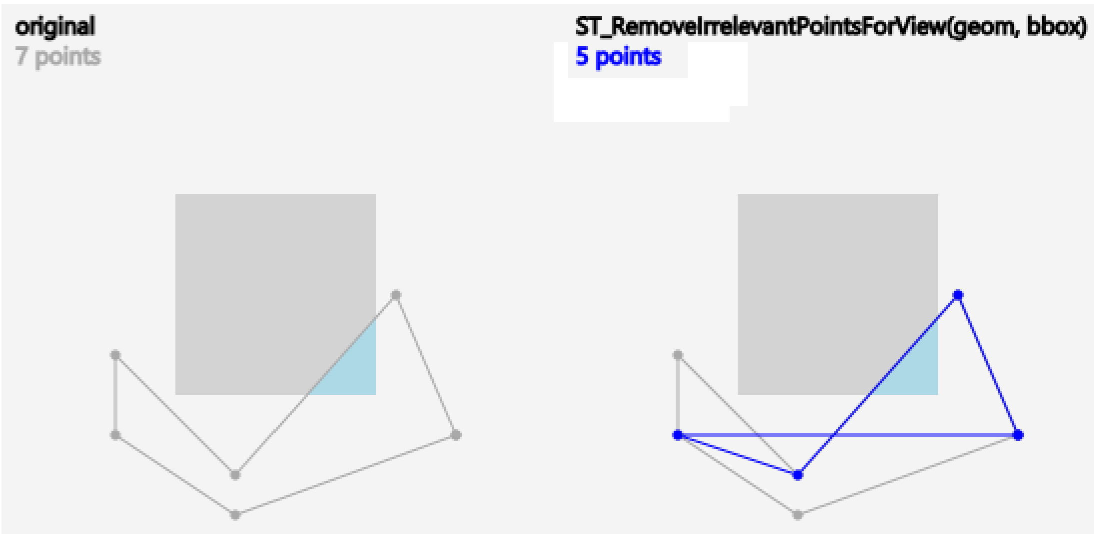
- sorts out points without computing new intersection points which avoids rounding errors and usually increases performance,
- returns a geometry with equal or similar point number,
- leads to the same rendering result within the specified view, and
- may introduce self-intersections which would make the resulting geometry invalid (see example below).

If `cartesian_hint` is set to `true`, the algorithm applies additional optimizations involving cartesian math to further reduce the resulting point number. Please note that using this option might introduce rendering artifacts if the resulting coordinates are projected into another (non-cartesian) coordinate system before rendering.

Warning
For polygons, this function does currently not ensure that the result is valid. This situation can be checked with ST_IsValid and repaired with ST_MakeValid.



Example: ST_RemoveIrrelevantPointsForView() applied to a polygon. Blue points remain, the rendering result (light-blue area) within the grey view box remains as well.



Example: Due to the fact that points are just sorted out and no new points are computed, the result of ST_RemoveIrrelevantPointsForView() may contain self-intersections.

Availability: 3.5.0

□□

```
SELECT ST_AsText(
                ST_RemoveIrrelevantPointsForView(
                ST_GeomFromText('MULTIPOLYGON(((10 10, 20 10, 30 10, 40 10, 20 20, 10 20, 10 10)),((10 10, 20 10, 20 20, 10 20, 10 10)))'),
                ST_MakeEnvelope(12,12,18,18), true));

        st_astext
        ---------
            MULTIPOLYGON(((10 10,40 10,20 20,10 20,10 10)),((10 10,20 10,20 20,10 20,10 10)))
```

```
SELECT ST_AsText(
                ST_RemoveIrrelevantPointsForView(
                ST_GeomFromText('MULTILINESTRING((0 0, 10 0,20 0,30 0), (0 15, 5 15, 10 15, 15 15, 20 15, 25 15, 30 15, 40 15), (13 13,15 15,17 17))'),
                ST_MakeEnvelope(12,12,18,18), true));

        st_astext
        ---------
                MULTILINESTRING((10 15,15 15,20 15),(13 13,15 15,17 17))
```

```
SELECT ST_AsText(
                ST_RemoveIrrelevantPointsForView(
                ST_GeomFromText('LINESTRING(0 0, 10 0,20 0,30 0)'),
                ST_MakeEnvelope(12,12,18,18), true));

        st_astext
        ---------
            LINESTRING EMPTY
```

```
SELECT ST_AsText(
                ST_RemoveIrrelevantPointsForView(
                ST_GeomFromText('POLYGON((0 30, 15 30, 30 30, 30 0, 0 0, 0 30))'),
                ST_MakeEnvelope(12,12,18,18), true));

        st_astext
        ---------
            POLYGON((15 30,30 0,0 0,15 30))
```

```
SELECT ST_AsText(
                ST_RemoveIrrelevantPointsForView(
                ST_GeomFromText('POLYGON((0 30, 15 30, 30 30, 30 0, 0 0, 0 30))'),
                ST_MakeEnvelope(12,12,18,18)));

        st_astext
        ---------
            POLYGON((0 30,30 30,30 0,0 0,0 30))
```

□□

ST_ClipByBox2D, ST_Intersection

7.5.27 ST_RemoveSmallParts

ST_RemoveSmallParts — Removes small parts (polygon rings or linestrings) of a geometry.

Synopsis

geometry **ST_RemoveSmallParts**(geometry geom, double precision minSizeX, double precision minSizeY);

⊠⊠

Returns a geometry without small parts (exterior or interior polygon rings, or linestrings).

This function can be used as preprocessing step for creating simplified maps, e. g. to remove small islands or holes.

It evaluates only geometries of type (MULTI)POLYGON and (MULTI)LINESTRING. Other geometries remain unchanged.

If *minSizeX* is greater than 0, parts are sorted out if their width is smaller than *minSizeX*.

If *minSizeY* is greater than 0, parts are sorted out if their height is smaller than *minSizeY*.

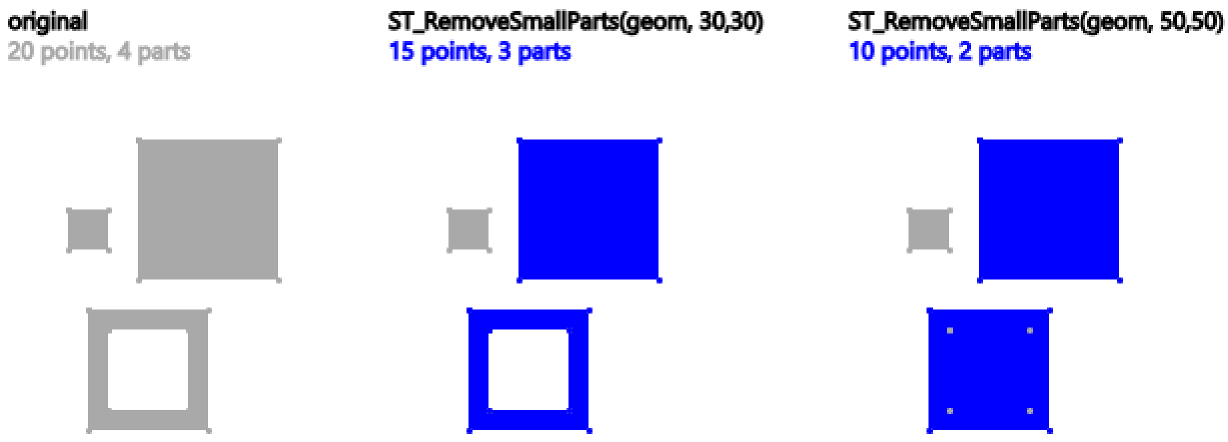
Both *minSizeX* and *minSizeY* are measured in coordinate system units of the geometry.

For polygon types, evaluation is done separately for each ring which can lead to one of the following results:

- the original geometry,
- a POLYGON with all rings with less vertices,
- a POLYGON with a reduced number of interior rings (having possibly less vertices),
- a POLYGON EMPTY, or
- a MULTIPOLYGON with a reduced number of polygons (having possibly less interior rings or vertices), or
- a MULTIPOLYGON EMPTY.

For linestring types, evaluation is done for each linestring which can lead to one of the following results:

- the original geometry,
- a LINESTRING with a reduced number of vertices,
- a LINESTRING EMPTY,
- a MULTILINESTRING with a reduced number of linestrings (having possibly less vertices), or
- a MULTILINESTRING EMPTY.



Example: ST_RemoveSmallParts() applied to a multi-polygon. Blue parts remain.

Availability: 3.5.0

⊠⊠

```
SELECT ST_AsText(
                        ST_RemoveSmallParts(
                        ST_GeomFromText('MULTIPOLYGON(
                                ((60 160, 120 160, 120 220, 60 220, 60 160), (70 170, 70 210, 110 210, 110 170, 70 170)),
                                ((85 75, 155 75, 155 145, 85 145, 85 75)),
                                ((50 110, 70 110, 70 130, 50 130, 50 110)))'),
                                50, 50));

                st_astext
                ---------
                        MULTIPOLYGON(((60 160,120 160,120 220,60 220,60 160)),((85 75,155 75,155 145,85 145,85 75)))
```

```
SELECT ST_AsText(
                        ST_RemoveSmallParts(
                        ST_GeomFromText('LINESTRING(10 10, 20 20)'),
                                50, 50));

                st_astext
                ---------
                        LINESTRING EMPTY
```

7.5.28 ST_Reverse

ST_Reverse — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Reverse**(geometry g1);

□□

□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□.

Enhanced: 2.4.0 support for curves was introduced.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

□□

```
SELECT ST_AsText(geom) as line, ST_AsText(ST_Reverse(geom)) As reverseline
FROM
(SELECT ST_MakeLine(ST_Point(1,2),
                ST_Point(1,10)) As geom) as foo;
--result
                line         |     reverseline
---------------------+----------------------
LINESTRING(1 2,1 10) | LINESTRING(1 10,1 2)
```

7.5.29 ST_Segmentize

ST_Segmentize — Returns a modified geometry/geography having no segment longer than a given distance.

Synopsis

geometry **ST_Segmentize**(geometry geom, float max_segment_length);
geography **ST_Segmentize**(geography geog, float max_segment_length);

□□

Returns a modified geometry/geography having no segment longer than `max_segment_length`. Length is computed in 2D. Segments are always split into equal-length subsegments.

- For geometry, the maximum length is in the units of the spatial reference system.
- For geography, the maximum length is in meters. Distances are computed on the sphere. Added vertices are created along the spherical great-circle arcs defined by segment endpoints.

> **Note**
> This only shortens long segments. It does not lengthen segments shorter than the maximum length.

> **Warning**
> For inputs containing long segments, specifying a relatively short `max_segment_length` can cause a very large number of vertices to be added. This can happen unintentionally if the argument is specified accidentally as a number of segments, rather than a maximum length.

1.2.2 □□□□□□□□□□□□.

Enhanced: 3.0.0 Segmentize geometry now produces equal-length subsegments

Enhanced: 2.3.0 Segmentize geography now produces equal-length subsegments

□□□□: 2.1.0 □□□□□□□□□□□□□□□□□□.

Changed: 2.1.0 As a result of the introduction of geography support, the usage `ST_Segmentize('LINESTRING 2, 3 4)', 0.5)` causes an ambiguous function error. The input needs to be properly typed as a geometry or geography. Use ST_GeomFromText, ST_GeogFromText or a cast to the required type (e.g. `ST_Segmentize('LINESTRING(1 2, 3 4)'::geometry, 0.5) )`

□□

Segmentizing a line. Long segments are split evenly, and short segments are not split.

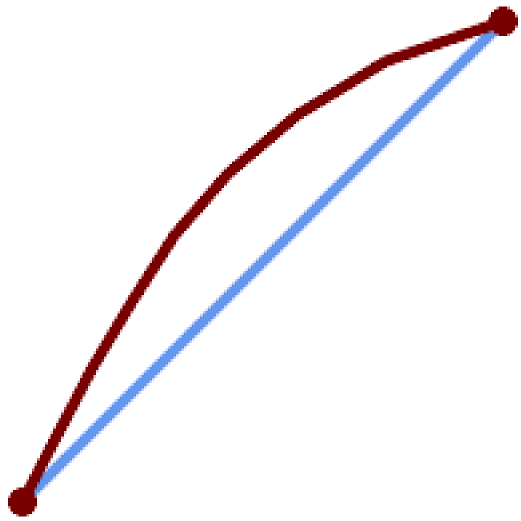
```
SELECT ST_AsText(ST_Segmentize(
    'MULTILINESTRING((0 0, 0 1, 0 9),(1 10, 1 18))'::geometry,
        5 ) );
---------------------------------------------------
MULTILINESTRING((0 0,0 1,0 5,0 9),(1 10,1 14,1 18))
```

Segmentizing a polygon:

```
SELECT ST_AsText(
        ST_Segmentize(('POLYGON((0 0, 0 8, 30 0, 0 0))'::geometry), 10));
-------------------------------------------------------
POLYGON((0 0,0 8,7.5 6,15 4,22.5 2,30 0,20 0,10 0,0 0))
```

Segmentizing a geographic line, using a maximum segment length of 2000 kilometers. Vertices are added along the great-circle arc connecting the endpoints.

```
SELECT ST_AsText(
        ST_Segmentize(('LINESTRING (0 0, 60 60)'::geography), 2000000));
-------------------------------------------------------------
LINESTRING(0 0,4.252632294621186 8.43596525986862,8.69579947419404  ←
    16.824093489701564,13.550465473227048 25.107950473646188,19.1066053508691  ←
    33.21091076089908,25.779290201459894 41.01711439406505,34.188839517966954  ←
    48.337222885886,45.238153936612264 54.84733442373889,60 60)
```



A geographic line segmentized along a great circle arc

☒☒

ST_LineSubstring

7.5.30 ST_SetPoint

ST_SetPoint — ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_SetPoint**(geometry linestring, integer zerobasedposition, geometry point);

☒☒

☒☒☒☒☒☒ N ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒ 0-☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒, -1 ☒☒☒☒☒☒☒☒☒☒☒. ☒☒.

1.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒☒☒: 2.3.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

This function supports 3d and will not drop the z-index.

☒☒

```
--Change first point in line string from -1 3 to -1 1
SELECT ST_AsText(ST_SetPoint('LINESTRING(-1 2,-1 3)', 0, 'POINT(-1 1)'));
           st_astext
-----------------------
 LINESTRING(-1 1,-1 3)

---Change last point in a line string (lets play with 3d linestring this time)
SELECT ST_AsEWKT(ST_SetPoint(foo.geom, ST_NumPoints(foo.geom) - 1, ST_GeomFromEWKT('POINT ↩
    (-1 1 3)')))
FROM (SELECT ST_GeomFromEWKT('LINESTRING(-1 2 3,-1 3 4, 5 6 7)') As geom) As foo;
           st_asewkt
-----------------------
LINESTRING(-1 2 3,-1 3 4,-1 1 3)

SELECT ST_AsText(ST_SetPoint(g, -3, p))
FROM ST_GEomFromText('LINESTRING(0 0, 1 1, 2 2, 3 3, 4 4)') AS g
        , ST_PointN(g,1) as p;
           st_astext
-----------------------
LINESTRING(0 0,1 1,0 0,3 3,4 4)
```

☒☒

ST_AddPoint, ST_NPoints, ST_NumPoints, ST_PointN, ST_RemovePoint

7.5.31 ST_ShiftLongitude

ST_ShiftLongitude — Shifts the longitude coordinates of a geometry between -180..180 and 0..360.

Synopsis

geometry **ST_ShiftLongitude**(geometry geom);

⊠⊠

Reads every point/vertex in a geometry, and shifts its longitude coordinate from -180..0 to 180..360 and vice versa if between these ranges. This function is symmetrical so the result is a 0..360 representation of a -180..180 data and a -180..180 representation of a 0..360 data.

Note
This is only useful for data with coordinates in longitude/latitude; e.g. SRID 4326 (WGS 84 geographic)

Warning
1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠.

⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠”ST_Shift_Longitude” ⊠⊠⊠⊠.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
--single point forward transformation
SELECT ST_AsText(ST_ShiftLongitude('SRID=4326;POINT(270 0)'::geometry))

st_astext
----------
POINT(-90 0)


--single point reverse transformation
SELECT ST_AsText(ST_ShiftLongitude('SRID=4326;POINT(-90 0)'::geometry))

st_astext
----------
POINT(270 0)


--for linestrings the functions affects only to the sufficient coordinates
```

```
SELECT ST_AsText(ST_ShiftLongitude('SRID=4326;LINESTRING(174 12, 182 13)'::geometry))

st_astext
----------
LINESTRING(174 12,-178 13)
```

⊠⊠

ST_WrapX

7.5.32 ST_WrapX

ST_WrapX — X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_WrapX**(geometry geom, float8 wrap, float8 move);

⊠⊠

This function splits the input geometries and then moves every resulting component falling on the right (for negative 'move') or on the left (for positive 'move') of given 'wrap' line in the direction specified by the 'move' parameter, finally re-unioning the pieces together.

Note
⊠⊠.

Availability: 2.3.0 requires GEOS

This function supports 3d and will not drop the z-index.

⊠⊠

```
-- Move all components of the given geometries whose bounding box
-- falls completely on the left of x=0 to +360
select ST_WrapX(geom, 0, 360);

-- Move all components of the given geometries whose bounding box
-- falls completely on the left of x=-30 to +360
select ST_WrapX(geom, -30, 360);
```

⊠⊠

ST_ShiftLongitude

7.5.33 ST_SnapToGrid

ST_SnapToGrid — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (snap) ⊠⊠⊠⊠.

Synopsis

geometry **ST_SnapToGrid**(geometry geomA, float originX, float originY, float sizeX, float sizeY);
geometry **ST_SnapToGrid**(geometry geomA, float sizeX, float sizeY);
geometry **ST_SnapToGrid**(geometry geomA, float size);
geometry **ST_SnapToGrid**(geometry geomA, geometry pointOrigin, float sizeX, float sizeY, float sizeZ, float sizeM);

⊠⊠

⊠⊠ 1, 2, 3: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (cell) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (snap) ⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠ ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 4: 1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (ST_IsSimple ⊠⊠).

> **Note**
> 1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.0.0RC1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.1.0 ⊠⊠⊠⊠ Z ⊠ M ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

```
--Snap your geometries to a precision grid of 10^-3
UPDATE mytable
   SET geom = ST_SnapToGrid(geom, 0.001);

SELECT ST_AsText(ST_SnapToGrid(
                        ST_GeomFromText('LINESTRING(1.1115678 2.123, 4.111111 3.2374897, ↩
                            4.11112 3.23748667)'),
                        0.001)
                );
                          st_astext
-------------------------------------
 LINESTRING(1.112 2.123,4.111 3.237)
 --Snap a 4d geometry
SELECT ST_AsEWKT(ST_SnapToGrid(
```

```
        ST_GeomFromEWKT('LINESTRING(-1.1115678 2.123 2.3456 1.11111,
                4.111111 3.2374897 3.1234 1.1111, -1.11111112 2.123 2.3456 1.1111112)'),
 ST_GeomFromEWKT('POINT(1.12 2.22 3.2 4.4444)'),
 0.1, 0.1, 0.1, 0.01) );
                                                                  st_asewkt
------------------------------------------------------------------------------
 LINESTRING(-1.08 2.12 2.3 1.1144,4.12 3.22 3.1 1.1144,-1.08 2.12 2.3 1.1144)


--With a 4d geometry - the ST_SnapToGrid(geom,size) only touches x and y coords but keeps m ↩
     and z the same
SELECT ST_AsEWKT(ST_SnapToGrid(ST_GeomFromEWKT('LINESTRING(-1.1115678 2.123 3 2.3456,
                4.111111 3.2374897 3.1234 1.1111)'),
           0.01)      );
                                                      st_asewkt
---------------------------------------------------------
 LINESTRING(-1.11 2.12 3 2.3456,4.11 3.24 3.1234 1.1111)
```

⊠⊠

ST_Snap, ST_AsEWKT, ST_AsText, ST_GeomFromText, ST_GeomFromEWKT, ST_Simplify

7.5.34 ST_Snap

ST_Snap — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Snap**(geometry input, geometry reference, float tolerance);

⊠⊠

Snaps the vertices and segments of a geometry to another Geometry's vertices. A snap distance tolerance is used to control where snapping is performed. The result geometry is the input geometry with the vertices snapped. If no snapping occurs then the input geometry is returned unchanged.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

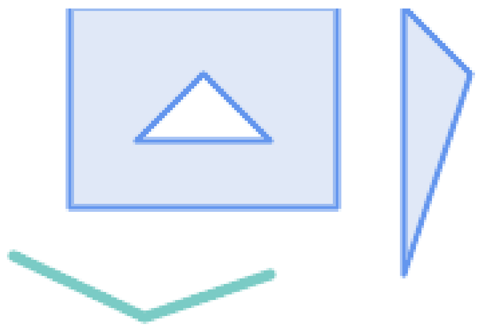
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ (heuristics) ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (ST_IsSimple ⊠⊠) ⊠⊠⊠⊠ (ST_IsValid ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

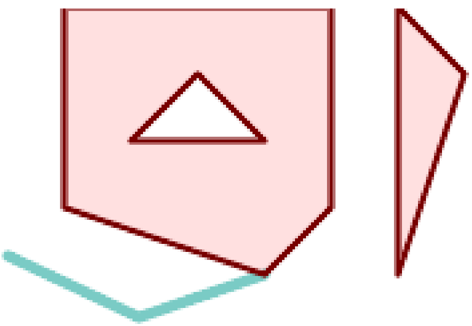
GEOS ⊠⊠⊠⊠⊠

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

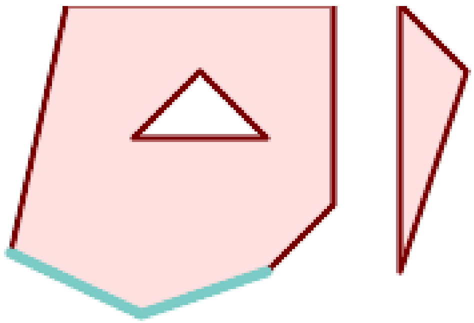


☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (☒☒☒☒☒)



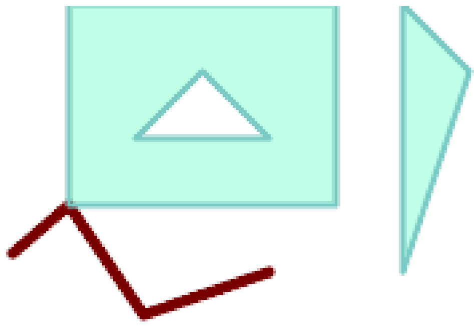
[illegible] 1.01 [illegible]. [illegible].

```
SELECT ST_AsText(ST_Snap(poly,line, ↩
     ST_Distance(poly,line)*1.01)) AS polysnapped
FROM (SELECT
   ST_GeomFromText('MULTIPOLYGON(
     ((26 125, 26 200, 126 200, 126 125, ↩
     26 125 ),
      ( 51 150, 101 150, 76 175, 51 150 ) ↩
     ),
      (( 151 100, 151 200, 176 175, 151 ↩
     100 )))') As poly,
       ST_GeomFromText('LINESTRING (5 ↩
     107, 54 84, 101 100)') As line
        ) As foo;

                             polysnapped
--------------------------------------------------------------------- ↩

 MULTIPOLYGON(((26 125,26 200,126 200,126 ↩
      125,101 100,26 125),
 (51 150,101 150,76 175,51 150)),((151 ↩
     100,151 200,176 175,151 100)))
```



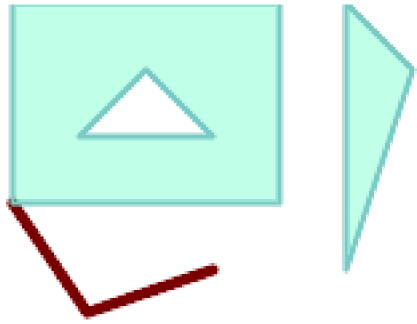
[illegible] 1.25 [illegible]. [illegible].

```
SELECT ST_AsText(
    ST_Snap(poly,line, ST_Distance(poly, ↩
     line)*1.25)
  ) AS polysnapped
FROM (SELECT
  ST_GeomFromText('MULTIPOLYGON(
    (( 26 125, 26 200, 126 200, 126 125, ↩
     26 125 ),
      ( 51 150, 101 150, 76 175, 51 150 ) ↩
     ),
      (( 151 100, 151 200, 176 175, 151 ↩
     100 )))') As poly,
       ST_GeomFromText('LINESTRING (5 ↩
     107, 54 84, 101 100)') As line
        ) As foo;

                             polysnapped
---------------------------------------------------------------------

MULTIPOLYGON(((5 107,26 200,126 200,126 ↩
     125,101 100,54 84,5 107),
(51 150,101 150,76 175,51 150)),((151 ↩
     100,151 200,176 175,151 100)))
```



⊠⊠⊠⊠ 1.01 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AsText(
   ST_Snap(line, poly, ST_Distance(poly, line)*1.01)
  ) AS linesnapped
FROM (SELECT
  ST_GeomFromText('MULTIPOLYGON(
     ((26 125, 26 200, 126 200, 126 125, 26 125),
      (51 150, 101 150, 76 175, 51 150 )),
      ((151 100, 151 200, 176 175, 151 100)))') As poly,
       ST_GeomFromText('LINESTRING (5 107, 54 84, 101 100)') As line
        ) As foo;

              linesnapped
----------------------------------------
 LINESTRING(5 107,26 125,54 84,101 100)
```



⊠⊠⊠⊠ 1.25 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AsText(
 ST_Snap(line, poly, ST_Distance(poly, line)*1.25)
  ) AS linesnapped
FROM (SELECT
  ST_GeomFromText('MULTIPOLYGON(
     (( 26 125, 26 200, 126 200, 126 125, 26 125 ),
      (51 150, 101 150, 76 175, 51 150 )),
      ((151 100, 151 200, 176 175, 151 100 )))') As poly,
       ST_GeomFromText('LINESTRING (5 107, 54 84, 101 100)') As line
        ) As foo;
              linesnapped
---------------------------------------
LINESTRING(26 125,54 84,101 100)
```

⊠⊠

ST_SnapToGrid

7.5.35 ST_SwapOrdinates

ST_SwapOrdinates — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_SwapOrdinates**(geometry geom, cstring ords);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
`ords` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ x, y, z, ⊠⊠⊠ m ⊠⊠⊠.
2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
-- Scale M value by 2
SELECT ST_AsText(
  ST_SwapOrdinates(
    ST_Scale(
      ST_SwapOrdinates(g,'xm'),
      2, 1
    ),
  'xm')
) FROM ( SELECT 'POINT ZM (0 0 0 2)'::geometry g ) foo;
     st_astext
--------------------
 POINT ZM (0 0 0 4)
```

⊠⊠

ST_FlipCoordinates

7.6 Geometry Validation

7.6.1 ST_IsValid

ST_IsValid — Tests if a geometry is well-formed in 2D.

Synopsis

boolean **ST_IsValid**(geometry g);
boolean **ST_IsValid**(geometry g, integer flags);

⊠⊠

Tests if an ST_Geometry value is well-formed and valid in 2D according to the OGC rules. For geometries with 3 and 4 dimensions, the validity is still only tested in 2 dimensions. For geometries that are invalid, a PostgreSQL NOTICE is emitted providing details of why it is not valid.

For the version with the `flags` parameter, supported values are documented in ST_IsValidDetail This version does not print a NOTICE explaining invalidity.

For more information on the definition of geometry validity, refer to Section 4.4

> **Note**
> SQL-MM defines the result of ST_IsValid(NULL) to be 0, while PostGIS returns NULL.

GEOS ⊠⊠⊠⊠⊠

The version accepting flags is available starting with 2.0.0.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.9

> **Note**
> Neither OGC-SFS nor SQL-MM specifications include a flag argument for ST_IsValid. The flag is a PostGIS extension.

⊠⊠

```
SELECT ST_IsValid(ST_GeomFromText('LINESTRING(0 0, 1 1)')) As good_line,
        ST_IsValid(ST_GeomFromText('POLYGON((0 0, 1 1, 1 2, 1 1, 0 0))')) As bad_poly
--results
NOTICE:  Self-intersection at or near point 0 0
 good_line | bad_poly
-----------+----------
 t         | f
```

⊠⊠

ST_IsSimple, ST_IsValidReason, ST_IsValidDetail,

7.6.2 ST_IsValidDetail

ST_IsValidDetail — Returns a `valid_detail` row stating if a geometry is valid or if not a reason and a location.

Synopsis

valid_detail **ST_IsValidDetail**(geometry geom, integer flags);

□□

Returns a `valid_detail` row, containing a boolean (`valid`) stating if a geometry is valid, a varchar (`reason`) stating a reason why it is invalid and a geometry (`location`) pointing out where it is invalid.

Useful to improve on the combination of ST_IsValid and ST_IsValidReason to generate a detailed report of invalid geometries.

The optional `flags` parameter is a bitfield. It can have the following values:

- 0: Use usual OGC SFS validity semantics.
- 1: Consider certain kinds of self-touching rings (inverted shells and exverted holes) as valid. This is also known as "the ESRI flag", since this is the validity model used by those tools. Note that this is invalid under the OGC model.

GEOS □□□□□

2.0.0 □□□□□□□□□□□□.

□□

```
--First 3 Rejects from a successful quintuplet experiment
SELECT gid, reason(ST_IsValidDetail(geom)), ST_AsText(location(ST_IsValidDetail(geom))) as location
FROM
(SELECT ST_MakePolygon(ST_ExteriorRing(e.buff), array_agg(f.line)) As geom, gid
FROM (SELECT ST_Buffer(ST_Point(x1*10,y1), z1) As buff, x1*10 + y1*100 + z1*1000 As gid
        FROM generate_series(-4,6) x1
        CROSS JOIN generate_series(2,5) y1
        CROSS JOIN generate_series(1,8) z1
        WHERE x1
> y1*0.5 AND z1 < x1*y1) As e
        INNER JOIN (SELECT ST_Translate(ST_ExteriorRing(ST_Buffer(ST_Point(x1*10,y1), z1)), y1*1, z1*2) As line
        FROM generate_series(-3,6) x1
        CROSS JOIN generate_series(2,5) y1
        CROSS JOIN generate_series(1,10) z1
        WHERE x1
> y1*0.75 AND z1 < x1*y1) As f
ON (ST_Area(e.buff)
> 78 AND ST_Contains(e.buff, f.line))
GROUP BY gid, e.buff) As quintuplet_experiment
WHERE ST_IsValid(geom) = false
ORDER BY gid
LIMIT 3;

 gid  |      reason       |  location
------+-------------------+-------------
 5330 | Self-intersection | POINT(32 5)
 5340 | Self-intersection | POINT(42 5)
 5350 | Self-intersection | POINT(52 5)

 --simple example
SELECT * FROM ST_IsValidDetail('LINESTRING(220227 150406,2220227 150407,222020 150410)');

 valid | reason | location
-------+--------+----------
 t     |        |
```

□□

ST_IsValid, ST_IsValidReason

7.6.3 ST_IsValidReason

ST_IsValidReason — Returns text stating if a geometry is valid, or a reason for invalidity.

Synopsis

text **ST_IsValidReason**(geometry geomA);
text **ST_IsValidReason**(geometry geomA, integer flags);

□□

Returns text stating if a geometry is valid, or if invalid a reason why.

Useful in combination with ST_IsValid to generate a detailed report of invalid geometries and reasons.

Allowed `flags` are documented in ST_IsValidDetail.

GEOS □□□□□

Availability: 1.4

Availability: 2.0 version taking flags.

□□

```
-- invalid bow-tie polygon
SELECT ST_IsValidReason(
    'POLYGON ((100 200, 100 100, 200 200,
     200 100, 100 200))'::geometry) as validity_info;
validity_info
--------------------------
Self-intersection[150 150]
```

```
--First 3 Rejects from a successful quintuplet experiment
SELECT gid, ST_IsValidReason(geom) as validity_info
FROM
(SELECT ST_MakePolygon(ST_ExteriorRing(e.buff), array_agg(f.line)) As geom, gid
FROM (SELECT ST_Buffer(ST_Point(x1*10,y1), z1) As buff, x1*10 + y1*100 + z1*1000 As gid
        FROM generate_series(-4,6) x1
        CROSS JOIN generate_series(2,5) y1
        CROSS JOIN generate_series(1,8) z1
        WHERE x1
> y1*0.5 AND z1 < x1*y1) As e
        INNER JOIN (SELECT ST_Translate(ST_ExteriorRing(ST_Buffer(ST_Point(x1*10,y1), z1)), y1*1, z1*2) As line
        FROM generate_series(-3,6) x1
        CROSS JOIN generate_series(2,5) y1
        CROSS JOIN generate_series(1,10) z1
        WHERE x1
> y1*0.75 AND z1 < x1*y1) As f
ON (ST_Area(e.buff)
> 78 AND ST_Contains(e.buff, f.line))
```

```
GROUP BY gid, e.buff) As quintuplet_experiment
WHERE ST_IsValid(geom) = false
ORDER BY gid
LIMIT 3;

 gid  |      validity_info
------+--------------------------
 5330 | Self-intersection [32 5]
 5340 | Self-intersection [42 5]
 5350 | Self-intersection [52 5]

 --simple example
SELECT ST_IsValidReason('LINESTRING(220227 150406,2220227 150407,222020 150410)');

 st_isvalidreason
------------------
 Valid Geometry
```

☒☒

ST_IsValid, ST_Summary

7.6.4 ST_MakeValid

ST_MakeValid — Attempts to make an invalid geometry valid without losing vertices.

Synopsis

geometry **ST_MakeValid**(geometry input);
geometry **ST_MakeValid**(geometry input, text params);

☒☒

The function attempts to create a valid representation of a given invalid geometry without losing any of the input vertices. Valid geometries are returned unchanged.

Supported inputs are: POINTS, MULTIPOINTS, LINESTRINGS, MULTILINESTRINGS, POLYGONS, MULTIPOLYGONS and GEOMETRYCOLLECTIONS containing any mix of them.

In case of full or partial dimensional collapses, the output geometry may be a collection of lower-to-equal dimension geometries, or a geometry of lower dimension.

Single polygons may become multi-geometries in case of self-intersections.

The `params` argument can be used to supply an options string to select the method to use for building valid geometry. The options string is in the format ”method=linework|structure keepcollapsed=true|false”. If no ”params” argument is provided, the ”linework” algorithm will be used as the default.

The ”method” key has two values.

- ”linework” is the original algorithm, and builds valid geometries by first extracting all lines, noding that linework together, then building a value output from the linework.
- ”structure” is an algorithm that distinguishes between interior and exterior rings, building new geometry by unioning exterior rings, and then differencing all interior rings.

The ”keepcollapsed” key is only valid for the ”structure” algorithm, and takes a value of ”true” or ”false”. When set to ”false”, geometry components that collapse to a lower dimensionality, for example a one-point linestring would be dropped.

GEOS □□□□□

2.0.0 □□□□□□□□□□□□□.

Enhanced: 2.0.1, speed improvements

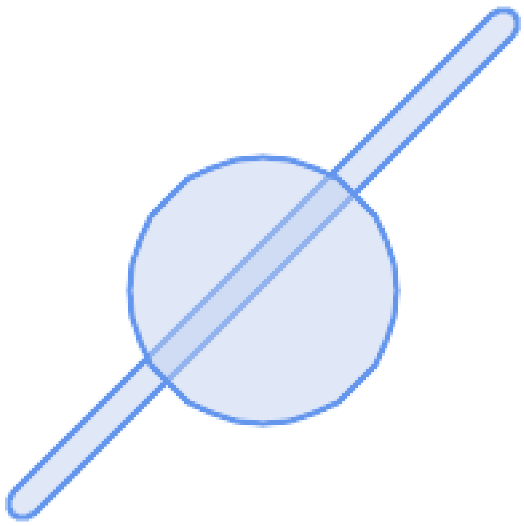
Enhanced: 2.1.0, added support for GEOMETRYCOLLECTION and MULTIPOINT.

Enhanced: 3.1.0, added removal of Coordinates with NaN values.

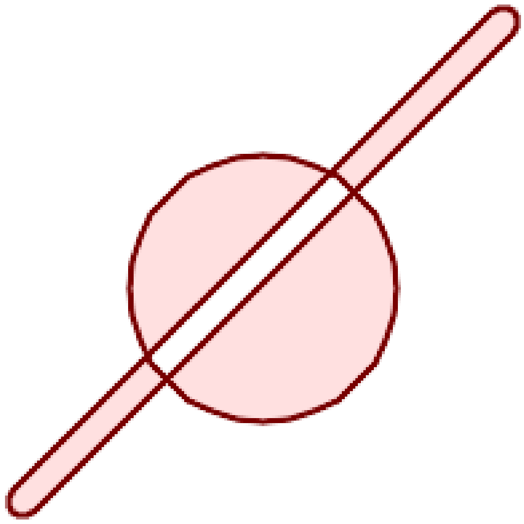
Enhanced: 3.2.0, added algorithm options, ’linework’ and ’structure’ which requires GEOS >= 3.10.0.

This function supports 3d and will not drop the z-index.

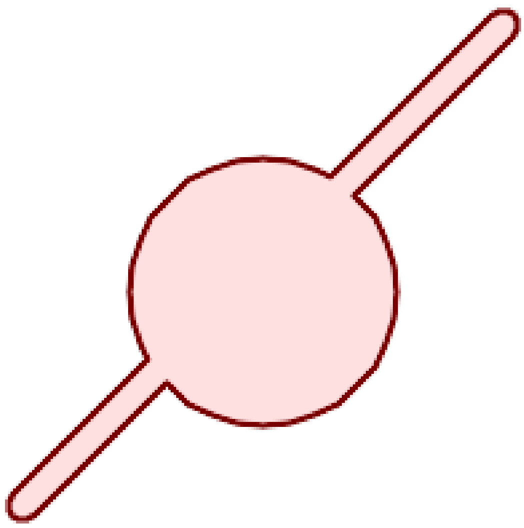
□□



before_geom: MULTIPOLYGON of 2 overlapping polygons

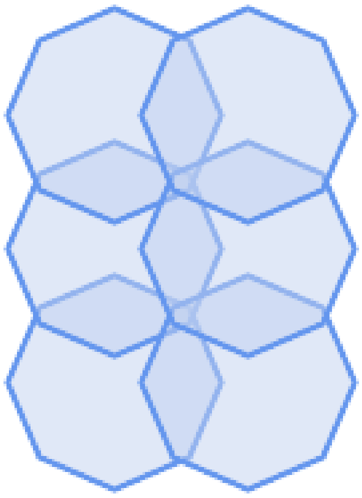


after_geom: MULTIPOLYGON of 4 non-overlapping polygons

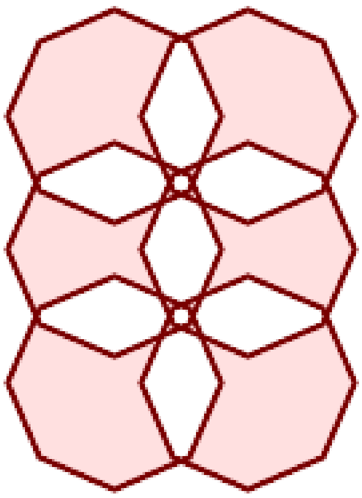


after_geom_structure: MULTIPOLYGON of 1 non-overlapping polygon

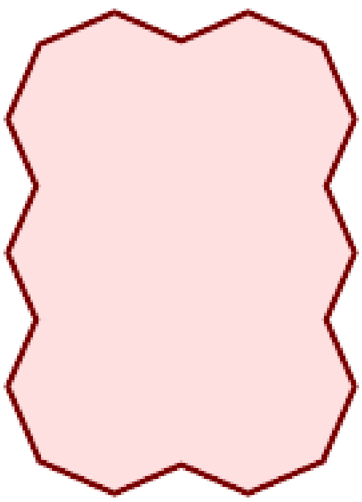
```
SELECT f.geom AS before_geom, ST_MakeValid(f.geom) AS after_geom, ST_MakeValid(f.geom, ↩
     'method=structure') AS after_geom_structure
FROM (SELECT 'MULTIPOLYGON(((186 194,187 194,188 195,189 195,190 195,
```



before_geom: MULTIPOLYGON of 6 overlapping polygons



after_geom: MULTIPOLYGON of 14 Non-overlapping polygons



after_geom_structure: MULTIPOLYGON of 1 Non-overlapping polygon

```
SELECT c.geom AS before_geom,
                    ST_MakeValid(c.geom) AS after_geom,
                    ST_MakeValid(c.geom, 'method=structure') AS after_geom_structure
        FROM (SELECT 'MULTIPOLYGON(((91 50,79 22,51 10,23 22,11 50,23 78,51 90,79 78,91 ↩
```

☒☒

```
SELECT ST_AsText(ST_MakeValid(
    'LINESTRING(0 0, 0 0)',
    'method=structure keepcollapsed=true'
    ));

 st_astext
------------
 POINT(0 0)


SELECT ST_AsText(ST_MakeValid(
    'LINESTRING(0 0, 0 0)',
    'method=structure keepcollapsed=false'
    ));

    st_astext
------------------
 LINESTRING EMPTY
```

☒☒

ST_IsValid, ST_Collect, ST_CollectionExtract

7.7 Spatial Reference System Functions

7.7.1 ST_InverseTransformPipeline

ST_InverseTransformPipeline — Return a new geometry with coordinates transformed to a different spatial reference system using the inverse of a defined coordinate transformation pipeline.

Synopsis

geometry **ST_InverseTransformPipeline**(geometry geom, text pipeline, integer to_srid);

☒☒

Return a new geometry with coordinates transformed to a different spatial reference system using a defined coordinate transformation pipeline to go in the inverse direction.

Refer to ST_TransformPipeline for details on writing a transformation pipeline.

Availability: 3.4.0

The SRID of the input geometry is ignored, and the SRID of the output geometry will be set to zero unless a value is provided via the optional `to_srid` parameter. When using ST_TransformPipeline the pipeline is executed in a forward direction. Using `ST_InverseTransformPipeline()` the pipeline is executed in the inverse direction.

Transforms using pipelines are a specialised version of ST_Transform. In most cases `ST_Transform` will choose the correct operations to convert between coordinate systems, and should be preferred.

⊠⊠

Change WGS 84 long lat to UTM 31N using the EPSG:16031 conversion

```
-- Inverse direction
SELECT ST_AsText(ST_InverseTransformPipeline('POINT(426857.9877165967 5427937.523342293)':: ↩
    geometry,
  'urn:ogc:def:coordinateOperation:EPSG::16031')) AS wgs_geom;

          wgs_geom
----------------------------
 POINT(2 48.99999999999999)
(1 row)
```

GDA2020 example.

```
-- using ST_Transform with automatic selection of a conversion pipeline.
SELECT ST_AsText(ST_Transform('SRID=4939;POINT(143.0 -37.0)'::geometry, 7844)) AS ↩
    gda2020_auto;

                 gda2020_auto
-----------------------------------------------
 POINT(143.00000635638918 -36.999986706128176)
(1 row)
```

⊠⊠

ST_Transform, ST_TransformPipeline

7.7.2 ST_SetSRID

ST_SetSRID — Set the SRID on a geometry.

Synopsis

geometry **ST_SetSRID**(geometry geom, integer srid);

⊠⊠

Sets the SRID on a geometry to a particular integer value. Useful in constructing bounding boxes for queries.

> **Note**
> This function does not transform the geometry coordinates in any way - it simply sets the meta data defining the spatial reference system the geometry is assumed to be in. Use ST_Transform if you want to transform the geometry into a new projection.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method supports Circular Strings and Curves.

⊠⊠

-- Mark a point as WGS 84 long lat --

```
SELECT ST_SetSRID(ST_Point(-123.365556, 48.428611),4326) As wgs84long_lat;
-- the ewkt representation (wrap with ST_AsEWKT) -
SRID=4326;POINT(-123.365556 48.428611)
```

-- Mark a point as WGS 84 long lat and then transform to web mercator (Spherical Mercator) --

```
SELECT ST_Transform(ST_SetSRID(ST_Point(-123.365556, 48.428611),4326),3785) As spere_merc;
-- the ewkt representation (wrap with ST_AsEWKT) -
SRID=3785;POINT(-13732990.8753491 6178458.96425423)
```

⊠⊠

Section 4.5, ST_SRID, ST_Transform, UpdateGeometrySRID

7.7.3 ST_SRID

ST_SRID — Returns the spatial reference identifier for a geometry.

Synopsis

integer **ST_SRID**(geometry g1);

⊠⊠

Returns the spatial reference identifier for the ST_Geometry as defined in spatial_ref_sys table. Section 4.5

> **Note**
> spatial_ref_sys table is a table that catalogs all spatial reference systems known to PostGIS and is used for transformations from one spatial reference system to another. So verifying you have the right spatial reference system identifier is important if you plan to ever transform your geometries.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.1

This method implements the SQL/MM specification. SQL-MM 3: 5.1.5

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_SRID(ST_GeomFromText('POINT(-71.1043 42.315)',4326));
    --result
    4326
```

⊠⊠

Section 4.5, ST_SetSRID, ST_Transform, ST_SRID, ST_SRID

7.7.4 ST_Transform

ST_Transform — Return a new geometry with coordinates transformed to a different spatial reference system.

Synopsis

geometry **ST_Transform**(geometry g1, integer srid);
geometry **ST_Transform**(geometry geom, text to_proj);
geometry **ST_Transform**(geometry geom, text from_proj, text to_proj);
geometry **ST_Transform**(geometry geom, text from_proj, integer to_srid);

⊠⊠

Returns a new geometry with its coordinates transformed to a different spatial reference system. The destination spatial reference `to_srid` may be identified by a valid SRID integer parameter (i.e. it must exist in the `spatial_ref_sys` table). Alternatively, a spatial reference defined as a PROJ.4 string can be used for `to_proj` and/or `from_proj`, however these methods are not optimized. If the destination spatial reference system is expressed with a PROJ.4 string instead of an SRID, the SRID of the output geometry will be set to zero. With the exception of functions with `from_proj`, input geometries must have a defined SRID.

ST_Transform is often confused with ST_SetSRID. ST_Transform actually changes the coordinates of a geometry from one spatial reference system to another, while ST_SetSRID() simply changes the SRID identifier of the geometry.

ST_Transform automatically selects a suitable conversion pipeline given the source and target spatial reference systems. To use a specific conversion method, use ST_TransformPipeline.

Note
Requires PostGIS be compiled with PROJ support. Use PostGIS_Full_Version to confirm you have PROJ support compiled in.

Note
If using more than one transformation, it is useful to have a functional index on the commonly used transformations to take advantage of index usage.

Note
1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

Enhanced: 2.3.0 support for direct PROJ.4 text was introduced.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.6

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

☒☒

Change Massachusetts state plane US feet geometry to WGS 84 long lat

```
SELECT ST_AsText(ST_Transform(ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,
  743265 2967450,743265.625 2967416,743238 2967416))',2249),4326)) As wgs_geom;

 wgs_geom
---------------------------
 POLYGON((-71.1776848522251 42.3902896512902,-71.1776843766326 42.3903829478009,
-71.1775844305465 42.3903826677917,-71.1775825927231 42.3902893647987,-71.177684
8522251 42.3902896512902));
(1 row)

--3D Circular String example
SELECT ST_AsEWKT(ST_Transform(ST_GeomFromEWKT('SRID=2249;CIRCULARSTRING(743238 2967416  ↩
    1,743238 2967450 2,743265 2967450 3,743265.625 2967416 3,743238 2967416 4)'),4326));

         st_asewkt
--------------------------------------------------------------------------------------
 SRID=4326;CIRCULARSTRING(-71.1776848522251 42.3902896512902 1,-71.1776843766326  ↩
     42.3903829478009 2,
 -71.1775844305465 42.3903826677917 3,
 -71.1775825927231 42.3902893647987 3,-71.1776848522251 42.3902896512902 4)
```

Example of creating a partial functional index. For tables where you are not sure all the geometries will be filled in, its best to use a partial index that leaves out null geometries which will both conserve space and make your index smaller and more efficient.

```
CREATE INDEX idx_geom_26986_parcels
  ON parcels
  USING gist
  (ST_Transform(geom, 26986))
  WHERE geom IS NOT NULL;
```

Examples of using PROJ.4 text to transform with custom spatial references.

```
-- Find intersection of two polygons near the North pole, using a custom Gnomic projection
-- See http://boundlessgeo.com/2012/02/flattening-the-peel/
 WITH data AS (
   SELECT
     ST_GeomFromText('POLYGON((170 50,170 72,-130 72,-130 50,170 50))', 4326) AS p1,
     ST_GeomFromText('POLYGON((-170 68,-170 90,-141 90,-141 68,-170 68))', 4326) AS p2,
     '+proj=gnom +ellps=WGS84 +lat_0=70 +lon_0=-160 +no_defs'::text AS gnom
 )
 SELECT ST_AsText(
   ST_Transform(
     ST_Intersection(ST_Transform(p1, gnom), ST_Transform(p2, gnom)),
   gnom, 4326))
 FROM data;
                                          st_astext
 --------------------------------------------------------------------------------
```

```
POLYGON((-170 74.053793645338,-141 73.4268621378904,-141 68,-170 68,-170 74.053793645338) ↩
    )
```

Configuring transformation behavior

Sometimes coordinate transformation involving a grid-shift can fail, for example if PROJ.4 has not been built with grid-shift files or the coordinate does not lie within the range for which the grid shift is defined. By default, PostGIS will throw an error if a grid shift file is not present, but this behavior can be configured on a per-SRID basis either by testing different `to_proj` values of PROJ.4 text, or altering the `proj4text` value within the `spatial_ref_sys` table.

For example, the proj4text parameter +datum=NAD87 is a shorthand form for the following +nadgrids parameter:

```
+nadgrids=@conus,@alaska,@ntv2_0.gsb,@ntv1_can.dat
```

The @ prefix means no error is reported if the files are not present, but if the end of the list is reached with no file having been appropriate (ie. found and overlapping) then an error is issued.

If, conversely, you wanted to ensure that at least the standard files were present, but that if all files were scanned without a hit a null transformation is applied you could use:

```
+nadgrids=@conus,@alaska,@ntv2_0.gsb,@ntv1_can.dat,null
```

The null grid shift file is a valid grid shift file covering the whole world and applying no shift. So for a complete example, if you wanted to alter PostGIS so that transformations to SRID 4267 that didn't lie within the correct range did not throw an ERROR, you would use the following:

```
UPDATE spatial_ref_sys SET proj4text = '+proj=longlat +ellps=clrk66 +nadgrids=@conus, ↩
    @alaska,@ntv2_0.gsb,@ntv1_can.dat,null +no_defs' WHERE srid = 4267;
```

⊠⊠

Section 4.5, ST_SetSRID, ST_SRID, UpdateGeometrySRID, ST_TransformPipeline

7.7.5 ST_TransformPipeline

ST_TransformPipeline — Return a new geometry with coordinates transformed to a different spatial reference system using a defined coordinate transformation pipeline.

Synopsis

geometry **ST_TransformPipeline**(geometry g1, text pipeline, integer to_srid);

⊠⊠

Return a new geometry with coordinates transformed to a different spatial reference system using a defined coordinate transformation pipeline.

Transformation pipelines are defined using any of the following string formats:

- `urn:ogc:def:coordinateOperation:AUTHORITY::CODE`. Note that a simple `EPSG:CODE` string does not uniquely identify a coordinate operation: the same EPSG code can be used for a CRS definition.

- A PROJ pipeline string of the form: `+proj=pipeline ...`. Automatic axis normalisation will not be applied, and if necessary the caller will need to add an additional pipeline step, or remove `axisswap` steps.
- Concatenated operations of the form: `urn:ogc:def:coordinateOperation,coordinateOperation:EPSG:`

Availability: 3.4.0

The SRID of the input geometry is ignored, and the SRID of the output geometry will be set to zero unless a value is provided via the optional `to_srid` parameter. When using `ST_TransformPipeline()` the pipeline is executed in a forward direction. Using ST_InverseTransformPipeline the pipeline is executed in the inverse direction.

Transforms using pipelines are a specialised version of ST_Transform. In most cases `ST_Transform` will choose the correct operations to convert between coordinate systems, and should be preferred.

□□

Change WGS 84 long lat to UTM 31N using the EPSG:16031 conversion

```
-- Forward direction
SELECT ST_AsText(ST_TransformPipeline('SRID=4326;POINT(2 49)'::geometry,
  'urn:ogc:def:coordinateOperation:EPSG::16031')) AS utm_geom;

                  utm_geom
--------------------------------------------
 POINT(426857.9877165967 5427937.523342293)
(1 row)

-- Inverse direction
SELECT ST_AsText(ST_InverseTransformPipeline('POINT(426857.9877165967 5427937.523342293)':: ↩
    geometry,
  'urn:ogc:def:coordinateOperation:EPSG::16031')) AS wgs_geom;

          wgs_geom
----------------------------
 POINT(2 48.99999999999999)
(1 row)
```

GDA2020 example.

```
-- using ST_Transform with automatic selection of a conversion pipeline.
SELECT ST_AsText(ST_Transform('SRID=4939;POINT(143.0 -37.0)'::geometry, 7844)) AS  ↩
    gda2020_auto;

                 gda2020_auto
-----------------------------------------------
 POINT(143.00000635638918 -36.999986706128176)
(1 row)

-- using a defined conversion (EPSG:8447)
SELECT ST_AsText(ST_TransformPipeline('SRID=4939;POINT(143.0 -37.0)'::geometry,
  'urn:ogc:def:coordinateOperation:EPSG::8447')) AS gda2020_code;

                   gda2020_code
----------------------------------------------
 POINT(143.0000063280214 -36.999986718287545)
(1 row)

-- using a PROJ pipeline definition matching EPSG:8447, as returned from
-- 'projinfo -s EPSG:4939 -t EPSG:7844'.
```

```
-- NOTE: any 'axisswap' steps must be removed.
SELECT ST_AsText(ST_TransformPipeline('SRID=4939;POINT(143.0 -37.0)'::geometry,
  '+proj=pipeline
   +step +proj=unitconvert +xy_in=deg +xy_out=rad
   +step +proj=hgridshift +grids=au_icsm_GDA94_GDA2020_conformal_and_distortion.tif
   +step +proj=unitconvert +xy_in=rad +xy_out=deg')) AS gda2020_pipeline;

                   gda2020_pipeline
----------------------------------------------
 POINT(143.0000063280214 -36.999986718287545)
(1 row)
```

⊠⊠

ST_Transform, ST_InverseTransformPipeline

7.7.6 postgis_srs_codes

postgis_srs_codes — Return the list of SRS codes associated with the given authority.

Synopsis

setof text **postgis_srs_codes**(text auth_name);

⊠⊠

Returns a set of all `auth_srid` for the given `auth_name`.

Availability: 3.4.0

Proj version 6+

⊠⊠

List the first ten codes associated with the EPSG authority.

```
SELECT * FROM postgis_srs_codes('EPSG') LIMIT 10;

 postgis_srs_codes
-------------------
 2000
 20004
 20005
 20006
 20007
 20008
 20009
 2001
 20010
 20011
```

⊠⊠

postgis_srs, postgis_srs_all, postgis_srs_search

7.7.7 postgis_srs

postgis_srs — Return a metadata record for the requested authority and srid.

Synopsis

setof record **postgis_srs**(text auth_name, text auth_srid);

⊠⊠

Returns a metadata record for the requested `auth_srid` for the given `auth_name`. The record will have the `auth_name`, `auth_srid`, `srname`, `srtext`, `proj4text`, and the corners of the area of usage, `point_sw` and `point_ne`.

Availability: 3.4.0

Proj version 6+

⊠⊠

Get the metadata for EPSG:3005.

```
SELECT * FROM postgis_srs('EPSG', '3005');

auth_name | EPSG
auth_srid | 3005
srname    | NAD83 / BC Albers
srtext    | PROJCS["NAD83 / BC Albers", ... ]]
proj4text | +proj=aea +lat_0=45 +lon_0=-126 +lat_1=50 +lat_2=58.5 +x_0=1000000 +y_0=0 + ↩
    datum=NAD83 +units=m +no_defs +type=crs
point_sw  | 0101000020E6100000E17A14AE476161C00000000000204840
point_ne  | 0101000020E610000085EB51B81E855CC0E17A14AE47014E40
```

⊠⊠

postgis_srs_codes, postgis_srs_all, postgis_srs_search

7.7.8 postgis_srs_all

postgis_srs_all — Return metadata records for every spatial reference system in the underlying Proj database.

Synopsis

setof record **postgis_srs_all**(void);

⊠⊠

Returns a set of all metadata records in the underlying Proj database. The records will have the `auth_name`, `auth_srid`, `srname`, `srtext`, `proj4text`, and the corners of the area of usage, `point_sw` and `point_ne`.

Availability: 3.4.0

Proj version 6+

☒☒

Get the first 10 metadata records from the Proj database.

```
SELECT auth_name, auth_srid, srname FROM postgis_srs_all() LIMIT 10;

 auth_name | auth_srid |                  srname
-----------+-----------+------------------------------------------
 EPSG      | 2000      | Anguilla 1957 / British West Indies Grid
 EPSG      | 20004     | Pulkovo 1995 / Gauss-Kruger zone 4
 EPSG      | 20005     | Pulkovo 1995 / Gauss-Kruger zone 5
 EPSG      | 20006     | Pulkovo 1995 / Gauss-Kruger zone 6
 EPSG      | 20007     | Pulkovo 1995 / Gauss-Kruger zone 7
 EPSG      | 20008     | Pulkovo 1995 / Gauss-Kruger zone 8
 EPSG      | 20009     | Pulkovo 1995 / Gauss-Kruger zone 9
 EPSG      | 2001      | Antigua 1943 / British West Indies Grid
 EPSG      | 20010     | Pulkovo 1995 / Gauss-Kruger zone 10
 EPSG      | 20011     | Pulkovo 1995 / Gauss-Kruger zone 11
```

☒☒

postgis_srs_codes, postgis_srs, postgis_srs_search

7.7.9 postgis_srs_search

postgis_srs_search — Return metadata records for projected coordinate systems that have areas of usage that fully contain the bounds parameter.

Synopsis

setof record **postgis_srs_search**(geometry bounds, text auth_name=EPSG);

☒☒

Return a set of metadata records for projected coordinate systems that have areas of usage that fully contain the bounds parameter. Each record will have the `auth_name`, `auth_srid`, `srname`, `srtext`, `proj4text`, and the corners of the area of usage, `point_sw` and `point_ne`.

The search only looks for projected coordinate systems, and is intended for users to explore the possible systems that work for the extent of their data.

Availability: 3.4.0

Proj version 6+

☒☒

Search for projected coordinate systems in Louisiana.

```
SELECT auth_name, auth_srid, srname,
  ST_AsText(point_sw) AS point_sw,
  ST_AsText(point_ne) AS point_ne
FROM postgis_srs_search('SRID=4326;LINESTRING(-90 30, -91 31)')
LIMIT 3;
```

```
 auth_name | auth_srid |                 srname                 |      point_sw       |        ↩
    point_ne
-----------+-----------+--------------------------------------+--------------------+--------------

 EPSG      | 2801      | NAD83(HARN) / Louisiana South        | POINT(-93.94 28.85) | POINT ↩
    (-88.75 31.07)
 EPSG      | 3452      | NAD83 / Louisiana South (ftUS)       | POINT(-93.94 28.85) | POINT ↩
    (-88.75 31.07)
 EPSG      | 3457      | NAD83(HARN) / Louisiana South (ftUS) | POINT(-93.94 28.85) | POINT ↩
    (-88.75 31.07)
```

Scan a table for max extent and find projected coordinate systems that might suit.

```
WITH ext AS (
  SELECT ST_Extent(geom) AS geom, Max(ST_SRID(geom)) AS srid
  FROM foo
)
SELECT auth_name, auth_srid, srname,
  ST_AsText(point_sw) AS point_sw,
  ST_AsText(point_ne) AS point_ne
FROM ext
CROSS JOIN postgis_srs_search(ST_SetSRID(ext.geom, ext.srid))
LIMIT 3;
```

⊠⊠

postgis_srs_codes, postgis_srs_all, postgis_srs

7.8 Geometry Input

7.8.1 Well-Known Text (WKT)

7.8.1.1 ST_BdPolyFromText

ST_BdPolyFromText — ⊠⊠⊠⊠⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_BdPolyFromText**(text WKT, integer srid);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ ST_BdMPolyFromText ⊠⊠⊠⊠⊠⊠, ⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_BuildArea() ⊠⊠ ⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

GEOS ⊠⊠⊠⊠⊠⊠

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_BuildArea, ST_BdMPolyFromText

7.8.1.2 ST_BdMPolyFromText

ST_BdMPolyFromText — ⊠⊠⊠⊠⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_BdMPolyFromText**(text WKT, integer srid);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_BdPolyFromText ⊠⊠⊠ ⊠⊠⊠, ⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_BuildArea() ⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

GEOS ⊠⊠⊠⊠⊠⊠

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_BuildArea, ST_BdPolyFromText

7.8.1.3 ST_GeogFromText

ST_GeogFromText — WKT (⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geography **ST_GeogFromText**(text EWKT);

⊠⊠

WKT ⊠⊠⊠⊠⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID 4326 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeographyFromText ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
--- converting lon lat coords to geography
ALTER TABLE sometable ADD COLUMN geog geography(POINT,4326);
UPDATE sometable SET geog = ST_GeogFromText('SRID=4326;POINT(' || lon || ' ' || lat || ')') ↩
    ;

--- specify a geography point using EPSG:4267, NAD27
SELECT ST_AsEWKT(ST_GeogFromText('SRID=4267;POINT(-77.0092 38.889588)'));
```

⊠⊠

ST_AsText, ST_GeographyFromText

7.8.1.4 ST_GeographyFromText

ST_GeographyFromText — WKT (⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geography **ST_GeographyFromText**(text EWKT);

⊠⊠

WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID 4326 ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_GeogFromText, ST_AsText

7.8.1.5 ST_GeomCollFromText

ST_GeomCollFromText — Makes a collection Geometry from collection WKT with the given SRID. If SRID is not given, it defaults to 0.

Synopsis

geometry **ST_GeomCollFromText**(text WKT, integer srid);
geometry **ST_GeomCollFromText**(text WKT);

⊠⊠

Makes a collection Geometry from the Well-Known-Text (WKT) representation with the given SRID. If SRID is not given, it defaults to 0.

OGC ⊠⊠ 3.2.6.2 - ⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

WKT ⊠⊠⊠⊠⊠⊠ (GEOMETRYCOLLECTION) ⊠⊠⊠⊠⊠⊠ null ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

This method implements the SQL/MM specification.

⊠⊠

```
SELECT ST_GeomCollFromText('GEOMETRYCOLLECTION(POINT(1 2),LINESTRING(1 2, 3 4))');
```

⊠⊠

ST_GeomFromText, ST_SRID

7.8.1.6 ST_GeomFromEWKT

ST_GeomFromEWKT — EWKT(Extended Well-Known Text) ⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeomFromEWKT**(text EWKT);

⊠⊠

OGC EWKT(Extended Well-Known Text) ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> EWKT ⊠⊠⊠ OGC ⊠⊠⊠⊠⊠⊠⊠⊠, SRID(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT ST_GeomFromEWKT('SRID=4269;LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144 42.25932)');
SELECT ST_GeomFromEWKT('SRID=4269;MULTILINESTRING((-71.160281 42.258729,-71.160837 42.259113,-71.161144 42.25932))');

SELECT ST_GeomFromEWKT('SRID=4269;POINT(-71.064544 42.28787)');

SELECT ST_GeomFromEWKT('SRID=4269;POLYGON((-71.1776585052917 42.3902909739571,-71.1776820268866 42.3903701743239,
-71.1776063012595 42.3903825660754,-71.1775826583081 42.3903033653531,-71.1776585052917 42.3902909739571))');

SELECT ST_GeomFromEWKT('SRID=4269;MULTIPOLYGON(((-71.1031880899493 42.3152774590236,
-71.1031627617667 42.3152960829043,-71.102923838298 42.3149156848307,
-71.1023097974109 42.3151969047397,-71.1019285062273 42.3147384934248,
-71.102505233663 42.3144722937587,-71.10277487471 42.3141658254797,
-71.103113945163 42.3142739188902,-71.10324876416 42.31402489987,
-71.1033002961013 42.3140393340215,-71.1033488797549 42.3139495090772,
-71.103396240451 42.3138632439557,-71.1041521907712 42.3141153348029,
-71.1041411411543 42.3141545014533,-71.1041287795912 42.3142114839058,
-71.1041188134329 42.3142693656241,-71.1041112482575 42.3143272556118,
-71.1041072845732 42.3143851580048,-71.1041057218871 42.3144430686681,
-71.1041065602059 42.3145009876017,-71.1041097995362 42.3145589148055,
-71.1041166403905 42.3146168544148,-71.1041258822717 42.3146748022936,
-71.1041375307579 42.3147318674446,-71.1041492906949 42.3147711126569,
-71.1041598612795 42.314808571739,-71.1042515013869 42.3151287620809,
-71.1041173835118 42.3150739481917,-71.1040809891419 42.3151344119048,
-71.1040438678912 42.3151191367447,-71.1040194562988 42.3151832057859,
-71.1038734225584 42.3151140942995,-71.1038446938243 42.3151006300338,
-71.1038315271889 42.315094347535,-71.1037393329282 42.315054824985,
-71.1035447555574 42.3152608696313,-71.1033436658644 42.3151648370544,
-71.1032580383161 42.3152269126061,-71.103223066939 42.3152517403219,
-71.1031880899493 42.3152774590236)),
((-71.1043632495873 42.315113108546,-71.1043583974082 42.3151211109857,
-71.1043443253471 42.3150676015829,-71.1043850704575 42.3150793250568,-71.1043632495873 42.315113108546)))');
```

```
--3d circular string
SELECT ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)');
```

```
--Polyhedral Surface example
SELECT ST_GeomFromEWKT('POLYHEDRALSURFACE(
        ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
        ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
        ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
        ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
        ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
        ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1))
)');
```

⊠⊠

ST_AsEWKT, ST_GeomFromText

7.8.1.7 ST_GeomFromMARC21

ST_GeomFromMARC21 — Takes MARC21/XML geographic data as input and returns a PostGIS geometry object.

Synopsis

geometry **ST_GeomFromMARC21** (text marcxml);

⊠⊠

This function creates a PostGIS geometry from a MARC21/XML record, which can contain a `POINT` or a `POLYGON`. In case of multiple geographic data entries in the same MARC21/XML record, a `MULTIPOINT` or `MULTIPOLYGON` will be returned. If the record contains mixed geometry types, a `GEOMETRYCOLLECTION` will be returned. It returns NULL if the MARC21/XML record does not contain any geographic data (datafield:034).

LOC MARC21/XML versions supported:

- MARC21/XML 1.1

Availability: 3.3.0, requires libxml2 2.6+

> **Note**
> The MARC21/XML Coded Cartographic Mathematical Data currently does not provide any means to describe the Spatial Reference System of the encoded coordinates, so this function will always return a geometry with `SRID 0`.

> **Note**
> Returned `POLYGON` geometries will always be clockwise oriented.

⊠⊠

Converting MARC21/XML geographic data containing a single `POINT` encoded as `hddd.dddddd`

```
                SELECT
                ST_AsText(
                    ST_GeomFromMARC21('
                        <record xmlns="http://www.loc.gov/MARC21/slim">
                            <leader
>00000nz a2200000nc 4500</leader>
                            <controlfield tag="001"
>040277569</controlfield>
                            <datafield tag="034" ind1=" " ind2=" ">
                                <subfield code="d"
>W004.500000</subfield>
                                <subfield code="e"
>W004.500000</subfield>
                                <subfield code="f"
>N054.250000</subfield>
                                <subfield code="g"
```

```
>N054.250000</subfield>
                            </datafield>
                        </record
>'));

                st_astext
                -------------------
                POINT(-4.5 54.25)
                (1 row)
```

Converting MARC21/XML geographic data containing a single `POLYGON` encoded as `hdddmmss`

```
                SELECT
                ST_AsText(
                    ST_GeomFromMARC21('
                        <record xmlns="http://www.loc.gov/MARC21/slim">
                            <leader
>01062cem a2200241 a 4500</leader>
                            <controlfield tag="001"
>   84696781 </controlfield>
                            <datafield tag="034" ind1="1" ind2=" ">
                                <subfield code="a"
>a</subfield>
                                <subfield code="b"
>50000</subfield>
                                <subfield code="d"
>E0130600</subfield>
                                <subfield code="e"
>E0133100</subfield>
                                <subfield code="f"
>N0523900</subfield>
                                <subfield code="g"
>N0522300</subfield>
                            </datafield>
                        </record
>'));

                st_astext
                -------------------------------------------------------------------------------------

                POLYGON((13.1 52.65,13.516666666666667 52.65,13.516666666666667  ↩
                    52.38333333333333,13.1 52.38333333333333,13.1 52.65))
                (1 row)
```

Converting MARC21/XML geographic data containing a `POLYGON` and a `POINT`:

```
                SELECT
                ST_AsText(
                    ST_GeomFromMARC21('
                <record xmlns="http://www.loc.gov/MARC21/slim">
                    <datafield tag="034" ind1="1" ind2=" ">
                        <subfield code="a"
>a</subfield>
                        <subfield code="b"
>50000</subfield>
                        <subfield code="d"
```

```
>E0130600</subfield>
                        <subfield code=”e”
>E0133100</subfield>
                        <subfield code=”f”
>N0523900</subfield>
                        <subfield code=”g”
>N0522300</subfield>
                    </datafield>
                    <datafield tag=”034” ind1=” ” ind2=” ”>
                        <subfield code=”d”
>W004.500000</subfield>
                        <subfield code=”e”
>W004.500000</subfield>
                        <subfield code=”f”
>N054.250000</subfield>
                        <subfield code=”g”
>N054.250000</subfield>
                    </datafield>
                </record
>'));
                                                                                         st_astext ↩

                ----------------------------------------------------------------------------------

                GEOMETRYCOLLECTION(POLYGON((13.1 52.65,13.516666666666667  ↩
                    52.65,13.516666666666667 52.38333333333333,13.1 52.38333333333333,13.1  ↩
                    52.65)),POINT(-4.5 54.25))
                (1 row)
```

⊠⊠

ST_AsMARC21

7.8.1.8 ST_GeometryFromText

ST_GeometryFromText — WKT(Well-Known Text) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeometryFromText**(text WKT);
geometry **ST_GeometryFromText**(text WKT, integer srid);

⊠⊠

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.40

⊠⊠

ST_GeomFromText

7.8.1.9 ST_GeomFromText

ST_GeomFromText — WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeomFromText**(text WKT);
geometry **ST_GeomFromText**(text WKT, integer srid);

⊠⊠

OGC WKT(Well-Known Text) ⊠⊠⊠⊠⊠⊠⊠ PostGIS ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ST_GeomFromText ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠, ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠ (SRID=0) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. ⊠ ⊠ 3.2.6.2 - ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.40

This method supports Circular Strings and Curves.

> **Note**
> While not OGC-compliant, ST_MakePoint is faster than ST_GeomFromText and ST_PointFromText. It is also easier to use for numeric coordinate values. ST_Point is another option similar in speed to ST_MakePoint and is OGC-compliant, but doesn't support anything but 2D points.

> **Warning**
> ⊠⊠⊠⊠: PostGIS 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromText('GEOMETRYCOLLECTION(EMPTY)') ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 2.0.0 ⊠⊠⊠⊠, SQL/MM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠. ⊠⊠⊠ ST_GeomFromText('GEOMETRYCOLLECTION EMPTY') ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_GeomFromText('LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144 ↩
    42.25932)');
SELECT ST_GeomFromText('LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144 ↩
    42.25932)',4269);

SELECT ST_GeomFromText('MULTILINESTRING((-71.160281 42.258729,-71.160837 ↩
    42.259113,-71.161144 42.25932))');

SELECT ST_GeomFromText('POINT(-71.064544 42.28787)');

SELECT ST_GeomFromText('POLYGON((-71.1776585052917 42.3902909739571,-71.1776820268866 ↩
    42.3903701743239,
```

```
-71.1776063012595 42.3903825660754,-71.1775826583081 42.3903033653531,-71.1776585052917 42.3902909739571))');

SELECT ST_GeomFromText('MULTIPOLYGON(((-71.1031880899493 42.3152774590236,
-71.1031627617667 42.3152960829043,-71.102923838298 42.3149156848307,
-71.1023097974109 42.3151969047397,-71.1019285062273 42.3147384934248,
-71.102505233663 42.3144722937587,-71.10277487471 42.3141658254797,
-71.103113945163 42.3142739188902,-71.10324876416 42.31402489987,
-71.1033002961013 42.3140393340215,-71.1033488797549 42.3139495090772,
-71.103396240451 42.3138632439557,-71.1041521907712 42.3141153348029,
-71.1041411411543 42.3141545014533,-71.1041287795912 42.3142114839058,
-71.1041188134329 42.3142693656241,-71.1041112482575 42.3143272556118,
-71.1041072845732 42.3143851580048,-71.1041057218871 42.3144430686681,
-71.1041065602059 42.3145009876017,-71.1041097995362 42.3145589148055,
-71.1041166403905 42.3146168544148,-71.1041258822717 42.3146748022936,
-71.1041375307579 42.3147318674446,-71.1041492906949 42.3147711126569,
-71.1041598612795 42.314808571739,-71.1042515013869 42.3151287620809,
-71.1041173835118 42.3150739481917,-71.1040809891419 42.3151344119048,
-71.1040438678912 42.3151191367447,-71.1040194562988 42.3151832057859,
-71.1038734225584 42.3151140942995,-71.1038446938243 42.3151006300338,
-71.1038315271889 42.315094347535,-71.1037393329282 42.315054824985,
-71.1035447555574 42.3152608696313,-71.1033436658644 42.3151648370544,
-71.1032580383161 42.3152269126061,-71.103223066939 42.3152517403219,
-71.1031880899493 42.3152774590236)),
((-71.1043632495873 42.315113108546,-71.1043583974082 42.3151211109857,
-71.1043443253471 42.3150676015829,-71.1043850704575 42.3150793250568,-71.1043632495873 42.315113108546)))',4326);

SELECT ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 150505,220227 150406)');
```

⊠⊠

ST_GeomFromEWKT, ST_GeomFromWKB, ST_SRID

7.8.1.10 ST_LineFromText

ST_LineFromText — ⊠⊠⊠ SRID ⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ 0 ⊠⊠⊠⊠.

Synopsis

geometry **ST_LineFromText**(text WKT);
geometry **ST_LineFromText**(text WKT, integer srid);

⊠⊠

Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0. If WKT passed in is not a LINESTRING, then null is returned.

Note
OGC ⊠⊠ 3.2.6.2 - ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

This method implements the SQL/MM specification. SQL-MM 3: 7.2.8

⊠⊠

```
SELECT ST_LineFromText('LINESTRING(1 2, 3 4)') AS aline, ST_LineFromText('POINT(1 2)') AS ↵
    null_return;
aline                            | null_return
------------------------------------------------
010200000002000000000000000000F ... | t
```

⊠⊠

ST_GeomFromText

7.8.1.11 ST_MLineFromText

ST_MLineFromText — WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_MultiLineString ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_MLineFromText**(text WKT, integer srid);
geometry **ST_MLineFromText**(text WKT);

⊠⊠

Makes a Geometry from Well-Known-Text (WKT) with the given SRID. If SRID is not given, it defaults to 0.

OGC ⊠⊠ 3.2.6.2 - ⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ null ⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

This method implements the SQL/MM specification. SQL-MM 3: 9.4.4

⊠⊠

```
SELECT ST_MLineFromText('MULTILINESTRING((1 2, 3 4), (4 5, 6 7))');
```

⊠⊠

ST_GeomFromText

7.8.1.12 ST_MPointFromText

ST_MPointFromText — Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.

Synopsis

geometry **ST_MPointFromText**(text WKT, integer srid);
geometry **ST_MPointFromText**(text WKT);

⊠⊠

Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.

OGC ⊠⊠ 3.2.6.2 - ⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ null ⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. 3.2.6.2

This method implements the SQL/MM specification. SQL-MM 3: 9.2.4

⊠⊠

```
SELECT ST_MPointFromText('MULTIPOINT((1 2),(3 4))');
SELECT ST_MPointFromText('MULTIPOINT((-70.9590 42.1180),(-70.9611 42.1223))', 4326);
```

⊠⊠

ST_GeomFromText

7.8.1.13 ST_MPolyFromText

ST_MPolyFromText — Makes a MultiPolygon Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.

Synopsis

geometry **ST_MPolyFromText**(text WKT, integer srid);
geometry **ST_MPolyFromText**(text WKT);

⊠⊠

Makes a MultiPolygon from WKT with the given SRID. If SRID is not given, it defaults to 0.

OGC ⊠⊠ 3.2.6.2 - ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

This method implements the SQL/MM specification. SQL-MM 3: 9.6.4

⊠⊠

```
SELECT ST_MPolyFromText('MULTIPOLYGON(((0 0 1,20 0 1,20 20 1,0 20 1,0 0 1),(5 5 3,5 7 3,7 7 
    3,7 5 3,5 5 3)))');
SELECt ST_MPolyFromText('MULTIPOLYGON(((-70.916 42.1002,-70.9468 42.0946,-70.9765 
   42.0872,-70.9754 42.0875,-70.9749 42.0879,-70.9752 42.0881,-70.9754 42.0891,-70.9758 
   42.0894,-70.9759 42.0897,-70.9759 42.0899,-70.9754 42.0902,-70.9756 42.0906,-70.9753 
   42.0907,-70.9753 42.0917,-70.9757 42.0924,-70.9755 42.0928,-70.9755 42.0942,-70.9751 
   42.0948,-70.9755 42.0953,-70.9751 42.0958,-70.9751 42.0962,-70.9759 42.0983,-70.9767 
   42.0987,-70.9768 42.0991,-70.9771 42.0997,-70.9771 42.1003,-70.9768 42.1005,-70.977 
   42.1011,-70.9766 42.1019,-70.9768 42.1026,-70.9769 42.1033,-70.9775 42.1042,-70.9773 
   42.1043,-70.9776 42.1043,-70.9778 42.1048,-70.9773 42.1058,-70.9774 42.1061,-70.9779 
   42.1065,-70.9782 42.1078,-70.9788 42.1085,-70.9798 42.1087,-70.9806 42.109,-70.9807 
   42.1093,-70.9806 42.1099,-70.9809 42.1109,-70.9808 42.1112,-70.9798 42.1116,-70.9792 
   42.1127,-70.979 42.1129,-70.9787 42.1134,-70.979 42.1139,-70.9791 42.1141,-70.9987 
   42.1116,-71.0022 42.1273,
       -70.9408 42.1513,-70.9315 42.1165,-70.916 42.1002)))',4326);
```

⊠⊠

ST_GeomFromText, ST_SRID

7.8.1.14 ST_PointFromText

ST_PointFromText — ⊠⊠⊠ SRID ⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. SRID ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠, ⊠⊠⊠⊠ 0 ⊠⊠⊠⊠.

Synopsis

geometry **ST_PointFromText**(text WKT);
geometry **ST_PointFromText**(text WKT, integer srid);

⊠⊠

Constructs a PostGIS ST_Geometry point object from the OGC Well-Known text representation. If SRID is not given, it defaults to unknown (currently 0). If geometry is not a WKT point representation, returns null. If completely invalid WKT, then throws an error.

> **Note**
> ST_PointFromText ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠, ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠. spatial_ref_sys ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ OGC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_MakePoint ⊠⊠ OGC ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Point ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. ⊠⊠ 3.2.6.2 - ⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM 3: 6.1.8

⊠⊠

```
SELECT ST_PointFromText('POINT(-71.064544 42.28787)');
SELECT ST_PointFromText('POINT(-71.064544 42.28787)', 4326);
```

⊠⊠

ST_GeomFromText, ST_MakePoint, ST_Point, ST_SRID

7.8.1.15 ST_PolygonFromText

ST_PolygonFromText — Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.

Synopsis

geometry **ST_PolygonFromText**(text WKT);
geometry **ST_PolygonFromText**(text WKT, integer srid);

⊠⊠

Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0. Returns null if WKT is not a polygon.

OGC ⊠⊠ 3.2.6.2 - ⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

This method implements the SQL/MM specification. SQL-MM 3: 8.3.6

⊠⊠

```
SELECT ST_PolygonFromText('POLYGON((-71.1776585052917 42.3902909739571,-71.1776820268866 ↩
    42.3903701743239,
-71.1776063012595 42.3903825660754,-71.1775826583081 42.3903033653531,-71.1776585052917 ↩
    42.3902909739571))');
st_polygonfromtext
------------------
010300000001000000050000006...


SELECT ST_PolygonFromText('POINT(1 2)') IS NULL as point_is_notpoly;

point_is_not_poly
----------
t
```

⊠⊠

ST_GeomFromText

7.8.1.16 ST_WKTToSQL

ST_WKTToSQL — WKT(Well-Known Text) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFromT
⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_WKTToSQL**(text WKT);

⊠⊠

This method implements the SQL/MM specification. SQL-MM 3: 5.1.34

⊠⊠

ST_GeomFromText

7.8.2 Well-Known Binary (WKB)

7.8.2.1 ST_GeogFromWKB

ST_GeogFromWKB — WKB ⊠⊠⊠⊠⊠⊠⊠⊠ EWKB(⊠⊠ WKB) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geography **ST_GeogFromWKB**(bytea wkb);

⊠⊠

ST_GeogFromWKB ⊠⊠⊠⊠⊠⊠⊠ WKB ⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠ WKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠ (Geometry Factory) ⊠⊠⊠⊠⊠⊠⊠.

SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ 4326(WGS84 ⊠⊠⊠) ⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

⊠⊠

```
--Although bytea rep contains single \, these need to be escaped when inserting into a ←
    table
SELECT ST_AsText(
ST_GeogFromWKB(E'\\001\\002\\000\\000\\000\\002\\000\\000\\000\\037\\205\\353Q ←
    \\270~\\\\\\300\\323Mb\\020X\\231C@\\020X9\\264\\310~\\\\\\300)\\\\\\217\\302\\365\\230 ←
    C@')
);
                                          st_astext
------------------------------------------------------
 LINESTRING(-113.98 39.198,-113.981 39.195)
(1 row)
```

⊠⊠

ST_GeogFromText, ST_AsBinary

7.8.2.2 ST_GeomFromEWKB

ST_GeomFromEWKB — EWKB(Extended Well-Known Binary) ⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠ ⊠.

Synopsis

geometry **ST_GeomFromEWKB**(bytea EWKB);

⊠⊠

OGC EWKB(Extended Well-Known Binary) ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> EWKB ⊠⊠⊠ OGC ⊠⊠⊠⊠⊠⊠⊠⊠, SRID(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

NAD83 ⊠⊠⊠ (SRID 4269) ⊠⊠⊠⊠ LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144 42.25932) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

> **Note**
> ⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (\) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (’) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, standard_conforming_strings ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ \ ⊠” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ AsEWKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_GeomFromEWKB(E'\\001\\002\\000\\000 \\255\\020\\000\\000\\003\\000\\000\\000\\344 ↩
    J=
\\013B\\312Q\\300n\\303(\\010\\036!E@''\\277E''K
\\312Q\\300\\366{b\\235*!E@\\225|\\354.P\\312Q
\\300p\\231\\323e1!E@');
```

> **Note**
> In PostgreSQL 9.1+ - standard_conforming_strings is set to on by default, where as in past versions it was set to off. You can change defaults as needed for a single query or at the database or server level. Below is how you would do it with standard_conforming_strings = on. In this case we escape the ’ with standard ansi ’, but slashes are not escaped

```
set standard_conforming_strings = on;
SELECT ST_GeomFromEWKB('\001\002\000\000 \255\020\000\000\003\000\000\000\344J=\012\013B
    \312Q\300n\303(\010\036!E@''\277E''K\012\312Q\300\366{b\235*!E@\225|\354.P\312Q\012\300 ↩
        p\231\323e1')
```

⊠⊠

ST_AsBinary, ST_AsEWKB, ST_GeomFromWKB

7.8.2.3 ST_GeomFromWKB

ST_GeomFromWKB — WKB(Well-Known Binary) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeomFromWKB**(bytea geom);
geometry **ST_GeomFromWKB**(bytea geom, integer srid);

⊠⊠

ST_GeogFromWKB ⊠⊠⊠⊠⊠⊠⊠ WKB ⊠⊠⊠⊠⊠ SRID(⊠⊠⊠⊠⊠⊠⊠⊠ ID) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠ (Geometry Factory) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_WKBToSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ 0(unkown) ⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.7.2 - ⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.41

This method supports Circular Strings and Curves.

⊠⊠

```
--Although bytea rep contains single \, these need to be escaped when inserting into a table
                -- unless standard_conforming_strings is set to on.
SELECT ST_AsEWKT(
ST_GeomFromWKB(E'\\001\\002\\000\\000\\000\\002\\000\\000\\000\\037\\205\\353Q\\270~\\\\\\300\\323Mb\\020X\\231C@\\020X9\\264\\310~\\\\\\300)\\\\\\217\\302\\365\\230C@',4326)
);
                                          st_asewkt
------------------------------------------------------
 SRID=4326;LINESTRING(-113.98 39.198,-113.981 39.195)
(1 row)

SELECT
  ST_AsText(
        ST_GeomFromWKB(
          ST_AsEWKB('POINT(2 5)'::geometry)
        )
  );
 st_astext
------------
 POINT(2 5)
(1 row)
```

⊠⊠

ST_WKBToSQL, ST_AsBinary, ST_GeomFromEWKB

7.8.2.4 ST_LineFromWKB

ST_LineFromWKB — ⊠⊠⊠ SRID ⊠⊠⊠ WKB ⊠⊠⊠ LINESTRING ⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_LineFromWKB**(bytea WKB);
geometry **ST_LineFromWKB**(bytea WKB, integer srid);

⊠⊠

ST_LineFromWKB ⊠⊠⊠⊠⊠⊠⊠ WKB ⊠⊠⊠⊠ SRID(⊠⊠⊠⊠⊠⊠⊠⊠ ID) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ - ⊠⊠⊠, LINESTRING ⊠⊠ - ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠ (Geometry Factory) ⊠⊠⊠⊠⊠⊠⊠.

SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠. ⊠⊠⊠ bytea ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, NULL ⊠⊠⊠⊠⊠⊠⊠.

Note
OGC ⊠⊠ 3.2.6.2 - ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠⊠ LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ ST_GeomFromWKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFromWKB ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

This method implements the SQL/MM specification. SQL-MM 3: 7.2.9

⊠⊠

```
SELECT ST_LineFromWKB(ST_AsBinary(ST_GeomFromText('LINESTRING(1 2, 3 4)'))) AS aline,
                ST_LineFromWKB(ST_AsBinary(ST_GeomFromText('POINT(1 2)'))) IS NULL AS ↩
                    null_return;
aline                            | null_return
------------------------------------------------
010200000002000000000000000000F ... | t
```

⊠⊠

ST_GeomFromWKB, ST_LinestringFromWKB

7.8.2.5 ST_LinestringFromWKB

ST_LinestringFromWKB — ⊠⊠⊠ SRID ⊠⊠⊠ WKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_LinestringFromWKB**(bytea WKB);
geometry **ST_LinestringFromWKB**(bytea WKB, integer srid);

⊠⊠

ST_LinestringFromWKB ⊠⊠⊠⊠⊠⊠ WKB ⊠⊠⊠⊠ SRID(⊠⊠⊠⊠⊠⊠⊠ ID) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ - ⊠⊠⊠, LINESTRING ⊠⊠ - ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠ (Geometry Factory) ⊠⊠⊠⊠⊠ ⊠.

SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ 0 ⊠⊠⊠⊠. ⊠⊠⊠ bytea ⊠ LINESTRING ⊠⊠⊠⊠⊠⊠⊠, NULL ⊠⊠⊠⊠ ⊠⊠.

Note
OGC ⊠⊠ 3.2.6.2 - ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠ (conformance suite) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠ LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ ST_GeomFromWKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFromWKB ⊠⊠⊠⊠⊠, LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

This method implements the SQL/MM specification. SQL-MM 3: 7.2.9

⊠⊠

```
SELECT
  ST_LineStringFromWKB(
        ST_AsBinary(ST_GeomFromText('LINESTRING(1 2, 3 4)'))
  ) AS aline,
  ST_LinestringFromWKB(
        ST_AsBinary(ST_GeomFromText('POINT(1 2)'))
  ) IS NULL AS null_return;
   aline                            | null_return
------------------------------------------------
010200000002000000000000000000F ... | t
```

⊠⊠

ST_GeomFromWKB, ST_LineFromWKB

7.8.2.6 ST_PointFromWKB

ST_PointFromWKB — ⊠⊠⊠ SRID ⊠⊠⊠ WKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeomFromWKB**(bytea geom);
geometry **ST_GeomFromWKB**(bytea geom, integer srid);

⊠⊠

ST_PointFromWKB ⊠⊠⊠⊠⊠⊠ WKB ⊠⊠⊠⊠ SRID(⊠⊠⊠⊠⊠⊠⊠ ID) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ - ⊠⊠⊠, POINT ⊠⊠ - ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠ (Geometry Factory) ⊠⊠⊠⊠⊠⊠.

SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ 0 ⊠⊠⊠⊠. ⊠⊠⊠ bytea ⊠⊠⊠⊠⊠⊠⊠⊠⊠, NULL ⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.7.2

This method implements the SQL/MM specification. SQL-MM 3: 6.1.9

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT
  ST_AsText(
        ST_PointFromWKB(
          ST_AsEWKB('POINT(2 5)'::geometry)
        )
  );
 st_astext
------------
 POINT(2 5)
(1 row)

SELECT
  ST_AsText(
        ST_PointFromWKB(
          ST_AsEWKB('LINESTRING(2 5, 2 6)'::geometry)
        )
  );
 st_astext
-----------

(1 row)
```

⊠⊠

ST_GeomFromWKB, ST_LineFromWKB

7.8.2.7 ST_WKBToSQL

ST_WKBToSQL — WKB(Well-Known Binary) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromWKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_WKBToSQL**(bytea WKB);

⊠⊠

This method implements the SQL/MM specification. SQL-MM 3: 5.1.36

⊠⊠

ST_GeomFromWKB

7.8.3 Other Formats

7.8.3.1 ST_Box2dFromGeoHash

ST_Box2dFromGeoHash — GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠ BOX2D ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

box2d **ST_Box2dFromGeoHash**(text geohash, integer precision=full_precision_of_geohash);

⊠⊠

GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠ BOX2D ⊠⊠⊠⊠⊠⊠⊠.

If no `precision` is specified ST_Box2dFromGeoHash returns a BOX2D based on full precision of the input GeoHash string.

`precision` ⊠⊠⊠⊠⊠⊠⊠, ST_Box2dFromGeoHash ⊠ GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ BOX2D ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ BOX2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_Box2dFromGeoHash('9qqj7nmxncgyy4d0dbxqz0');

                st_geomfromgeohash
--------------------------------------------------
 BOX(-115.172816 36.114646,-115.172816 36.114646)

SELECT ST_Box2dFromGeoHash('9qqj7nmxncgyy4d0dbxqz0', 0);

 st_box2dfromgeohash
----------------------
 BOX(-180 -90,180 90)

 SELECT ST_Box2dFromGeoHash('9qqj7nmxncgyy4d0dbxqz0', 10);
                            st_box2dfromgeohash
---------------------------------------------------------------------------
 BOX(-115.17282128334 36.1146408319473,-115.172810554504 36.1146461963654)
```

⊠⊠

ST_GeoHash, ST_GeomFromGeoHash, ST_PointFromGeoHash

7.8.3.2 ST_GeomFromGeoHash

ST_GeomFromGeoHash — GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeomFromGeoHash**(text geohash, integer precision=full_precision_of_geohash);

⊠⊠

GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`precision` ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_GeomFromGeoHash ⊠⊠⊠ GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`precision` ⊠⊠⊠⊠⊠⊠, ST_GeomFromGeoHash ⊠ GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_AsText(ST_GeomFromGeoHash('9qqj7nmxncgyy4d0dbxqz0'));
                                                        st_astext
----------------------------------------------------------------------------------------------------------------

 POLYGON((-115.172816 36.114646,-115.172816 36.114646,-115.172816 36.114646,-115.172816
    36.114646,-115.172816 36.114646))

SELECT ST_AsText(ST_GeomFromGeoHash('9qqj7nmxncgyy4d0dbxqz0', 4));
                                                          st_astext
----------------------------------------------------------------------------------------------------------------

 POLYGON((-115.3125 36.03515625,-115.3125 36.2109375,-114.9609375 36.2109375,-114.9609375
    36.03515625,-115.3125 36.03515625))

SELECT ST_AsText(ST_GeomFromGeoHash('9qqj7nmxncgyy4d0dbxqz0', 10));
                                                                                       st_astext

----------------------------------------------------------------------------------------------------------------

 POLYGON((-115.17282128334 36.1146408319473,-115.17282128334
    36.1146461963654,-115.172810554504 36.1146461963654,-115.172810554504
    36.1146408319473,-115.17282128334 36.1146408319473))
```

⊠⊠

ST_GeoHash,ST_Box2dFromGeoHash, ST_PointFromGeoHash

7.8.3.3 ST_GeomFromGML

ST_GeomFromGML — ⊠⊠⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeomFromGML**(text geomgml);
geometry **ST_GeomFromGML**(text geomgml, integer srid);

⊠⊠

OGC GML ⊠⊠⊠⊠⊠⊠⊠ PostGIS ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠.

ST_GeomFromGML ⊠ GML ⊠⊠⊠⊠ (geometry fragment) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GML ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠ OGC GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- GML 3.2.1 ⊠⊠⊠⊠⊠⊠
- GML 3.1.1 ⊠⊠⊠⊠⊠⊠⊠⊠ SF-2 (GML 3.1.0 ⊠ 3.0.0 ⊠⊠⊠⊠)
- GML 2.1.2

OGC GML ⊠⊠: http://www.opengeospatial.org/standards/gml

1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. LibXML2 1.6 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

GML ⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (MultiGeometry) ⊠⊠⊠ 2D ⊠ 3D ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ Z ⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromGML ⊠⊠⊠⊠⊠⊠ 2D ⊠⊠⊠⊠⊠ ⊠.

GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRS ⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ST_GeomFromGML ⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠ srsName ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠.

ST_GeomFromGML ⊠⊠⊠⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GML ⊠⊠⊠ XLink ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ST_GeomFromGML ⊠⊠⊠ SQL/MM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□: srsName □□□□□□□□

```
SELECT ST_GeomFromGML($$
    <gml:LineString xmlns:gml=”http://www.opengis.net/gml”
                        srsName=”EPSG:4269”>
        <gml:coordinates>
            -71.16028,42.258729 -71.160837,42.259112 -71.161143,42.25932
        </gml:coordinates>
    </gml:LineString>
$$);
```

□□: XLink □□

```
SELECT ST_GeomFromGML($$
    <gml:LineString xmlns:gml=”http://www.opengis.net/gml”
            xmlns:xlink=”http://www.w3.org/1999/xlink”
            srsName=”urn:ogc:def:crs:EPSG::4269”>
        <gml:pointProperty>
            <gml:Point gml:id=”p1”
><gml:pos
>42.258729 -71.16028</gml:pos
></gml:Point>
        </gml:pointProperty>
        <gml:pos
>42.259112 -71.160837</gml:pos>
        <gml:pointProperty>
            <gml:Point xlink:type=”simple” xlink:href=”#p1”/>
        </gml:pointProperty>
    </gml:LineString>
$$);
```

□□: □□□□□□

```
SELECT ST_AsEWKT(ST_GeomFromGML('
<gml:PolyhedralSurface xmlns:gml=”http://www.opengis.net/gml”>
<gml:polygonPatches>
  <gml:PolygonPatch>
    <gml:exterior>
      <gml:LinearRing
><gml:posList srsDimension=”3”
>0 0 0 0 0 1 0 1 1 0 1 0 0 0 0</gml:posList
></gml:LinearRing>
    </gml:exterior>
  </gml:PolygonPatch>
  <gml:PolygonPatch>
    <gml:exterior>
        <gml:LinearRing
><gml:posList srsDimension=”3”
>0 0 0 0 1 0 1 1 0 1 0 0 0 0 0</gml:posList
></gml:LinearRing>
    </gml:exterior>
  </gml:PolygonPatch>
  <gml:PolygonPatch>
    <gml:exterior>
        <gml:LinearRing
><gml:posList srsDimension=”3”
```

```
>0 0 0 1 0 0 1 0 1 0 0 1 0 0 0</gml:posList
></gml:LinearRing>
    </gml:exterior>
  </gml:PolygonPatch>
  <gml:PolygonPatch>
    <gml:exterior>
        <gml:LinearRing
><gml:posList srsDimension="3"
>1 1 0 1 1 1 1 0 1 1 0 0 1 1 0</gml:posList
></gml:LinearRing>
    </gml:exterior>
  </gml:PolygonPatch>
  <gml:PolygonPatch>
    <gml:exterior>
        <gml:LinearRing
><gml:posList srsDimension="3"
>0 1 0 0 1 1 1 1 1 1 1 0 0 1 0</gml:posList
></gml:LinearRing>
    </gml:exterior>
  </gml:PolygonPatch>
  <gml:PolygonPatch>
    <gml:exterior>
        <gml:LinearRing
><gml:posList srsDimension="3"
>0 0 1 1 0 1 1 1 1 0 1 1 0 0 1</gml:posList
></gml:LinearRing>
    </gml:exterior>
  </gml:PolygonPatch>
</gml:polygonPatches>
</gml:PolyhedralSurface
>'));

-- result --
 POLYHEDRALSURFACE(((0 0 0,0 0 1,0 1 1,0 1 0,0 0 0)),
 ((0 0 0,0 1 0,1 1 0,1 0 0,0 0 0)),
 ((0 0 0,1 0 0,1 0 1,0 0 1,0 0 0)),
 ((1 1 0,1 1 1,1 0 1,1 0 0,1 1 0)),
 ((0 1 0,0 1 1,1 1 1,1 1 0,0 1 0)),
 ((0 0 1,1 0 1,1 1 1,0 1 1,0 0 1)))
```

□□

Section 2.2.3, ST_AsGML, ST_GMLToSQL

7.8.3.4 ST_GeomFromGeoJSON

ST_GeomFromGeoJSON — GeoJSON □□□□□□□□ PostGIS □□□□□□□□□□.

Synopsis

geometry **ST_GeomFromGeoJSON**(text geomjson);
geometry **ST_GeomFromGeoJSON**(json geomjson);
geometry **ST_GeomFromGeoJSON**(jsonb geomjson);

⊠⊠

GeoJSON ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

ST_GeomFromGML ⊠ JSON ⊠⊠⊠⊠ (geometry fragment) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ JSON ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 3.0.0 parsed geometry defaults to SRID=4326 if not specified otherwise.

Enhanced: 2.5.0 can now accept json and jsonb as inputs.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. JSON-C 0.9 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> JSON-C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. JSON-C ⊠⊠⊠⊠⊠⊠⊠, "--with-jsondir=/path/to/json-c" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ Section 2.2.3 ⊠⊠⊠⊠ ⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_AsText(ST_GeomFromGeoJSON('{"type":"Point","coordinates":[-48.23456,20.12345]}')) ↵
     As wkt;
wkt
------
POINT(-48.23456 20.12345)
```

```
-- a 3D linestring
SELECT ST_AsText(ST_GeomFromGeoJSON('{"type":"LineString","coordinates ↵
    ":[[1,2,3],[4,5,6],[7,8,9]]}')) As wkt;

wkt
-------------------
LINESTRING(1 2,4 5,7 8)
```

⊠⊠

ST_AsText, ST_AsGeoJSON, Section 2.2.3

7.8.3.5 ST_GeomFromKML

ST_GeomFromKML — ⊠⊠⊠ KML ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeomFromKML**(text geomkml);

⊠⊠

OGC KML ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠.

ST_GeomFromKML ⊠ KML ⊠⊠⊠⊠ (geometry fragment) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ KML ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠ OGC KML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- KML 2.2.0 ⊠⊠⊠⊠⊠⊠

OGC KML ⊠⊠: http://www.opengeospatial.org/standards/kml

Availability: 1.5, requires libxml2 2.6+

This function supports 3d and will not drop the z-index.

Note
ST_GeomFromKML ⊠⊠⊠ SQL/MM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: srsName ⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_GeomFromKML($$
    <LineString>
        <coordinates
>-71.1663,42.2614
            -71.1667,42.2616</coordinates>
    </LineString>
$$);
```

⊠⊠

Section 2.2.3, ST_AsKML

7.8.3.6 ST_GeomFromTWKB

ST_GeomFromTWKB — TWKB("Tiny Well-Known Binary") ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeomFromTWKB**(bytea twkb);

⊠⊠

`ST_GeomFromTWKB` ⊠⊠⊠ TWKB("Tiny Well-Known Binary") ⊠⊠⊠⊠⊠ (WKB) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

☒☒

```
SELECT ST_AsText(ST_GeomFromTWKB(ST_AsTWKB('LINESTRING(126 34, 127 35)'::geometry)));

         st_astext
-----------------------------
 LINESTRING(126 34, 127 35)
(1 row)


SELECT ST_AsEWKT(
  ST_GeomFromTWKB(E'\\x620002f7f40dbce4040105')
);
                                          st_asewkt
------------------------------------------------------
LINESTRING(-113.98 39.198,-113.981 39.195)
(1 row)
```

☒☒

ST_AsTWKB

7.8.3.7 ST_GMLToSQL

ST_GMLToSQL — GML ☒☒☒☒☒☒ ST_Geometry ☒☒☒☒☒☒☒. ☒☒☒☒ ST_GeomFromGML ☒☒☒ ☒☒☒☒☒.

Synopsis

geometry **ST_GMLToSQL**(text geomgml);
geometry **ST_GMLToSQL**(text geomgml, integer srid);

☒☒

This method implements the SQL/MM specification. SQL-MM 3: 5.1.50 (☒☒☒☒☒☒☒☒☒)

1.5 ☒☒☒☒☒☒☒☒☒☒☒☒☒. LibXML2 1.6 ☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒ (polyhedral surface) ☒ TIN ☒☒☒☒☒☒☒.

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒ SRID ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

Section 2.2.3, ST_GeomFromGML, ST_AsGML

7.8.3.8 ST_LineFromEncodedPolyline

ST_LineFromEncodedPolyline — ☒☒☒☒☒☒☒☒☒ (polyline) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_LineFromEncodedPolyline**(text polyline, integer precision=5);

□□

□□□□□□□□□□□□□□□□□□□□□□□□□□.

Optional `precision` specifies how many decimal places will be preserved in Encoded Polyline. Value should be the same on encoding and decoding, or coordinates will be incorrect.

□□: http://developers.google.com/maps/documentation/utilities/polylinealgorithm

2.2.0 □□□□□□□□□□□□.

□□

```
-- Create a line string from a polyline
SELECT ST_AsEWKT(ST_LineFromEncodedPolyline('_p~iF~ps|U_ulLnnqC_mqNvxq`@'));
-- result --
SRID=4326;LINESTRING(-120.2 38.5,-120.95 40.7,-126.453 43.252)

-- Select different precision that was used for polyline encoding
SELECT ST_AsEWKT(ST_LineFromEncodedPolyline('_p~iF~ps|U_ulLnnqC_mqNvxq`@',6));
-- result --
SRID=4326;LINESTRING(-12.02 3.85,-12.095 4.07,-12.6453 4.3252)
```

□□

ST_AsEncodedPolyline

7.8.3.9 ST_PointFromGeoHash

ST_PointFromGeoHash — GeoHash □□□□□□□□□□□□□□□□.

Synopsis

point **ST_PointFromGeoHash**(text geohash, integer precision=full_precision_of_geohash);

□□

GeoHash □□□□□□□□□□□□□□□□. □□□□□□ GeoHash □□□□□□□.

`precision` □□□□□□□□□, ST_PointFromGeoHash □□□ GeoHash □□□□□□□□□□□□□□□□□□□□□□□.

`precision` □□□□□□, ST_PointFromGeoHash □ GeoHash □□□□□□□□□□□□□□□□□□□□□□□□.

2.1.0 □□□□□□□□□□□□.

□□

```
SELECT ST_AsText(ST_PointFromGeoHash('9qqj7nmxncgyy4d0dbxqz0'));
          st_astext
------------------------------
 POINT(-115.172816 36.114646)

SELECT ST_AsText(ST_PointFromGeoHash('9qqj7nmxncgyy4d0dbxqz0', 4));
             st_astext
-----------------------------------
 POINT(-115.13671875 36.123046875)

SELECT ST_AsText(ST_PointFromGeoHash('9qqj7nmxncgyy4d0dbxqz0', 10));
                 st_astext
-------------------------------------------
 POINT(-115.172815918922 36.1146435141563)
```

☒☒

ST_GeoHash, ST_Box2dFromGeoHash, ST_GeomFromGeoHash

7.8.3.10 ST_FromFlatGeobufToTable

ST_FromFlatGeobufToTable — Creates a table based on the structure of FlatGeobuf data.

Synopsis

void **ST_FromFlatGeobufToTable**(text schemaname, text tablename, bytea FlatGeobuf input data);

☒☒

Creates a table based on the structure of FlatGeobuf data. (http://flatgeobuf.org).

`schema` Schema name.

`table` Table name.

`data` Input FlatGeobuf data.

Availability: 3.2.0

7.8.3.11 ST_FromFlatGeobuf

ST_FromFlatGeobuf — Reads FlatGeobuf data.

Synopsis

setof anyelement **ST_FromFlatGeobuf**(anyelement Table reference, bytea FlatGeobuf input data);

☒☒

Reads FlatGeobuf data (http://flatgeobuf.org). NOTE: PostgreSQL bytea cannot exceed 1GB.

`tabletype` reference to a table type.

`data` input FlatGeobuf data.

Availability: 3.2.0

7.9 Geometry Output

7.9.1 Well-Known Text (WKT)

7.9.1.1 ST_AsEWKT

ST_AsEWKT — ⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_AsEWKT**(geometry g1);
text **ST_AsEWKT**(geometry g1, integer maxdecimaldigits=15);
text **ST_AsEWKT**(geography g1);
text **ST_AsEWKT**(geography g1, integer maxdecimaldigits=15);

⊠⊠

Returns the Well-Known Text representation of the geometry prefixed with the SRID. The optional *maxdecimaldigits* argument may be used to reduce the maximum number of decimal digits after floating point used in output (defaults to 15).

To perform the inverse conversion of EWKT representation to PostGIS geometry use ST_GeomFromEWKT.

> **Warning**
> Using the *maxdecimaldigits* parameter can cause output geometry to become invalid. To avoid this use ST_ReducePrecision with a suitable gridsize first.

> **Note**
> The WKT spec does not include the SRID. To get the OGC WKT format use ST_AsText.

> **Warning**
> WKT format does not maintain precision so to prevent floating truncation, use ST_AsBinary or ST_AsEWKB format for transport.

Enhanced: 3.1.0 support for optional precision parameter.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
SELECT ST_AsEWKT('0103000020E61000000100000005000000000000
                        000000000000000000000000000000000000000000000000000000
                        F03F000000000000F03F000000000000F03F000000000000F03
                        F000000000000000000000000000000000000000000000000'::geometry);

                   st_asewkt
--------------------------------
SRID=4326;POLYGON((0 0,0 1,1 1,1 0,0 0))
(1 row)

SELECT ST_AsEWKT('0108000080030000000000000060 ↩
    E30A4100000000785C0241000000000000F03F0000000018
E20A4100000000485F024100000000000000400000000018
E20A4100000000305C02410000000000000840')

--st_asewkt---
CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)
```

☒☒

ST_AsBinary, ST_AsEWKB, ST_AsText, ST_GeomFromEWKT

7.9.1.2 ST_AsText

ST_AsText — ☒☒/☒☒☒☒ WKT(Well-Known Text) ☒☒☒☒ SRID ☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

text **ST_AsText**(geometry g1);
text **ST_AsText**(geometry g1, integer maxdecimaldigits = 15);
text **ST_AsText**(geography g1);
text **ST_AsText**(geography g1, integer maxdecimaldigits = 15);

☒☒

Returns the OGC Well-Known Text (WKT) representation of the geometry/geography. The optional *maxdecimaldigits* argument may be used to limit the number of digits after the decimal point in output ordinates (defaults to 15).

To perform the inverse conversion of WKT representation to PostGIS geometry use ST_GeomFromText.

Note
The standard OGC WKT representation does not include the SRID. To include the SRID as part of the output representation, use the non-standard PostGIS function ST_AsEWKT

Warning
The textual representation of numbers in WKT may not maintain full floating-point precision. To ensure full accuracy for data storage or transport it is best to use Well-Known Binary (WKB) format (see ST_AsBinary and *maxdecimaldigits*).

Warning
Using the *maxdecimaldigits* parameter can cause output geometry to become invalid. To avoid this use ST_ReducePrecision with a suitable gridsize first.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 2.5 - optional parameter precision introduced.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.1

This method implements the SQL/MM specification. SQL-MM 3: 5.1.25

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_AsText('01030000000100000005000000000000000000
000000000000000000000000000000000000000000000000
F03F000000000000F03F000000000000F03F000000000000F03
F0000000000000000000000000000000000000000000000');

    st_astext
--------------------------------
 POLYGON((0 0,0 1,1 1,1 0,0 0))
```

Full precision output is the default.

```
SELECT ST_AsText('POINT(111.1111111 1.1111111)'));
    st_astext
------------------------------
 POINT(111.1111111 1.1111111)
```

The *maxdecimaldigits* argument can be used to limit output precision.

```
SELECT ST_AsText('POINT(111.1111111 1.1111111)'), 2);
    st_astext
--------------------
 POINT(111.11 1.11)
```

⊠⊠

ST_AsBinary, ST_AsEWKB, ST_AsEWKT, ST_GeomFromText

7.9.2 Well-Known Binary (WKB)

7.9.2.1 ST_AsBinary

ST_AsBinary — Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.

Synopsis

bytea **ST_AsBinary**(geometry g1);
bytea **ST_AsBinary**(geometry g1, text NDR_or_XDR);
bytea **ST_AsBinary**(geography g1);
bytea **ST_AsBinary**(geography g1, text NDR_or_XDR);

⊠⊠

Returns the OGC/ISO Well-Known Binary (WKB) representation of the geometry. The first function variant defaults to encoding using server machine endian. The second function variant takes a text argument specifying the endian encoding, either little-endian ('NDR') or big-endian ('XDR').

WKB format is useful to read geometry data from the database and maintaining full numeric precision. This avoids the precision rounding that can happen with text formats such as WKT.

To perform the inverse conversion of WKB to PostGIS geometry use ST_GeomFromWKB.

> **Note**
> The OGC/ISO WKB format does not include the SRID. To get the EWKB format which does include the SRID use ST_AsEWKB

> **Note**
> The default behavior in PostgreSQL 9.0 has been changed to output bytea in hex encoding. If your GUI tools require the old behavior, then SET bytea_output='escape' in your database.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `ST_AsBinary('POINT(1 2)')` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, `n st_asbinary(unknown) is not unique error` ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ `ST_AsBinary('POINT(1 2)'::geometry);` ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, `legacy.sql` ⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.1

This method implements the SQL/MM specification. SQL-MM 3: 5.1.37

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_AsBinary(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

                   st_asbinary
--------------------------------
\x0103000000010000000500000000000000000000000000000000000000000000000000000000000000
000000f03f000000000000f03f000000000000f03f000000000000f03f00000000000000000000000
00000000000000000000000000
```

```
SELECT ST_AsBinary(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326), 'XDR');
                   st_asbinary
--------------------------------
\x00000000030000000100000005000000000000000000000000000000000000000000000000003ff000
00000000003ff00000000000003ff00000000000003ff000000000000000000000000000000000000
00000000000000000000000000
```

⊠⊠

ST_GeomFromWKB, ST_AsEWKB, ST_AsTWKB, ST_AsText,

7.9.2.2 ST_AsEWKB

ST_AsEWKB — Return the Extended Well-Known Binary (EWKB) representation of the geometry with SRID meta data.

Synopsis

bytea **ST_AsEWKB**(geometry g1);
bytea **ST_AsEWKB**(geometry g1, text NDR_or_XDR);

⊠⊠

Returns the Extended Well-Known Binary (EWKB) representation of the geometry with SRID metadata. The first function variant defaults to encoding using server machine endian. The second function variant takes a text argument specifying the endian encoding, either little-endian ('NDR') or big-endian ('XDR').

WKB format is useful to read geometry data from the database and maintaining full numeric precision. This avoids the precision rounding that can happen with text formats such as WKT.

To perform the inverse conversion of EWKB to PostGIS geometry use ST_GeomFromEWKB.

> **Note**
> To get the OGC/ISO WKB format use ST_AsBinary. Note that OGC/ISO WKB format does not include the SRID.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT ST_AsEWKB(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

                   st_asewkb
--------------------------------
\x0103000020e610000001000000050000000000000000000000000000000000000000000000000000
00000000000000f03f000000000000f03f000000000000f03f000000000000f03f00000000000000
0000000000000000000000000000000000
```

```
SELECT ST_AsEWKB(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326), 'XDR');
                   st_asewkb
--------------------------------
\x0020000003000010e6000000010000000500000000000000000000000000000000000000000000000
003ff00000000000003ff00000000000003ff00000000000003ff0000000000000000000000000000
0000000000000000000000000000000000
```

⊠⊠

ST_AsBinary, ST_GeomFromEWKB, ST_SRID

7.9.2.3 ST_AsHEXEWKB

ST_AsHEXEWKB — ⊠⊠⊠⊠⊠⊠⊠ (NDR) ⊠⊠⊠⊠⊠⊠ (XDR) ⊠⊠⊠⊠⊠⊠ HEXEWKB (⊠⊠⊠) ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

Synopsis

text **ST_AsHEXEWKB**(geometry g1, text NDRorXDR);
text **ST_AsHEXEWKB**(geometry g1);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠ (NDR) ⊠⊠⊠⊠⊠⊠ (XDR) ⊠⊠⊠⊠⊠⊠ HEXEWKB (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ NDR ⊠⊠⊠⊠.

> **Note**
> 1.2.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_AsHEXEWKB(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));
		which gives same answer as

		SELECT ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326)::text;

		st_ashexewkb
		--------
		0103000020E61000000100000005000
		00000000000000000000000000000000
		00000000000000000000000000000F03F
		000000000000F03F000000000000F03F000000000000F03
		F000000000000000000000000000000000000000000000000
```

7.9.3 Other Formats

7.9.3.1 ST_AsEncodedPolyline

ST_AsEncodedPolyline — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_AsEncodedPolyline**(geometry geom, integer precision=5);

⊠⊠

Returns the geometry as an Encoded Polyline. This format is used by Google Maps with precision=5 and by Open Source Routing Machine with precision=5 and 6.

Optional `precision` specifies how many decimal places will be preserved in Encoded Polyline. Value should be the same on encoding and decoding, or coordinates will be incorrect.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠

```
SELECT ST_AsEncodedPolyline(GeomFromEWKT('SRID=4326;LINESTRING(-120.2 38.5,-120.95 ↩
    40.7,-126.453 43.252)'));
	--result--
	|_p~iF~ps|U_ulLnnqC_mqNvxq`@
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (segmentize) ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
-- the SQL for Boston to San Francisco, segments every 100 KM
	SELECT ST_AsEncodedPolyline(
		ST_Segmentize(
			ST_GeogFromText('LINESTRING(-71.0519 42.4935,-122.4483 37.64)'),
				100000)::geometry) As encodedFlightPath;
```

⊠⊠⊠⊠ $ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
<script type="text/javascript" src="http://maps.googleapis.com/maps/api/js?libraries=geometry"
></script>
<script type="text/javascript">
        flightPath = new google.maps.Polyline({
                       path:  google.maps.geometry.encoding.decodePath("$encodedFlightPath"),
                       map: map,
                       strokeColor: '#0000CC',
                       strokeOpacity: 1.0,
                       strokeWeight: 4
               });
</script>
```

□□

ST_LineFromEncodedPolyline, ST_Segmentize

7.9.3.2 ST_AsFlatGeobuf

ST_AsFlatGeobuf — Return a FlatGeobuf representation of a set of rows.

Synopsis

bytea **ST_AsFlatGeobuf**(anyelement set row);
bytea **ST_AsFlatGeobuf**(anyelement row, bool index);
bytea **ST_AsFlatGeobuf**(anyelement row, bool index, text geom_name);

□□

Return a FlatGeobuf representation (http://flatgeobuf.org) of a set of rows corresponding to a FeatureCollection. NOTE: PostgreSQL bytea cannot exceed 1GB.

`row` row data with at least a geometry column.

`index` toggle spatial index creation. Default is false.

`geom_name` is the name of the geometry column in the row data. If NULL it will default to the first found geometry column.

Availability: 3.2.0

7.9.3.3 ST_AsGeobuf

ST_AsGeobuf — Return a Geobuf representation of a set of rows.

Synopsis

bytea **ST_AsGeobuf**(anyelement set row);
bytea **ST_AsGeobuf**(anyelement row, text geom_name);

⊠⊠

Return a Geobuf representation (https://github.com/mapbox/geobuf) of a set of rows corresponding to a FeatureCollection. Every input geometry is analyzed to determine maximum precision for optimal storage. Note that Geobuf in its current form cannot be streamed so the full output will be assembled in memory.

`row` row data with at least a geometry column.

`geom_name` is the name of the geometry column in the row data. If NULL it will default to the first found geometry column.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT encode(ST_AsGeobuf(q, 'geom'), 'base64')
    FROM (SELECT ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))') AS geom) AS q;
 st_asgeobuf
----------------------------------
 GAAiEAoOCgwIBBoIAAAAAgIAAAE=
```

7.9.3.4 ST_AsGeoJSON

ST_AsGeoJSON — Return a geometry or feature in GeoJSON format.

Synopsis

text **ST_AsGeoJSON**(record feature, text geom_column="", integer maxdecimaldigits=9, boolean pretty_bool=false, text id_column='');
text **ST_AsGeoJSON**(geometry geom, integer maxdecimaldigits=9, integer options=8);
text **ST_AsGeoJSON**(geography geog, integer maxdecimaldigits=9, integer options=0);

⊠⊠

Returns a geometry as a GeoJSON "geometry" object, or a row as a GeoJSON "feature" object.

The resulting GeoJSON geometry and feature representations conform with the GeoJSON specifications RFC 7946, except when the parsed geometries are referenced with a CRS other than WGS84 longitude and latitude (EPSG:4326, urn:ogc:def:crs:OGC::CRS84); the GeoJSON geometry object will then have a short CRS SRID identifier attached by default. 2D and 3D Geometries are both supported. GeoJSON only supports SFS 1.1 geometry types (no curve support for example).

The `geom_column` parameter is used to distinguish between multiple geometry columns. If omitted, the first geometry column in the record will be determined. Conversely, passing the parameter will save column type lookups.

The `maxdecimaldigits` argument may be used to reduce the maximum number of decimal places used in output (defaults to 9). If you are using EPSG:4326 and are outputting the geometry only for display, `maxdecimaldigits=6` can be a good choice for many maps.

> **Warning**
> Using the *`maxdecimaldigits`* parameter can cause output geometry to become invalid. To avoid this use ST_ReducePrecision with a suitable gridsize first.

The `options` argument can be used to add BBOX or CRS in GeoJSON output:

- 0: means no option
- 1: GeoJSON BBOX
- 2: GeoJSON Short CRS (⊠: EPSG:4326)
- 4: GeoJSON Long CRS (⊠: urn:ogc:def:crs:EPSG::4326)
- 8: GeoJSON Short CRS if not EPSG:4326 (default)

The `id_column` parameter is used to set the "id" member of the returned GeoJSON features. As per GeoJSON RFC, this SHOULD be used whenever a feature has a commonly used identifier, such as a primary key. When not specified, the produced features will not get an "id" member and any columns other than the geometry, including any potential keys, will just end up inside the feature's "properties" member.

The GeoJSON specification states that polygons are oriented using the Right-Hand Rule, and some clients require this orientation. This can be ensured by using ST_ForcePolygonCCW . The specification also requires that geometry be in the WGS84 coordinate system (SRID = 4326). If necessary geometry can be projected into WGS84 using ST_Transform: `ST_Transform( geom, 4326 )`.

GeoJSON can be tested and viewed online at geojson.io and geojsonlint.com. It is widely supported by web mapping frameworks:

- OpenLayers GeoJSON Example
- Leaflet GeoJSON Example
- Mapbox GL GeoJSON Example

1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (default arg) ⊠⊠⊠⊠⊠⊠⊠⊠ (named arg) ⊠⊠⊠⊠⊠⊠.

Changed: 3.0.0 support records as input

Changed: 3.0.0 output SRID if not EPSG:4326.

Changed: 3.5.0 allow specifying the column containing the feature id

This function supports 3d and will not drop the z-index.

⊠⊠

Generate a FeatureCollection:

```
SELECT json_build_object(
    'type', 'FeatureCollection',
    'features', json_agg(ST_AsGeoJSON(t.*, id_column =
> 'id')::json)
    )
FROM ( VALUES (1, 'one', 'POINT(1 1)'::geometry),
              (2, 'two', 'POINT(2 2)'),
              (3, 'three', 'POINT(3 3)')
     ) as t(id, name, geom);
```

```
{"type" : "FeatureCollection", "features" : [{"type": "Feature", "geometry": {"type":"Point","coordinates":[1,1]}, "id": 1, "properties": {"name": "one"}}, {"type": "Feature", "geometry": {"type":"Point","coordinates":[2,2]}, "id": 2, "properties": {"name": "two"}}, {"type": "Feature", "geometry": {"type":"Point","coordinates":[3,3]}, "id": 3, "properties": {"name": "three"}}]}
```

Generate a Feature:

```
SELECT ST_AsGeoJSON(t.*, id_column =
> 'id')
FROM (VALUES (1, 'one', 'POINT(1 1)'::geometry)) AS t(id, name, geom);
```

```
st_asgeojson
-----------------------------------------------------------------------------------------------------

 {"type": "Feature", "geometry": {"type":"Point","coordinates":[1,1]}, "id": 1, "properties": {"name": "one"}}
```

Don't forget to transform your data to WGS84 longitude, latitude to conform with the GeoJSON specification:

```
SELECT ST_AsGeoJSON(ST_Transform(geom,4326)) from fe_edges limit 1;
```

```
st_asgeojson
-----------------------------------------------------------------------------------------------------


{"type":"MultiLineString","coordinates":[[[-89.734634999999997,31.492072000000000],
[-89.734955999999997,31.492237999999997]]]}
```

3D geometries are supported:

```
SELECT ST_AsGeoJSON('LINESTRING(1 2 3, 4 5 6)');
```

```
{"type":"LineString","coordinates":[[1,2,3],[4,5,6]]}
```

Options argument can be used to add BBOX and CRS in GeoJSON output:

```
SELECT ST_AsGeoJSON(ST_SetSRID('POINT(1 1)'::geometry, 4326), 9, 4|1);
```

```
{"type":"Point","crs":{"type":"name","properties":{"name":"urn:ogc:def:crs:EPSG::4326"}},"bbox":[1.000000000,1.000000000,1.000000000,1.000000000],"coordinates":[1,1]}
```

⊠⊠

ST_GeomFromGeoJSON, ST_ForcePolygonCCW , ST_Transform

7.9.3.5 ST_AsGML

ST_AsGML — ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_AsGML**(geometry geom, integer maxdecimaldigits=15, integer options=0);
text **ST_AsGML**(geography geog, integer maxdecimaldigits=15, integer options=0, text nprefix=null, text id=null);
text **ST_AsGML**(integer version, geometry geom, integer maxdecimaldigits=15, integer options=0, text nprefix=null, text id=null);
text **ST_AsGML**(integer version, geography geog, integer maxdecimaldigits=15, integer options=0, text nprefix=null, text id=null);

⊠⊠

Return the geometry as a Geography Markup Language (GML) element. The version parameter, if specified, may be either 2 or 3. If no version parameter is specified then the default is assumed to be 2. The `maxdecimaldigits` argument may be used to reduce the maximum number of decimal places used in output (defaults to 15).

> **Warning**
> Using the *`maxdecimaldigits`* parameter can cause output geometry to become invalid. To avoid this use ST_ReducePrecision with a suitable gridsize first.

GML 2 ⊠ 2.1.2 ⊠⊠⊠, GML 3 ⊠ 3.1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

' ⊠⊠' ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (bitfield) ⊠⊠⊠⊠⊠⊠⊠. CRS ⊠⊠⊠⊠⊠⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- 0: GML Short CRS (⊠: EPSG:4326), ⊠⊠⊠
- 1: GML Long CRS (⊠: urn:ogc:def:crs:EPSG::4326)
- 2: GML 3 ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ srsDimension ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- 4: GML 3 ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ <Curve> ⊠⊠ <LineString> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- 16: ⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠ (⊠: srid=4326) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (axis order) ⊠⊠⊠⊠⊠⊠⊠⊠, GML 3.1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- 32: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (envelope) ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠' ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠' ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠'gml' ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.3.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GML 3 ⊠ ⊠⊠'4' ⊠⊠⊠⊠⊠⊠⊠⊠⊠. GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠'32' ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (named arg) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠ GML 3 ⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ST_AsGML ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 17.2

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠: ⊠⊠ 2

```
SELECT ST_AsGML(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));
                st_asgml
                --------
                <gml:Polygon srsName="EPSG:4326"
><gml:outerBoundaryIs
><gml:LinearRing
><gml:coordinates
>0,0 0,1 1,1 1,0 0,0</gml:coordinates
></gml:LinearRing
></gml:outerBoundaryIs
></gml:Polygon>
```

⊠⊠: ⊠⊠ 3

```
-- Flip coordinates and output extended EPSG (16 | 1)--
SELECT ST_AsGML(3, ST_GeomFromText('POINT(5.234234233242 6.34534534534)',4326), 5, 17);
                        st_asgml
                        --------
                <gml:Point srsName="urn:ogc:def:crs:EPSG::4326"
><gml:pos
>6.34535 5.23423</gml:pos
></gml:Point>
```

```
-- Output the envelope (32) --
SELECT ST_AsGML(3, ST_GeomFromText('LINESTRING(1 2, 3 4, 10 20)',4326), 5, 32);
                st_asgml
                --------
        <gml:Envelope srsName="EPSG:4326">
                <gml:lowerCorner
>1 2</gml:lowerCorner>
                <gml:upperCorner
>10 20</gml:upperCorner>
        </gml:Envelope>
```

```
-- Output the envelope (32) , reverse (lat lon instead of lon lat) (16), long srs (1)= 32 | ↩
     16 | 1 = 49 --
SELECT ST_AsGML(3, ST_GeomFromText('LINESTRING(1 2, 3 4, 10 20)',4326), 5, 49);
        st_asgml
        --------
<gml:Envelope srsName="urn:ogc:def:crs:EPSG::4326">
        <gml:lowerCorner
>2 1</gml:lowerCorner>
        <gml:upperCorner
```

```
>20 10</gml:upperCorner>
</gml:Envelope>
```

```
-- Polyhedral Example --
SELECT ST_AsGML(3, ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0) ↩
    ),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )'));
        st_asgml
        --------
 <gml:PolyhedralSurface>
<gml:polygonPatches>
   <gml:PolygonPatch>
                <gml:exterior>
                          <gml:LinearRing>
                                   <gml:posList srsDimension=”3”
>0 0 0 0 0 1 0 1 1 0 1 0 0 0 0</gml:posList>
                          </gml:LinearRing>
                </gml:exterior>
   </gml:PolygonPatch>
   <gml:PolygonPatch>
                <gml:exterior>
                          <gml:LinearRing>
                                   <gml:posList srsDimension=”3”
>0 0 0 0 1 0 1 1 0 1 0 0 0 0 0</gml:posList>
                          </gml:LinearRing>
                </gml:exterior>
   </gml:PolygonPatch>
   <gml:PolygonPatch>
                <gml:exterior>
                          <gml:LinearRing>
                                   <gml:posList srsDimension=”3”
>0 0 0 1 0 0 1 0 1 0 0 1 0 0 0</gml:posList>
                          </gml:LinearRing>
                </gml:exterior>
   </gml:PolygonPatch>
   <gml:PolygonPatch>
                <gml:exterior>
                          <gml:LinearRing>
                                   <gml:posList srsDimension=”3”
>1 1 0 1 1 1 1 0 1 1 0 0 1 1 0</gml:posList>
                          </gml:LinearRing>
                </gml:exterior>
   </gml:PolygonPatch>
   <gml:PolygonPatch>
                <gml:exterior>
                          <gml:LinearRing>
                                   <gml:posList srsDimension=”3”
>0 1 0 0 1 1 1 1 1 1 1 0 0 1 0</gml:posList>
                          </gml:LinearRing>
                </gml:exterior>
   </gml:PolygonPatch>
   <gml:PolygonPatch>
                <gml:exterior>
                          <gml:LinearRing>
                                   <gml:posList srsDimension=”3”
>0 0 1 1 0 1 1 1 1 0 1 1 0 0 1</gml:posList>
                          </gml:LinearRing>
                </gml:exterior>
   </gml:PolygonPatch>
```

```
</gml:polygonPatches>
</gml:PolyhedralSurface>
```

⊠⊠

ST_GeomFromGML

7.9.3.6 ST_AsKML

ST_AsKML — ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_AsKML**(geometry geom, integer maxdecimaldigits=15, text nprefix=NULL);
text **ST_AsKML**(geography geog, integer maxdecimaldigits=15, text nprefix=NULL);

⊠⊠

⊠⊠⊠ KML(Keyhole Markup Language) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠ 15), ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Warning
Using the *maxdecimaldigits* parameter can cause output geometry to become invalid. To avoid this use ST_ReducePrecision with a suitable gridsize first.

Note
PostGIS ⊠ Proj ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Proj ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS_Full_Version ⊠⊠⊠⊠⊠⊠⊠.

Note
1.2.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1.3.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
Changed: 3.0.0 - Removed the ”versioned” variant signature

Note
ST_AsKML ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_AsKML(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

                st_askml
                --------
                <Polygon
><outerBoundaryIs
><LinearRing
><coordinates
>0,0 0,1 1,1 1,0 0,0</coordinates
></LinearRing
></outerBoundaryIs
></Polygon>

                --3d linestring
                SELECT ST_AsKML('SRID=4326;LINESTRING(1 2 3, 4 5 6)');
                <LineString
><coordinates
>1,2,3 4,5,6</coordinates
></LineString>
```

⊠⊠

ST_AsSVG, ST_AsGML

7.9.3.7 ST_AsLatLonText

ST_AsLatLonText — ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_AsLatLonText**(geometry pt, text format=”);

⊠⊠

⊠⊠⊠⊠⊠, ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ X(⊠⊠) ⊠ Y(⊠⊠) ⊠⊠⊠” ⊠⊠” ⊠⊠ (⊠⊠⊠ -180 ⊠⊠⊠ 180 ⊠, ⊠⊠⊠ -90 ⊠⊠⊠ 90 ⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□. □□□ □□□□□□□□□□”D”, □□□□□□”M”, □□□□□□”S”, □□□□□□□ (□□□□, cardinal direction) □□□□□□”C” □□□. D, M, S □□□□□□□□□□□□□□□□□□□□□□□□□□□□ (”SSS.SSSS” □”1.0023” □□□□□□□□□□□).

M, S, C □□□□□□□. ”C” □□□□□□, □□□□□□□□□□□”-” □□□□□□□□□□. ”S” □□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. ”M” □□□□□□, □□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□.

□□□□□□□□ (□□□□□ 0 □) □□□□□□□□□□□□.

2.0 □□□□□□□□□□□□.

□□

□□□□

```
SELECT (ST_AsLatLonText('POINT (-3.2342342 -2.32498)'));
      st_aslatlontext
----------------------------
 2°19'29.928”S 3°14'3.243”W
```

(□□□□□□□) □□□□□□□□.

```
SELECT (ST_AsLatLonText('POINT (-3.2342342 -2.32498)', 'D°M''S.SSS”C'));
      st_aslatlontext
----------------------------
 2°19'29.928”S 3°14'3.243”W
```

D, M, S, C □. □□□□□□□□□□□□□□□□.

```
SELECT (ST_AsLatLonText('POINT (-3.2342342 -2.32498)', 'D degrees, M minutes, S seconds to ←
    the C'));
                                   st_aslatlontext
-------------------------------------------------------------------------------------
 2 degrees, 19 minutes, 30 seconds to the S 3 degrees, 14 minutes, 3 seconds to the W
```

□□□□□□□□□□□□□□□□□□.

```
SELECT (ST_AsLatLonText('POINT (-3.2342342 -2.32498)', 'D°M''S.SSS”'));
      st_aslatlontext
----------------------------
 -2°19'29.928” -3°14'3.243”
```

□□□□□□□□□□□□□.

```
SELECT (ST_AsLatLonText('POINT (-3.2342342 -2.32498)', 'D.DDDD degrees C'));
          st_aslatlontext
-----------------------------------
 2.3250 degrees S 3.2342 degrees W
```

□□□□□□□□□□□□□.

```
SELECT (ST_AsLatLonText('POINT (-302.2342342 -792.32498)'));
        st_aslatlontext
-------------------------------
 72°19'29.928”S 57°45'56.757”E
```

7.9.3.8 ST_AsMARC21

ST_AsMARC21 — Returns geometry as a MARC21/XML record with a geographic datafield (034).

Synopsis

text **ST_AsMARC21** (geometry geom , text format='hdddmmss');

⊠⊠

This function returns a MARC21/XML record with Coded Cartographic Mathematical Data representing the bounding box of a given geometry. The `format` parameter allows to encode the coordinates in subfields `$d`,`$e`,`$f` and `$g` in all formats supported by the MARC21/XML standard. Valid formats are:

- cardinal direction, degrees, minutes and seconds (default): `hdddmmss`
- decimal degrees with cardinal direction: `hddd.dddddd`
- decimal degrees without cardinal direction: `ddd.dddddd`
- decimal minutes with cardinal direction: `hdddmm.mmmm`
- decimal minutes without cardinal direction: `dddmm.mmmm`
- decimal seconds with cardinal direction: `hdddmmss.sss`

The decimal sign may be also a comma, e.g. `hdddmm,mmmm`.

The precision of decimal formats can be limited by the number of characters after the decimal sign, e.g. `hdddmm.mm` for decimal minutes with a precision of two decimals.

This function ignores the Z and M dimensions.

LOC MARC21/XML versions supported:

- MARC21/XML 1.1

Availability: 3.3.0

Note
This function does not support non lon/lat geometries, as they are not supported by the MARC21/XML standard (Coded Cartographic Mathematical Data).

Note
The MARC21/XML Standard does not provide any means to annotate the spatial reference system for Coded Cartographic Mathematical Data, which means that this information will be lost after conversion to MARC21/XML.

⊠⊠

Converting a `POINT` to MARC21/XML formatted as hdddmmss (default)

```
SELECT ST_AsMARC21('SRID=4326;POINT(-4.504289 54.253312)'::geometry);

                st_asmarc21
-------------------------------------------------
<record xmlns="http://www.loc.gov/MARC21/slim">
    <datafield tag="034" ind1="1" ind2=" ">
```

```
                        <subfield code="a"
>a</subfield>
                        <subfield code="d"
>W0043015</subfield>
                        <subfield code="e"
>W0043015</subfield>
                        <subfield code="f"
>N0541512</subfield>
                        <subfield code="g"
>N0541512</subfield>
                    </datafield>
                </record>
```

Converting a `POLYGON` to MARC21/XML formatted in decimal degrees

```
                SELECT ST_AsMARC21('SRID=4326;POLYGON((-4.5792388916015625 ↩
                    54.18172660239091,-4.56756591796875 ↩
                    54.196993557130355,-4.546623229980469 ↩
                    54.18313300502024,-4.5792388916015625 54.18172660239091))'::geometry,' ↩
                    hddd.dddd');

                <record xmlns="http://www.loc.gov/MARC21/slim">
                    <datafield tag="034" ind1="1" ind2=" ">
                        <subfield code="a"
>a</subfield>
                        <subfield code="d"
>W004.5792</subfield>
                        <subfield code="e"
>W004.5466</subfield>
                        <subfield code="f"
>N054.1970</subfield>
                        <subfield code="g"
>N054.1817</subfield>
                    </datafield>
                </record>
```

Converting a `GEOMETRYCOLLECTION` to MARC21/XML formatted in decimal minutes. The geometries order in the MARC21/XML output correspond to their order in the collection.

```
                SELECT ST_AsMARC21('SRID=4326;GEOMETRYCOLLECTION(POLYGON((13.1 ↩
                    52.65,13.516666666666667 52.65,13.516666666666667 52.38333333333333,13.1 ↩
                     52.38333333333333,13.1 52.65)),POINT(-4.5 54.25))'::geometry,'hdddmm. ↩
                    mmmm');

                                st_asmarc21
                -------------------------------------------------
                <record xmlns="http://www.loc.gov/MARC21/slim">
                    <datafield tag="034" ind1="1" ind2=" ">
                        <subfield code="a"
>a</subfield>
                        <subfield code="d"
>E01307.0000</subfield>
```

```
                        <subfield code="e"
>E01331.0000</subfield>
                        <subfield code="f"
>N05240.0000</subfield>
                        <subfield code="g"
>N05224.0000</subfield>
                    </datafield>
                    <datafield tag="034" ind1="1" ind2=" ">
                        <subfield code="a"
>a</subfield>
                        <subfield code="d"
>W00430.0000</subfield>
                        <subfield code="e"
>W00430.0000</subfield>
                        <subfield code="f"
>N05415.0000</subfield>
                        <subfield code="g"
>N05415.0000</subfield>
                    </datafield>
                </record>
```

☒☒

ST_GeomFromMARC21

7.9.3.9 ST_AsMVTGeom

ST_AsMVTGeom — Transforms a geometry into the coordinate space of a MVT tile.

Synopsis

geometry **ST_AsMVTGeom**(geometry geom, box2d bounds, integer extent=4096, integer buffer=256, boolean clip_geom=true);

☒☒

Transforms a geometry into the coordinate space of a MVT (Mapbox Vector Tile) tile, clipping it to the tile bounds if required. The geometry must be in the coordinate system of the target map (using ST_Transform if needed). Commonly this is Web Mercator (SRID:3857).

The function attempts to preserve geometry validity, and corrects it if needed. This may cause the result geometry to collapse to a lower dimension.

The rectangular bounds of the tile in the target map coordinate space must be provided, so the geometry can be transformed, and clipped if required. The bounds can be generated using ST_TileEnvelope.

This function is used to convert geometry into the tile coordinate space required by ST_AsMVT.

`geom` is the geometry to transform, in the coordinate system of the target map.

`bounds` is the rectangular bounds of the tile in map coordinate space, with no buffer.

`extent` is the tile extent size in tile coordinate space as defined by the MVT specification. Defaults to 4096.

`buffer` is the buffer size in tile coordinate space for geometry clippig. Defaults to 256.

`clip_geom` is a boolean to control if geometries are clipped or encoded as-is. Defaults to true.

2.2.0 □□□□□□□□□□□□.

Note
From 3.0, Wagyu can be chosen at configure time to clip and validate MVT polygons. This library is faster and produces more correct results than the GEOS default, but it might drop small polygons.

□□

```
SELECT ST_AsText(ST_AsMVTGeom(
        ST_GeomFromText('POLYGON ((0 0, 10 0, 10 5, 0 -5, 0 0))'),
        ST_MakeBox2D(ST_Point(0, 0), ST_Point(4096, 4096)),
        4096, 0, false));
                              st_astext
--------------------------------------------------------------------
 MULTIPOLYGON(((5 4096,10 4091,10 4096,5 4096)),((5 4096,0 4101,0 4096,5 4096)))
```

Canonical example for a Web Mercator tile using a computed tile bounds to query and clip geometry. This assumes the data.geom column has srid of 4326.

```
SELECT ST_AsMVTGeom(
            ST_Transform( geom, 3857 ),
            ST_TileEnvelope(12, 513, 412), extent =
> 4096, buffer =
> 64) AS geom
  FROM data
  WHERE geom && ST_Transform(ST_TileEnvelope(12, 513, 412, margin =
> (64.0 / 4096)),4326)
```

□□

ST_AsMVT, ST_TileEnvelope, PostGIS_Wagyu_Version

7.9.3.10 ST_AsMVT

ST_AsMVT — Aggregate function returning a MVT representation of a set of rows.

Synopsis

bytea **ST_AsMVT**(anyelement set row);
bytea **ST_AsMVT**(anyelement row, text name);
bytea **ST_AsMVT**(anyelement row, text name, integer extent);
bytea **ST_AsMVT**(anyelement row, text name, integer extent, text geom_name);
bytea **ST_AsMVT**(anyelement row, text name, integer extent, text geom_name, text feature_id_name);

⊠⊠

An aggregate function which returns a binary Mapbox Vector Tile representation of a set of rows corresponding to a tile layer. The rows must contain a geometry column which will be encoded as a feature geometry. The geometry must be in tile coordinate space and valid as per the MVT specification. ST_AsMVTGeom can be used to transform geometry into tile coordinate space. Other row columns are encoded as feature attributes.

The Mapbox Vector Tile format can store features with varying sets of attributes. To use this capability supply a JSONB column in the row data containing Json objects one level deep. The keys and values in the JSONB values will be encoded as feature attributes.

Tiles with multiple layers can be created by concatenating multiple calls to this function using `||` or `STRING_AGG`.

> **Important**
> Do not call with a `GEOMETRYCOLLECTION` as an element in the row. However you can use ST_AsMVTGeom to prepare a geometry collection for inclusion.

`row` row data with at least a geometry column.

`name` is the name of the layer. Default is the string "default".

`extent` is the tile extent in screen space as defined by the specification. Default is 4096.

`geom_name` is the name of the geometry column in the row data. Default is the first geometry column. Note that PostgreSQL by default automatically folds unquoted identifiers to lower case, which means that unless the geometry column is quoted, e.g. `"MyMVTGeom"`, this parameter must be provided as lowercase.

`feature_id_name` is the name of the Feature ID column in the row data. If NULL or negative the Feature ID is not set. The first column matching name and valid type (smallint, integer, bigint) will be used as Feature ID, and any subsequent column will be added as a property. JSON properties are not supported.

Enhanced: 3.0 - added support for Feature ID.

Enhanced: 2.5.0 - added support parallel query.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
WITH mvtgeom AS
(
  SELECT ST_AsMVTGeom(geom, ST_TileEnvelope(12, 513, 412), extent =
> 4096, buffer =
> 64) AS geom, name, description
  FROM points_of_interest
  WHERE geom && ST_TileEnvelope(12, 513, 412, margin =
> (64.0 / 4096))
)
SELECT ST_AsMVT(mvtgeom.*)
FROM mvtgeom;
```

⊠⊠

ST_AsMVTGeom, ST_TileEnvelope

7.9.3.11 ST_AsSVG

ST_AsSVG — Returns SVG path data for a geometry.

Synopsis

text **ST_AsSVG**(geometry geom, integer rel=0, integer maxdecimaldigits=15);
text **ST_AsSVG**(geography geog, integer rel=0, integer maxdecimaldigits=15);

⊠⊠

⊠⊠⊠ SVG(Scalar Vector Graphics) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ (relative move) ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ (absolute move) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠ 15) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠. 'rel' ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ cx/cy ⊠⊠⊠⊠⊠⊠⊠, 'rel' ⊠⊠⊠⊠⊠ 1 ⊠⊠ x/y ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (",") ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (";") ⊠⊠⊠⊠⊠⊠⊠⊠.

For working with PostGIS SVG graphics, checkout pg_svg library which provides plpgsql functions for working with outputs from ST_AsSVG.

Enhanced: 3.4.0 to support all curve types

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (default arg) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (named arg) ⊠⊠⊠⊠⊠⊠⊠.

Note
1.2.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.4.0 ⊠⊠⊠⊠ http://www.w3.org/TR/SVG/paths.html#PathDataBNF ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ L ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_AsSVG('POLYGON((0 0,0 1,1 1,1 0,0 0))'::geometry);

st_assvg
--------
M 0 0 L 0 -1 1 -1 1 0 Z
```

Circular string

```
SELECT ST_AsSVG( ST_GeomFromText('CIRCULARSTRING(-2 0,0 2,2 0,0 2,2 4)') );

st_assvg
--------
M -2 0 A 2 2 0 0 1 2 0 A 2 2 0 0 1 2 -4
```

Multi-curve

```
SELECT ST_AsSVG('MULTICURVE((5 5,3 5,3 3,0 3),
 CIRCULARSTRING(0 0,2 1,2 2))'::geometry, 0, 0);
 st_assvg
------------------------------------------------
 M 5 -5 L 3 -5 3 -3 0 -3 M 0 0 A 2 2 0 0 0 2 -2
```

Multi-surface

```
SELECT ST_AsSVG('MULTISURFACE(
CURVEPOLYGON(CIRCULARSTRING(-2 0,-1 -1,0 0,1 -1,2 0,0 2,-2 0),
    (-1 0,0 0.5,1 0,0 1,-1 0)),
((7 8,10 10,6 14,4 11,7 8)))'::geometry, 0, 2);

st_assvg
---------------------------------------------------------
M -2 0 A 1 1 0 0 0 0 0 A 1 1 0 0 0 2 0 A 2 2 0 0 0 -2 0 Z
M -1 0 L 0 -0.5 1 0 0 -1 -1 0 Z
M 7 -8 L 10 -10 6 -14 4 -11 Z
```

7.9.3.12 ST_AsTWKB

ST_AsTWKB — ⊠⊠⊠ TWKB(Tiny Well-Known Binary) ⊠⊠⊠⊠⊠⊠.

Synopsis

bytea **ST_AsTWKB**(geometry geom, integer prec=0, integer prec_z=0, integer prec_m=0, boolean with_sizes=false, boolean with_boxes=false);
bytea **ST_AsTWKB**(geometry[] geom, bigint[] ids, integer prec=0, integer prec_z=0, integer prec_m=0, boolean with_sizes=false, boolean with_boxes=false);

⊠⊠

⊠⊠⊠ TWKB(Tiny Well-Known Binary) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. TWKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠.

⊠⊠⊠. ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ ⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TWKB ⊠⊠⊠⊠⊠⊠⊠).

⊠⊠⊠ TWKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ ⊠⊠⊠. array_agg ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> https://github.com/TWKB/Specification ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, https://github.com/-TWKB/twkb.js ⊠⊠.

Enhanced: 2.4.0 memory and speed improvements.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_AsTWKB('LINESTRING(1 1,5 5)'::geometry);
                 st_astwkb
--------------------------------------------
\x02000202020808
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TWKB ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠"array_agg()" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TWKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AsTWKB(array_agg(geom), array_agg(gid)) FROM mytable;
                 st_astwkb
--------------------------------------------
\x040402020400000202
```

⊠⊠

ST_GeomFromTWKB, ST_AsBinary, ST_AsEWKB, ST_AsEWKT, ST_GeomFromText

7.9.3.13 ST_AsX3D

ST_AsX3D — ⊠⊠⊠ X3D XML ⊠⊠⊠⊠⊠⊠: ISO-IEC-19776-1.2-X3DEncodings-XML ⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_AsX3D**(geometry g1, integer maxdecimaldigits=15, integer options=0);

⊠⊠

⊠⊠⊠ http://www.web3d.org/standards/number/19776-1 ⊠⊠⊠⊠⊠⊠ X3D XML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. maxdecimaldigits (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 15 ⊠⊠⊠⊠.

> **Note**
> X3D ⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠ X3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ (bug ticket) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ PostGIS 2D/3D ⊠⊠⊠ X3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

' ⊠⊠' ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 2.2 ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ X3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ x/y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_AsX3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (long,lat or X,Y) ⊠⊠⊠⊠⊠⊠, X3D ⊠⊠⊠⊠⊠⊠⊠/⊠⊠, y/x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- 0: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X/Y(⊠⊠⊠⊠⊠⊠/⊠⊠ = X,Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠), ⊠⊠⊠⊠, ⊠ (非) ⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠).
- 1: X ⊠ Y ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ (GeoCoordinate) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠"latitude_first"(⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- 2: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ WGS84 ⊠⊠⊠ (SRID 4326) ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X3D ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ GeoCoordinate geoSystem='"GD" "WE" "longitude_first"' ⊠⊠⊠⊠. X3D ⊠⊠⊠⊠ GeoCoordinate geoSystem='"GD" "WE" "latitude_first"' ⊠⊠⊠⊠⊠⊠, (2 + 1) = 3 ⊠⊠⊠⊠⊠.

PostGIS ⊠⊠	2D X3D ⊠⊠	3D X3D ⊠⊠
LINESTRING	⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ PolyLine2D ⊠⊠⊠⊠⊠⊠.	LineSet
MULTILINESTRING	⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ PolyLine2D ⊠⊠⊠⊠⊠⊠.	IndexedLineSet
MULTIPOINT	Polypoint2D	PointSet
POINT	⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.	⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
(MULTI) POLYGON, POLYHEDRALSURFACE	⊠⊠⊠⊠⊠⊠⊠ X3D ⊠⊠⊠ (markup) ⊠⊠⊠.	IndexedFaceSet (⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ (faceset) ⊠⊠⊠ ⊠⊠⊠⊠.)
TIN	TriangleSet2D (⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.)	IndexedTriangleSet

Note

2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Lots of advancements happening in 3D space particularly with X3D Integration with HTML5

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X3D ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠, ⊠⊠⊠, ⊠⊠⊠⊠ Free Wrl ⊠⊠⊠⊠ ⊠ http://freewrl.sourceforge.net/ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ FreeWRL_Launcher ⊠⊠⊠⊠⊠⊠⊠⊠.

Also check out PostGIS minimalist X3D viewer that utilizes this function and x3dDom html/js open source toolkit.

2.0.0 ⊠⊠⊠⊠ ISO-IEC-19776-1.2-X3DEncodings-XML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (x/y, ⊠⊠/⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠ X3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ FreeWrl ⊠⊠⊠ X3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT '<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specifications/x3d ←
    -3.0.dtd">
<X3D>
  <Scene>
    <Transform>
      <Shape>
       <Appearance>
            <Material emissiveColor=''0 0 1''/>
       </Appearance
> ' ||
       ST_AsX3D( ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )')) ||
      '</Shape>
    </Transform>
```

```
  </Scene>
</X3D
>' As x3ddoc;

                x3ddoc
                --------
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specifications/x3d ↩
    -3.0.dtd">
<X3D>
  <Scene>
    <Transform>
      <Shape>
       <Appearance>
            <Material emissiveColor='0 0 1'/>
       </Appearance>
       <IndexedFaceSet  coordIndex='0 1 2 3 -1 4 5 6 7 -1 8 9 10 11 -1 12 13 14 15 -1 16 17 ↩
            18 19 -1 20 21 22 23'>
            <Coordinate point='0 0 0 0 0 1 0 1 1 0 1 0 0 0 0 0 1 0 1 1 0 1 0 0 0 0 0 0 1 0 0 ↩
                1 0 1 0 0 1 1 1 0 1 1 1 0 1 1 0 0 0 1 0 0 1 1 1 1 1 1 0 0 0 1 1 0 1 1 1 ↩
                1 0 1 1' />
      </IndexedFaceSet>
      </Shape>
    </Transform>
  </Scene>
</X3D>
```

PostGIS buildings

Copy and paste the output of this query to x3d scene viewer and click Show

```
SELECT string_agg('<Shape
>' || ST_AsX3D(ST_Extrude(geom, 0,0, i*0.5)) ||
    '<Appearance>
          <Material diffuseColor="' || (0.01*i)::text || ' 0.8 0.2" specularColor="' || ↩
              (0.05*i)::text || ' 0 0.5"/>
        </Appearance>
    </Shape
>', '')
FROM ST_Subdivide(ST_Letters('PostGIS'),20) WITH ORDINALITY AS f(geom,i);
```

Buildings formed by subdividing PostGIS and extrusion

☒☒: ☒☒☒☒☒☒ 6 ☒☒ 3 ☒☒☒☒☒☒☒☒

```
SELECT ST_AsX3D(
ST_Translate(
    ST_Force_3d(
        ST_Buffer(ST_Point(10,10),5, 'quad_segs=2')), 0,0,
    3)
  ,6) As x3dfrag;

x3dfrag
--------
<IndexedFaceSet coordIndex="0 1 2 3 4 5 6 7">
    <Coordinate point="15 10 3 13.535534 6.464466 3 10 5 3 6.464466 6.464466 3 5 10 3 6.464466 13.535534 3 10 15 3 13.535534 13.535534 3 " />
</IndexedFaceSet>
```

□□: TIN

```
SELECT ST_AsX3D(ST_GeomFromEWKT('TIN (((
                0 0 0,
                0 0 1,
                0 1 0,
                0 0 0
            )), ((
                0 0 0,
                0 1 0,
                1 1 0,
                0 0 0
            ))
            )')) As x3dfrag;

                x3dfrag
                --------
<IndexedTriangleSet  index='0 1 2 3 4 5'
><Coordinate point='0 0 0 0 0 1 0 1 0 0 0 0 0 1 0 1 1 0'/></IndexedTriangleSet>
```

□□: □□□□□□□□□□□ (□□□□□□□□□□□□□□)

```
SELECT ST_AsX3D(
                    ST_GeomFromEWKT('MULTILINESTRING((20 0 10,16 -12 10,0 -16 10,-12 -12 10,-20 0 10,-12 16 10,0 24 10,16 16 10,20 0 10),
  (12 0 10,8 8 10,0 12 10,-8 8 10,-8 0 10,-8 -4 10,0 -8 10,8 -4 10,12 0 10))')
) As x3dfrag;

                x3dfrag
                --------
<IndexedLineSet  coordIndex='0 1 2 3 4 5 6 7 0 -1 8 9 10 11 12 13 14 15 8'>
    <Coordinate point='20 0 10 16 -12 10 0 -16 10 -12 -12 10 -20 0 10 -12 16 10 0 24 10 16 16 10 12 0 10 8 8 10 0 12 10 -8 8 10 -8 0 10 -8 -4 10 0 -8 10 8 -4 10 ' />
 </IndexedLineSet>
```

7.9.3.14 ST_GeoHash

ST_GeoHash — □□□ GeoHash □□□□□□□□□.

Synopsis

text **ST_GeoHash**(geometry geom, integer maxchars=full_precision_of_point);

⊠⊠

Computes a GeoHash representation of a geometry. A GeoHash encodes a geographic Point into a text form that is sortable and searchable based on prefixing. A shorter GeoHash is a less precise representation of a point. It can be thought of as a box that contains the point.

Non-point geometry values with non-zero extent can also be mapped to GeoHash codes. The precision of the code depends on the geographic extent of the geometry.

If `maxchars` is not specified, the returned GeoHash code is for the smallest cell containing the input geometry. Points return a GeoHash with 20 characters of precision (about enough to hold the full double precision of the input). Other geometric types may return a GeoHash with less precision, depending on the extent of the geometry. Larger geometries are represented with less precision, smaller ones with more precision. The box determined by the GeoHash code always contains the input feature.

If `maxchars` is specified the returned GeoHash code has at most that many characters. It maps to a (possibly) lower precision representation of the input geometry. For non-points, the starting point of the calculation is the center of the bounding box of the geometry.

1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
ST_GeoHash requires input geometry to be in geographic (lon/lat) coordinates.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_GeoHash( ST_Point(-126,48) );

         st_geohash
----------------------
 c0w3hf1s70w3hf1s70w3

SELECT ST_GeoHash( ST_Point(-126,48), 5);

 st_geohash
------------
 c0w3h

-- This line contains the point, so the GeoHash is a prefix of the point code
SELECT ST_GeoHash('LINESTRING(-126 48, -126.1 48.1)'::geometry);

 st_geohash
------------
 c0w3
```

⊠⊠

ST_GeomFromGeoHash, ST_PointFromGeoHash, ST_Box2dFromGeoHash

7.10 ⊠⊠⊠ (operator)

7.10.1 Bounding Box Operators

7.10.1.1 &&

&& — A ⊠ 2D ⊠⊠⊠⊠⊠ B ⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **&&**(geometry A , geometry B);
boolean **&&**(geography A , geography B);

⊠⊠

&& ⊠⊠⊠⊠⊠⊠ A ⊠ 2D ⊠⊠⊠⊠⊠⊠⊠ B ⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.
1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 && tbl2.column2 AS overlaps
FROM ( VALUES
        (1, 'LINESTRING(0 0, 3 3)'::geometry),
        (2, 'LINESTRING(0 1, 0 5)'::geometry)) AS tbl1,
( VALUES
        (3, 'LINESTRING(1 2, 4 6)'::geometry)) AS tbl2;

 column1 | column1 | overlaps
---------+---------+----------
           1 |       3 | t
           2 |       3 | f
(2 rows)
```

⊠⊠

ST_Intersects, ST_Extent, |&>, &>, &<|, &<, ~, @

7.10.1.2 &&(geometry,box2df)

&&(geometry,box2df) — Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).

Synopsis

boolean **&&**(geometry A , box2df B);

⊠⊠

The && operator returns TRUE if the cached 2D bounding box of geometry A intersects the 2D bounding box B, using float precision. This means that if B is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

> **Note**
> This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_Point(1,1) && ST_MakeBox2D(ST_Point(0,0), ST_Point(2,2)) AS overlaps;

 overlaps
----------
 t
(1 row)
```

⊠⊠

&&(box2df,geometry), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,geometry), ~(box2df,box2df), @(geometry,box2df), @(box2df,geometry), @(box2df,box2df)

7.10.1.3 &&(box2df,geometry)

&&(box2df,geometry) — Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.

Synopsis

boolean **&&**(box2df A , geometry B);

⊠⊠

The && operator returns TRUE if the 2D bounding box A intersects the cached 2D bounding box of geometry B, using float precision. This means that if A is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

> **Note**
> This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_MakeBox2D(ST_Point(0,0), ST_Point(2,2)) && ST_Point(1,1) AS overlaps;

 overlaps
----------
 t
(1 row)
```

⊠⊠

&&(geometry,box2df), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,geometry), ~(box2df,box2df), @(geometry,box2df), @(box2df,geometry), @(box2df,box2df)

7.10.1.4 &&(box2df,box2df)

&&(box2df,box2df) — Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.

Synopsis

boolean **&&**(box2df A , box2df B);

⊠⊠

The && operator returns TRUE if two 2D bounding boxes A and B intersect each other, using float precision. This means that if A (or B) is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

> **Note**
> This operator is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

☒☒

```
SELECT ST_MakeBox2D(ST_Point(0,0), ST_Point(2,2)) && ST_MakeBox2D(ST_Point(1,1), ST_Point ↩
    (3,3)) AS overlaps;

 overlaps
----------
 t
(1 row)
```

☒☒

&&(geometry,box2df), &&(box2df,geometry), ~(geometry,box2df), ~(box2df,geometry), ~(box2df,box2df), @(geometry,box2df), @(box2df,geometry), @(box2df,box2df)

7.10.1.5 &&&

&&& — A ☒ n ☒☒☒☒☒☒☒☒ B ☒ n ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ TRUE ☒☒☒☒☒☒☒.

Synopsis

boolean **&&&**(geometry A , geometry B);

☒☒

&&& ☒☒☒☒☒☒☒ A ☒ n ☒☒☒☒☒☒☒☒☒☒ B ☒ n ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ TRUE ☒☒☒☒☒☒☒.

> **Note**
> ☒☒☒☒☒☒ (operand) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

⊠⊠: 3 ⊠⊠⊠⊠⊠⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 &&& tbl2.column2 AS overlaps_3d,
                                    tbl1.column2 && tbl2.column2 AS overlaps_2d
FROM ( VALUES
        (1, 'LINESTRING Z(0 0 1, 3 3 2)'::geometry),
        (2, 'LINESTRING Z(1 2 0, 0 5 -1)'::geometry)) AS tbl1,
( VALUES
        (3, 'LINESTRING Z(1 2 1, 4 6 1)'::geometry)) AS tbl2;

 column1 | column1 | overlaps_3d | overlaps_2d
---------+---------+-------------+-------------
       1 |       3 | t           | t
       2 |       3 | f           | t
```

⊠⊠: 3DM ⊠⊠⊠⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 &&& tbl2.column2 AS overlaps_3zm,
                                    tbl1.column2 && tbl2.column2 AS overlaps_2d
FROM ( VALUES
        (1, 'LINESTRING M(0 0 1, 3 3 2)'::geometry),
        (2, 'LINESTRING M(1 2 0, 0 5 -1)'::geometry)) AS tbl1,
( VALUES
        (3, 'LINESTRING M(1 2 1, 4 6 1)'::geometry)) AS tbl2;

 column1 | column1 | overlaps_3zm | overlaps_2d
---------+---------+-------------+-------------
       1 |       3 | t           | t
       2 |       3 | f           | t
```

⊠⊠

&&

7.10.1.6 &&&(geometry,gidx)

&&&(geometry,gidx) — Returns TRUE if a geometry's (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).

Synopsis

boolean **&&&**(geometry A , gidx B);

⊠⊠

The &&& operator returns TRUE if the cached n-D bounding box of geometry A intersects the n-D bounding box B, using float precision. This means that if B is a (double precision) box3d, it will be internally converted to a float precision 3D bounding box (GIDX)

Note
This operator is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_MakePoint(1,1,1) &&& ST_3DMakeBox(ST_MakePoint(0,0,0), ST_MakePoint(2,2,2)) AS ↩
    overlaps;

 overlaps
----------
 t
(1 row)
```

⊠⊠

&&&(gidx,geometry), &&&(gidx,gidx)

7.10.1.7 &&&(gidx,geometry)

&&&(gidx,geometry) — Returns TRUE if a n-D float precision bounding box (GIDX) intersects a geometry's (cached) n-D bounding box.

Synopsis

boolean **&&&**(gidx A , geometry B);

⊠⊠

The &&& operator returns TRUE if the n-D bounding box A intersects the cached n-D bounding box of geometry B, using float precision. This means that if A is a (double precision) box3d, it will be internally converted to a float precision 3D bounding box (GIDX)

Note
This operator is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_3DMakeBox(ST_MakePoint(0,0,0), ST_MakePoint(2,2,2)) &&& ST_MakePoint(1,1,1) AS ↩
    overlaps;

 overlaps
----------
 t
(1 row)
```

⊠⊠

&&&(geometry,gidx), &&&(gidx,gidx)

7.10.1.8 &&&(gidx,gidx)

&&&(gidx,gidx) — Returns TRUE if two n-D float precision bounding boxes (GIDX) intersect each other.

Synopsis

boolean **&&&**(gidx A , gidx B);

⊠⊠

The &&& operator returns TRUE if two n-D bounding boxes A and B intersect each other, using float precision. This means that if A (or B) is a (double precision) box3d, it will be internally converted to a float precision 3D bounding box (GIDX)

> **Note**
> This operator is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_3DMakeBox(ST_MakePoint(0,0,0), ST_MakePoint(2,2,2)) &&& ST_3DMakeBox(ST_MakePoint ↩
    (1,1,1), ST_MakePoint(3,3,3)) AS overlaps;

 overlaps
----------
 t
(1 row)
```

⊠⊠

&&&(geometry,gidx), &&&(gidx,geometry)

7.10.1.9 &<

&< — A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **&<**(geometry A , geometry B);

⊠⊠

&< ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 &< tbl2.column2 AS overleft
FROM
  ( VALUES
        (1, 'LINESTRING(1 2, 4 6)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING(0 0, 3 3)'::geometry),
        (3, 'LINESTRING(0 1, 0 5)'::geometry),
        (4, 'LINESTRING(6 0, 6 1)'::geometry)) AS tbl2;

 column1 | column1 | overleft
---------+---------+----------
       1 |       2 | f
       1 |       3 | f
       1 |       4 | t
(3 rows)
```

⊠⊠

&&, |&>, &>, &<|

7.10.1.10 &<|

&<| — A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **&<|**(geometry A , geometry B);

⊠⊠

&<| ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, TRUE ⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

Note
⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 &<| tbl2.column2 AS overbelow
FROM
  ( VALUES
        (1, 'LINESTRING(6 0, 6 4)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING(0 0, 3 3)'::geometry),
        (3, 'LINESTRING(0 1, 0 5)'::geometry),
        (4, 'LINESTRING(1 2, 4 6)'::geometry)) AS tbl2;

 column1 | column1 | overbelow
---------+---------+-----------
       1 |       2 | f
       1 |       3 | t
       1 |       4 | t
(3 rows)
```

⊠⊠

&&, |&>, &>, &<

7.10.1.11 &>

&> — A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **&>**(geometry A , geometry B);

⊠⊠

&> ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 &
> tbl2.column2 AS overright
FROM
  ( VALUES
        (1, 'LINESTRING(1 2, 4 6)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING(0 0, 3 3)'::geometry),
        (3, 'LINESTRING(0 1, 0 5)'::geometry),
        (4, 'LINESTRING(6 0, 6 1)'::geometry)) AS tbl2;

 column1 | column1 | overright
---------+---------+-----------
       1 |       2 | t
       1 |       3 | t
       1 |       4 | f
(3 rows)
```

⊠⊠

&&, |&>, &<|, &<

7.10.1.12 <<

<< — A ⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **<<**(geometry A , geometry B);

⊠⊠

<< ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 << tbl2.column2 AS left
FROM
  ( VALUES
        (1, 'LINESTRING (1 2, 1 5)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING (0 0, 4 3)'::geometry),
        (3, 'LINESTRING (6 0, 6 5)'::geometry),
        (4, 'LINESTRING (2 2, 5 6)'::geometry)) AS tbl2;

 column1 | column1 | left
---------+---------+------
           1 |       2 | f
           1 |       3 | t
           1 |       4 | t
(3 rows)
```

⊠⊠

>>, |>>, <<|

7.10.1.13 <<|

<<| — A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **<<|**(geometry A , geometry B);

⊠⊠

<<| ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 <<| tbl2.column2 AS below
FROM
  ( VALUES
        (1, 'LINESTRING (0 0, 4 3)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING (1 4, 1 7)'::geometry),
        (3, 'LINESTRING (6 1, 6 5)'::geometry),
        (4, 'LINESTRING (2 3, 5 6)'::geometry)) AS tbl2;

 column1 | column1 | below
---------+---------+-------
           1 |       2 | t
```

```
            1 |        3 | f
            1 |        4 | f
(3 rows)
```

⊠⊠

<<, >>, |>>

7.10.1.14 =

= — Returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B.

Synopsis

boolean **=**(geometry A , geometry B);
boolean **=**(geography A , geography B);

⊠⊠

The = operator returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B. PostgreSQL uses the =, <, and > operators defined for geometries to perform internal orderings and comparison of geometries (ie. in a GROUP BY or ORDER BY clause).

> **Note**
> Only geometry/geography that are exactly equal in all respects, with the same coordinates, in the same order, are considered equal by this operator. For ”spatial equality”, that ignores things like coordinate order, and can detect features that cover the same spatial area with different representations, use ST_OrderingEquals or ST_Equals

> **Caution**
> This operand will NOT make use of any indexes that may be available on the geometries. For an index assisted exact equality test, combine = with &&.

Changed: 2.4.0, in prior versions this was bounding box equality not a geometric equality. If you need bounding box equality, use ~= instead.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT 'LINESTRING(0 0, 0 1, 1 0)'::geometry = 'LINESTRING(1 1, 0 0)'::geometry;
 ?column?
----------
 f
(1 row)

SELECT ST_AsText(column1)
FROM ( VALUES
        ('LINESTRING(0 0, 1 1)'::geometry),
        ('LINESTRING(1 1, 0 0)'::geometry)) AS foo;
          st_astext
---------------------
 LINESTRING(0 0,1 1)
 LINESTRING(1 1,0 0)
(2 rows)

-- Note: the GROUP BY uses the ”=” to compare for geometry equivalency.
SELECT ST_AsText(column1)
FROM ( VALUES
        ('LINESTRING(0 0, 1 1)'::geometry),
        ('LINESTRING(1 1, 0 0)'::geometry)) AS foo
GROUP BY column1;
      st_astext
---------------------
 LINESTRING(0 0,1 1)
 LINESTRING(1 1,0 0)
(2 rows)

-- In versions prior to 2.0, this used to return true --
 SELECT ST_GeomFromText('POINT(1707296.37 4820536.77)') =
        ST_GeomFromText('POINT(1707296.27 4820536.87)') As pt_intersect;

--pt_intersect --
f
```

⊠⊠

ST_Equals, ST_OrderingEquals, ~=

7.10.1.15 >>

>> — A ⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **>>**(geometry A , geometry B);

⊠⊠

>> ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2
>
> tbl2.column2 AS right
FROM
  ( VALUES
        (1, 'LINESTRING (2 3, 5 6)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING (1 4, 1 7)'::geometry),
        (3, 'LINESTRING (6 1, 6 5)'::geometry),
        (4, 'LINESTRING (0 0, 4 3)'::geometry)) AS tbl2;

 column1 | column1 | right
---------+---------+-------
       1 |       2 | t
       1 |       3 | f
       1 |       4 | f
(3 rows)
```

⊠⊠

<<, |>>, <<|

7.10.1.16 @

@ — B ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **@**(geometry A , geometry B);

⊠⊠

@ ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 @ tbl2.column2 AS contained
FROM
  ( VALUES
        (1, 'LINESTRING (1 1, 3 3)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING (0 0, 4 4)'::geometry),
        (3, 'LINESTRING (2 2, 4 4)'::geometry),
        (4, 'LINESTRING (1 1, 3 3)'::geometry)) AS tbl2;

 column1 | column1 | contained
```

```
---------+---------+-----------
        1 |       2 | t
        1 |       3 | f
        1 |       4 | t
(3 rows)
```

□□

~, &&

7.10.1.17 @(geometry,box2df)

@(geometry,box2df) — Returns TRUE if a geometry's 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).

Synopsis

boolean @(geometry A , box2df B);

□□

The @ operator returns TRUE if the A geometry's 2D bounding box is contained the 2D bounding box B, using float precision. This means that if B is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

> **Note**
> This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

□□

```
SELECT ST_Buffer(ST_GeomFromText('POINT(2 2)'), 1) @ ST_MakeBox2D(ST_Point(0,0), ST_Point ←
    (5,5)) AS is_contained;

 is_contained
--------------
 t
(1 row)
```

□□

&&(geometry,box2df), &&(box2df,geometry), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,geometry
~(box2df,box2df), @(box2df,geometry), @(box2df,box2df)

7.10.1.18 @(box2df,geometry)

@(box2df,geometry) — Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.

Synopsis

boolean @(box2df A , geometry B);

☒☒

The @ operator returns TRUE if the 2D bounding box A is contained into the B geometry's 2D bounding box, using float precision. This means that if B is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

> **Note**
> This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

☒☒

```
SELECT ST_MakeBox2D(ST_Point(2,2), ST_Point(3,3)) @ ST_Buffer(ST_GeomFromText('POINT(1 1)') ↩
    , 10) AS is_contained;

 is_contained
--------------
 t
(1 row)
```

☒☒

&&(geometry,box2df), &&(box2df,geometry), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,geometry
~(box2df,box2df), @(geometry,box2df), @(box2df,box2df)

7.10.1.19 @(box2df,box2df)

@(box2df,box2df) — Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.

Synopsis

boolean @(box2df A , box2df B);

⊠⊠

The @ operator returns TRUE if the 2D bounding box A is contained into the 2D bounding box B, using float precision. This means that if A (or B) is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

> **Note**
> This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_MakeBox2D(ST_Point(2,2), ST_Point(3,3)) @ ST_MakeBox2D(ST_Point(0,0), ST_Point ↩
    (5,5)) AS is_contained;

 is_contained
--------------
 t
(1 row)
```

⊠⊠

&&(geometry,box2df), &&(box2df,geometry), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,geometry), ~(box2df,box2df), @(geometry,box2df), @(box2df,geometry)

7.10.1.20 |&>

|&> — A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **|&>**(geometry A , geometry B);

⊠⊠

|&> ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 |&
> tbl2.column2 AS overabove
FROM
  ( VALUES
        (1, 'LINESTRING(6 0, 6 4)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING(0 0, 3 3)'::geometry),
        (3, 'LINESTRING(0 1, 0 5)'::geometry),
        (4, 'LINESTRING(1 2, 4 6)'::geometry)) AS tbl2;

 column1 | column1 | overabove
---------+---------+-----------
       1 |       2 | t
       1 |       3 | f
       1 |       4 | f
(3 rows)
```

□□

&&, &>, &<|, &<

7.10.1.21 |>>

|>> — A □□□□□□□□□ B □□□□□□□□□□□□□ TRUE □□□□□□.

Synopsis

boolean **|>>**(geometry A , geometry B);

□□

The |>> operator returns TRUE if the bounding box of geometry A is strictly above the bounding box of geometry B.

> **Note**
> □□□□□ (operand) □□□□□□□□□□□□□□□□□□□□□□□□□.

□□

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 |>> tbl2.column2 AS above
FROM
  ( VALUES
        (1, 'LINESTRING (1 4, 1 7)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING (0 0, 4 2)'::geometry),
        (3, 'LINESTRING (6 1, 6 5)'::geometry),
        (4, 'LINESTRING (2 3, 5 6)'::geometry)) AS tbl2;

 column1 | column1 | above
```

```
---------+---------+-------
        1 |       2 | t
        1 |       3 | f
        1 |       4 | f
(3 rows)
```

□□

<<, >>, <<|

7.10.1.22 ~

~ — A □□□□□□ B □□□□□□□□□□□□ TRUE □□□□□□.

Synopsis

boolean **~**(geometry A , geometry B);

□□

~ □□□□□□ A □□□□□□□□ B □□□□□□□□□□□□□□□ TRUE □□□□□□.

> **Note**
> □□□□□ (operand) □□□□□□□□□□□□□□□□□□□□□□□□□.

□□

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 ~ tbl2.column2 AS contains
FROM
  ( VALUES
        (1, 'LINESTRING (0 0, 3 3)'::geometry)) AS tbl1,
  ( VALUES
        (2, 'LINESTRING (0 0, 4 4)'::geometry),
        (3, 'LINESTRING (1 1, 2 2)'::geometry),
        (4, 'LINESTRING (0 0, 3 3)'::geometry)) AS tbl2;

 column1 | column1 | contains
---------+---------+----------
        1 |       2 | f
        1 |       3 | t
        1 |       4 | t
(3 rows)
```

□□

@, &&

7.10.1.23 ~(geometry,box2df)

~(geometry,box2df) — Returns TRUE if a geometry's 2D bonding box contains a 2D float precision bounding box (GIDX).

Synopsis

boolean **~**(geometry A , box2df B);

⊠⊠

The ~ operator returns TRUE if the 2D bounding box of a geometry A contains the 2D bounding box B, using float precision. This means that if B is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

> **Note**
> This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_Buffer(ST_GeomFromText('POINT(1 1)'), 10) ~ ST_MakeBox2D(ST_Point(0,0), ST_Point ↩
    (2,2)) AS contains;

 contains
----------
 t
(1 row)
```

⊠⊠

&&(geometry,box2df), &&(box2df,geometry), &&(box2df,box2df), ~(box2df,geometry), ~(box2df,box2df), @(geometry,box2df), @(box2df,geometry), @(box2df,box2df)

7.10.1.24 ~(box2df,geometry)

~(box2df,geometry) — Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bonding box.

Synopsis

boolean **~**(box2df A , geometry B);

⊠⊠

The ~ operator returns TRUE if the 2D bounding box A contains the B geometry's bounding box, using float precision. This means that if A is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

Note
This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_MakeBox2D(ST_Point(0,0), ST_Point(5,5)) ~ ST_Buffer(ST_GeomFromText('POINT(2 2)') ↩
    , 1) AS contains;

 contains
----------
 t
(1 row)
```

⊠⊠

&&(geometry,box2df), &&(box2df,geometry), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,box2df), @(geometry,box2df), @(box2df,geometry), @(box2df,box2df)

7.10.1.25 ~(box2df,box2df)

~(box2df,box2df) — Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).

Synopsis

boolean **~**(box2df A , box2df B);

⊠⊠

The ~ operator returns TRUE if the 2D bounding box A contains the 2D bounding box B, using float precision. This means that if A is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

Note
This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

⊠⊠

```
SELECT ST_MakeBox2D(ST_Point(0,0), ST_Point(5,5)) ~ ST_MakeBox2D(ST_Point(2,2), ST_Point ↵
    (3,3)) AS contains;

 contains
----------
 t
(1 row)
```

⊠⊠

&&(geometry,box2df), &&(box2df,geometry), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,geometry), @(geometry,box2df), @(box2df,geometry), @(box2df,box2df)

7.10.1.26 ~=

~= — A ⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **~=**(geometry A , geometry B);

⊠⊠

~= ⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports Polyhedral surfaces.

> **Warning**
> This operator has changed behavior in PostGIS 1.5 from testing for actual geometric equality to only checking for bounding box equality. To complicate things it also depends on if you have done a hard or soft upgrade which behavior your database has. To find out which behavior your database has you can run the query below. To check for true equality use ST_OrderingEquals or ST_Equals.

⊠⊠

```
select 'LINESTRING(0 0, 1 1)'::geometry ~= 'LINESTRING(0 1, 1 0)'::geometry as equality;
 equality   |
-----------------+
          t    |
```

⊠⊠

ST_Equals, ST_OrderingEquals, =

7.10.2 ⊠⊠⊠ (operator)

7.10.2.1 <->

<-> — A ⊠ B ⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

double precision **<->**(geometry A , geometry B);
double precision **<->**(geography A , geography B);

⊠⊠

<-> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ”ORDER BY” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (index-assisted) ⊠⊠⊠ (nearest neighbor) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, 9.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (distance sphere) ⊠⊠⊠⊠⊠⊠⊠⊠ KNN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠ GiST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ORDER BY ⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ a.geom ⊠⊠⊠⊠’SRID=3005;POINT(1011102 450541)’::geometry ⊠⊠⊠, (⊠⊠⊠⊠⊠/CTE(common table expression) ⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ OpenGeo workshop: Nearest-Neighbour Searching ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠ -- PostgreSQL 9.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ KNN(”K nearest neighbor”) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ KNN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠ -- PostgreSQL 9.5 ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Hybrid syntax) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS 2.2 ⊠⊠, PostgreSQL 9.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ KNN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□

```
SELECT ST_Distance(geom, 'SRID=3005;POINT(1011102 450541)'::geometry) as d,edabbr, vaabbr
FROM va2005
ORDER BY d limit 10;

        d         | edabbr | vaabbr
------------------+--------+--------
                0 | ALQ    | 128
 5541.57712511724 | ALQ    | 129A
 5579.67450712005 | ALQ    | 001
  6083.4207708641 | ALQ    | 131
  7691.2205404848 | ALQ    | 003
 7900.75451037313 | ALQ    | 122
 8694.20710669982 | ALQ    | 129B
 9564.24289057111 | ALQ    | 130
  12089.665931705 | ALQ    | 127
 18472.5531479404 | ALQ    | 002
(10 rows)
```

□□□ KNN □□□□□□□□□:

```
SELECT st_distance(geom, 'SRID=3005;POINT(1011102 450541)'::geometry) as d,edabbr, vaabbr
FROM va2005
ORDER BY geom <-> 'SRID=3005;POINT(1011102 450541)'::geometry limit 10;

        d         | edabbr | vaabbr
------------------+--------+--------
                0 | ALQ    | 128
 5541.57712511724 | ALQ    | 129A
 5579.67450712005 | ALQ    | 001
  6083.4207708641 | ALQ    | 131
  7691.2205404848 | ALQ    | 003
 7900.75451037313 | ALQ    | 122
 8694.20710669982 | ALQ    | 129B
 9564.24289057111 | ALQ    | 130
  12089.665931705 | ALQ    | 127
 18472.5531479404 | ALQ    | 002
(10 rows)
```

□□□□□□□□□□□”EXPLAIN ANALYZE” □□□□□□□□□□□□□□□□□□□□□□□□□□.

PostgreSQL 9.5 □□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□ KNN □□□□ CTE(common table expression) □□□□□□□, □□□□□□□□□□□ □□□□□□□□□□□□:

```
WITH index_query AS (
  SELECT ST_Distance(geom, 'SRID=3005;POINT(1011102 450541)'::geometry) as d,edabbr, vaabbr
        FROM va2005
  ORDER BY geom <-> 'SRID=3005;POINT(1011102 450541)'::geometry LIMIT 100)
  SELECT *
        FROM index_query
  ORDER BY d limit 10;

        d         | edabbr | vaabbr
------------------+--------+--------
                0 | ALQ    | 128
 5541.57712511724 | ALQ    | 129A
 5579.67450712005 | ALQ    | 001
  6083.4207708641 | ALQ    | 131
  7691.2205404848 | ALQ    | 003
```

```
 7900.75451037313 | ALQ    | 122
 8694.20710669982 | ALQ    | 129B
 9564.24289057111 | ALQ    | 130
  12089.665931705 | ALQ    | 127
 18472.5531479404 | ALQ    | 002
(10 rows)
```

⊠⊠

ST_DWithin, ST_Distance, <#>

7.10.2.2 |=|

|=| — A ⊠ B ⊠⊠⊠⊠⊠⊠⊠ (closest point of approach) ⊠⊠⊠⊠⊠ (trajectory) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

double precision **|=|**(geometry A , geometry B);

⊠⊠

|=| ⊠⊠⊠⊠⊠⊠⊠ (ST_IsValidTrajectory ⊠⊠) ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_DistanceCPA ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (PostgreSQL 9.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠) N ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (nearest neightbor) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ N ⊠⊠ GiST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ORDER BY ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ a.geom ⊠⊠⊠⊠’SRID=3005;LINESTRINGM(0 0 0,0 0 1)’::geometry ⊠⊠⊠, (⊠⊠⊠⊠/CTE(common table expression) ⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (index-supported) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- Save a literal query trajectory in a psql variable...
\set qt 'ST_AddMeasure(ST_MakeLine(ST_MakePointM(-350,300,0),ST_MakePointM(-410,490,0)) ↩
    ,10,20)'
-- Run the query !
SELECT track_id, dist FROM (
  SELECT track_id, ST_DistanceCPA(tr,:qt) dist
  FROM trajectories
  ORDER BY tr |=| :qt
```

```
  LIMIT 5
) foo;
 track_id        dist
----------+-------------------
      395 | 0.576496831518066
      380 |  5.06797130410151
      390 |  7.72262293958322
      385 |   9.8004461358071
      405 |  10.9534397988433
(5 rows)
```

⊠⊠

ST_DistanceCPA, ST_ClosestPointOfApproach, ST_IsValidTrajectory

7.10.2.3 <#>

<#> — A ⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

double precision **<#>**(geometry A , geometry B);

⊠⊠

<#> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (floating point) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ (PostgreSQL 9.1 ⊠ ⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ORDER BY ⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ g1.geom <#> ⊠⊠⊠⊠ ORDER BY (ST_GeomFromText('POINT(1 2)') <#> geom) ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.1 ⊠⊠⊠⊠⊠⊠⊠ KNN ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT *
FROM (
SELECT b.tlid, b.mtfcc,
        b.geom <#
> ST_GeomFromText('LINESTRING(746149 2948672,745954 2948576,
                745787 2948499,745740 2948468,745712 2948438,
                745690 2948384,745677 2948319)',2249) As b_dist,
```

```
                ST_Distance(b.geom, ST_GeomFromText('LINESTRING(746149 2948672,745954  ↩
                    2948576,
                745787 2948499,745740 2948468,745712 2948438,
                745690 2948384,745677 2948319)',2249)) As act_dist
    FROM bos_roads As b
    ORDER BY b_dist, b.tlid
    LIMIT 100) As foo
    ORDER BY act_dist, tlid LIMIT 10;

   tlid    | mtfcc |      b_dist      |     act_dist
-----------+-------+------------------+------------------
  85732027 | S1400 |                0 |                0
  85732029 | S1400 |                0 |                0
  85732031 | S1400 |                0 |                0
  85734335 | S1400 |                0 |                0
  85736037 | S1400 |                0 |                0
 624683742 | S1400 |                0 | 128.528874268666
  85719343 | S1400 | 260.839270432962 | 260.839270432962
  85741826 | S1400 | 164.759294123275 | 260.839270432962
  85732032 | S1400 |           277.75 | 311.830282365264
  85735592 | S1400 |           222.25 | 311.830282365264
(10 rows)
```

☒☒

ST_DWithin, ST_Distance, <->

7.10.2.4 <<->>

<<->> — Returns the n-D distance between the A and B geometries or bounding boxes

Synopsis

double precision **<<->>**(geometry A , geometry B);

☒☒

<<->> ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ N ☒ (☒☒☒☒☒) ☒☒☒☒☒☒☒☒☒☒. ☒☒☒ ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

> **Note**
> ☒☒☒☒☒☒ (operand) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ N ☒☒ GiST ☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒ ORDER BY ☒☒☒.

> **Note**
> ☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒ a.geom ☒☒☒☒☒’SRID=3005;POINT(1011102 450541)’::geometry ☒☒☒☒, (☒☒☒☒☒/CTE(common table expression) ☒☒☒☒☒☒☒) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. PostgreSQL 9.1 ☒☒☒☒☒☒☒☒ KNN ☒☒☒☒☒☒☒☒.

⊠⊠

<->

7.11 Spatial Relationships

7.11.1 Topological Relationships

7.11.1.1 ST_3DIntersects

ST_3DIntersects — Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)

Synopsis

boolean **ST_3DIntersects**(geometry geomA , geometry geomB);

⊠⊠

Overlaps, Touches, Within all imply spatial intersection. If any of the aforementioned returns true, then the geometries also spatially intersect. Disjoint implies false for spatial intersection.

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.

> **Note**
> Because of floating robustness failures, geometries don't always intersect as you'd expect them to after geometric processing. For example the closest point on a linestring to a geometry may not lie on the linestring. For these kind of issues where a distance of a centimeter you want to just consider as intersecting, use ST_3DDWithin.

Changed: 3.0.0 SFCGAL backend removed, GEOS backend supports TINs.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1

⊠⊠⊠⊠

```
SELECT ST_3DIntersects(pt, line), ST_Intersects(pt, line)
  FROM (SELECT 'POINT(0 0 2)'::geometry As pt, 'LINESTRING (0 0 1, 0 2 3)'::geometry As ↩
      line) As foo;
 st_3dintersects | st_intersects
-----------------+---------------
 f               | t
(1 row)
```

TIN Examples

```
SELECT ST_3DIntersects('TIN(((0 0 0,1 0 0,0 1 0,0 0 0)))'::geometry, 'POINT(.1 .1 0)':: ↩
    geometry);
 st_3dintersects
-----------------
 t
```

⊠⊠

ST_3DDWithin, ST_Intersects

7.11.1.2 ST_Contains

ST_Contains — Tests if every point of B lies in A, and their interiors have a point in common

Synopsis

boolean **ST_Contains**(geometry geomA, geometry geomB);

⊠⊠

Returns TRUE if geometry A contains geometry B. A contains B if and only if all points of B lie inside (i.e. in the interior or boundary of) A (or equivalently, no points of B lie in the exterior of A), and the interiors of A and B have at least one point in common.

In mathematical terms: $ST\_Contains(A, B) \Leftrightarrow (A \cap B = B) \wedge (Int(A) \cap Int(B) \neq \emptyset)$

The contains relationship is reflexive: every geometry contains itself. (In contrast, in the ST_ContainsProper predicate a geometry does *not* properly contain itself.) The relationship is antisymmetric: if `ST_Contains(A,` `= true` and `ST_Contains(B,A) = true`, then the two geometries must be topologically equal (`ST_Equals(A,` `= true`).

ST_Contains is the converse of ST_Within. So, `ST_Contains(A,B) = ST_Within(B,A)`.

> **Note**
> Because the interiors must have a common point, a subtlety of the definition is that polygons and lines do *not* contain lines and points lying fully in their boundary. For further details see Subtleties of OGC Covers, Contains, Within. The ST_Covers predicate provides a more inclusive relationship.

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_Contains`.

GEOS ⊠⊠⊠⊠⊠

Enhanced: 2.3.0 Enhancement to PIP short-circuit extended to support MultiPoints with few points. Prior versions only supported point in polygon.

> **Important**
> Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

> **Important**
> Do not use this function with invalid geometries. You will get unexpected results.

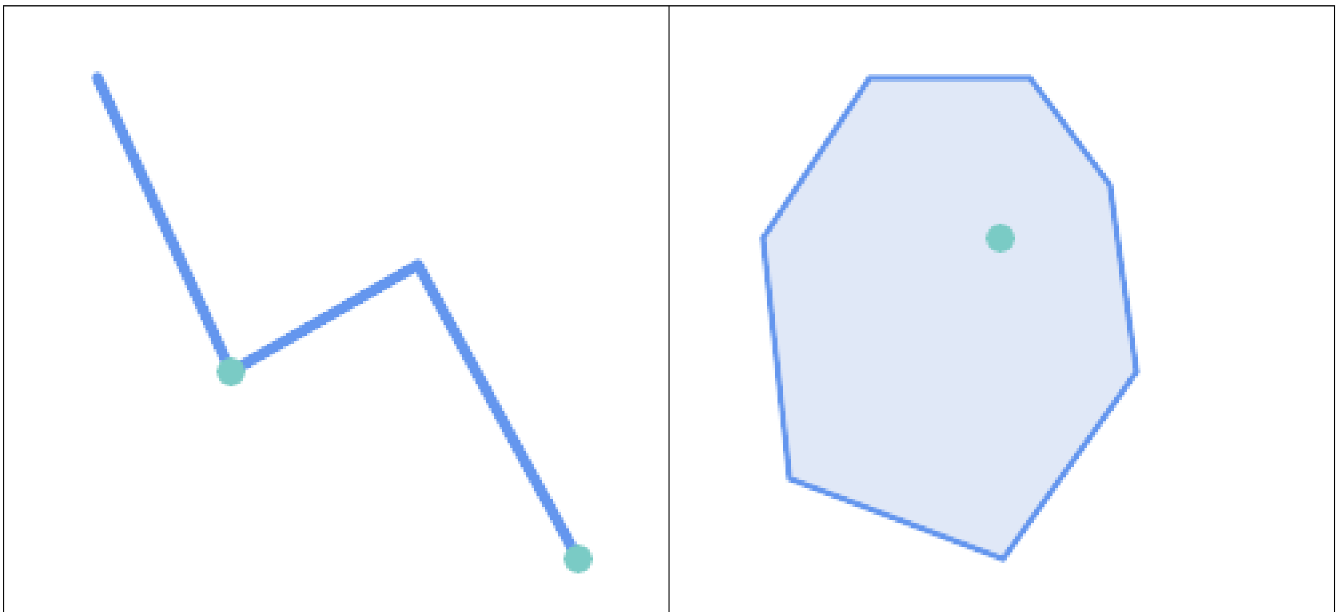
NOTE: this is the "allowable" version that returns a boolean, not an integer.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3 - same as within(geometry B, geometry A)

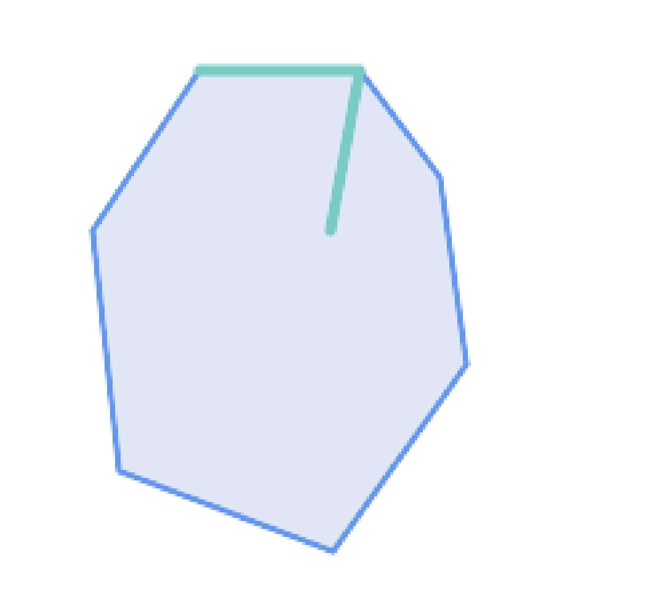
This method implements the SQL/MM specification. SQL-MM 3: 5.1.31

⊠⊠

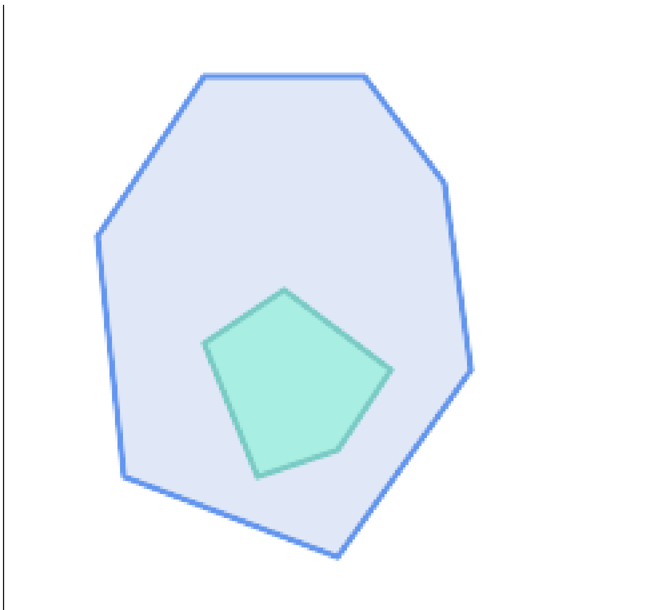
`ST_Contains` returns `TRUE` in the following situations:



LINESTRING / MULTIPOINT | *POLYGON / POINT*

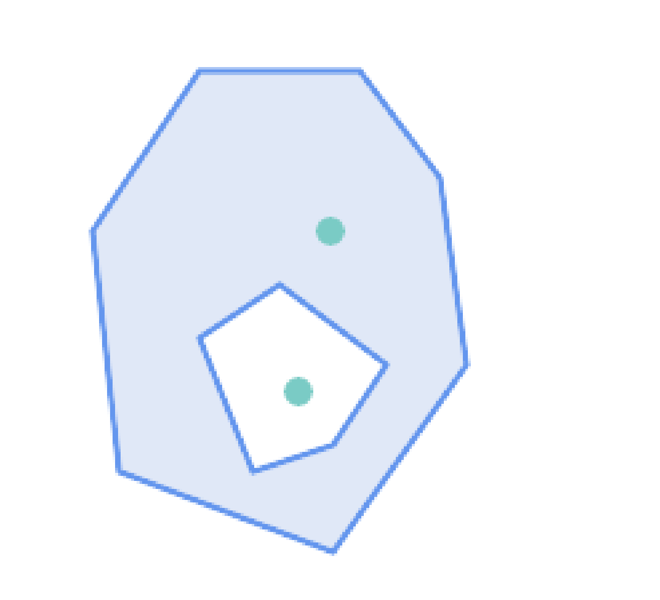


POLYGON / LINESTRING

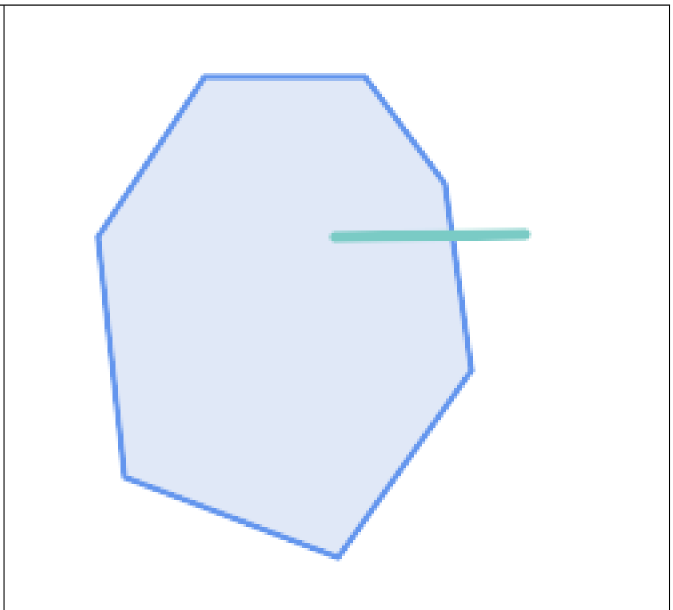


POLYGON / POLYGON

`ST_Contains` returns `FALSE` in the following situations:



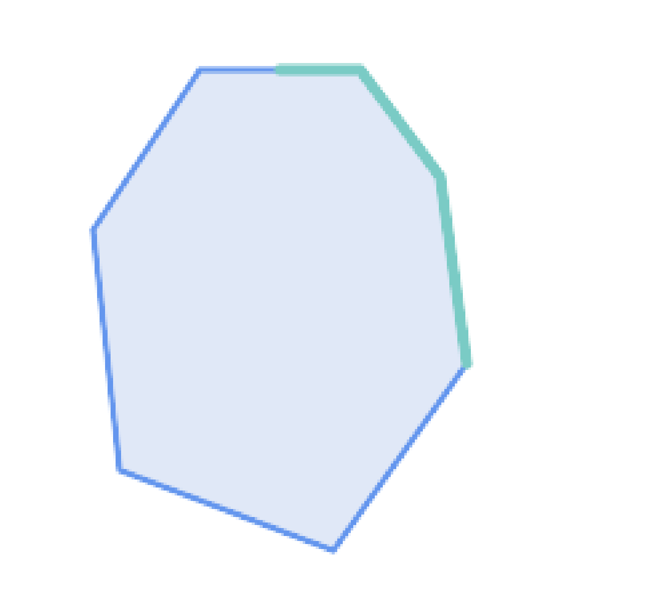
POLYGON / MULTIPOINT



POLYGON / LINESTRING

Due to the interior intersection condition `ST_Contains` returns `FALSE` in the following situations (whereas `ST_Covers` returns `TRUE`):


LINESTRING / POINT


POLYGON / LINESTRING

```
-- A circle within a circle
SELECT ST_Contains(smallc, bigc) As smallcontainsbig,
     ST_Contains(bigc,smallc) As bigcontainssmall,
     ST_Contains(bigc, ST_Union(smallc, bigc)) as bigcontainsunion,
     ST_Equals(bigc, ST_Union(smallc, bigc)) as bigisunion,
     ST_Covers(bigc, ST_ExteriorRing(bigc)) As bigcoversexterior,
     ST_Contains(bigc, ST_ExteriorRing(bigc)) As bigcontainsexterior
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 2)'), 10) As smallc,
       ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As bigc) As foo;

-- Result
  smallcontainsbig | bigcontainssmall | bigcontainsunion | bigisunion | bigcoversexterior | ↩
      bigcontainsexterior
------------------+------------------+------------------+------------+-------------------+----------

 f                | t                | t                | t          | t          | f

-- Example demonstrating difference between contains and contains properly
SELECT ST_GeometryType(geomA) As geomtype, ST_Contains(geomA,geomA) AS acontainsa,  ↩
    ST_ContainsProperly(geomA, geomA) AS acontainspropa,
   ST_Contains(geomA, ST_Boundary(geomA)) As acontainsba, ST_ContainsProperly(geomA,  ↩
       ST_Boundary(geomA)) As acontainspropba
FROM (VALUES ( ST_Buffer(ST_Point(1,1), 5,1) ),
       ( ST_MakeLine(ST_Point(1,1), ST_Point(-1,-1) ) ),
       ( ST_Point(1,1) )
    ) As foo(geomA);

  geomtype    | acontainsa | acontainspropa | acontainsba | acontainspropba
--------------+------------+----------------+-------------+-----------------
ST_Polygon    | t          | f              | f           | f
ST_LineString | t          | f              | f           | f
ST_Point      | t          | t              | f           | f
```

⊠⊠

ST_Boundary, ST_ContainsProperly, ST_Covers, ST_CoveredBy, ST_Equals, ST_Within

7.11.1.3 ST_ContainsProperly

ST_ContainsProperly — Tests if every point of B lies in the interior of A

Synopsis

boolean **ST_ContainsProperly**(geometry geomA, geometry geomB);

⊠⊠

Returns `true` if every point of B lies in the interior of A (or equivalently, no point of B lies in the the boundary or exterior of A).

In mathematical terms: $ST\_ContainsProperly(A, B) \Leftrightarrow Int(A) \cap B = B$

A contains B properly if the DE-9IM Intersection Matrix for the two geometries matches [T**FF*FF*]

A does not properly contain itself, but does contain itself.

A use for this predicate is computing the intersections of a set of geometries with a large polygonal geometry. Since intersection is a fairly slow operation, it can be more efficient to use containsProperly to filter out test geometries which lie fully inside the area. In these cases the intersection is known a priori to be exactly the original test geometry.

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_ContainsProperly`.

> **Note**
> The advantage of this predicate over ST_Contains and ST_Intersects is that it can be computed more efficiently, with no need to compute topology at individual points.

GEOS ⊠⊠⊠⊠⊠

1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Important**
> Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

> **Important**
> Do not use this function with invalid geometries. You will get unexpected results.

□□

```
--a circle within a circle
  SELECT ST_ContainsProperly(smallc, bigc) As smallcontainspropbig,
  ST_ContainsProperly(bigc,smallc) As bigcontainspropsmall,
  ST_ContainsProperly(bigc, ST_Union(smallc, bigc)) as bigcontainspropunion,
  ST_Equals(bigc, ST_Union(smallc, bigc)) as bigisunion,
  ST_Covers(bigc, ST_ExteriorRing(bigc)) As bigcoversexterior,
  ST_ContainsProperly(bigc, ST_ExteriorRing(bigc)) As bigcontainsexterior
  FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 2)'), 10) As smallc,
  ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As bigc) As foo;
  --Result
  smallcontainspropbig | bigcontainspropsmall | bigcontainspropunion | bigisunion |  ↩
      bigcoversexterior | bigcontainsexterior
------------------+------------------+------------------+------------+-------------------+----------

 f                    | t                    | f                    | t          | t  ↩
                    | f

 --example demonstrating difference between contains and contains properly
 SELECT ST_GeometryType(geomA) As geomtype, ST_Contains(geomA,geomA) AS acontainsa,  ↩
     ST_ContainsProperly(geomA, geomA) AS acontainspropa,
 ST_Contains(geomA, ST_Boundary(geomA)) As acontainsba, ST_ContainsProperly(geomA,  ↩
     ST_Boundary(geomA)) As acontainspropba
 FROM (VALUES ( ST_Buffer(ST_Point(1,1), 5,1) ),
      ( ST_MakeLine(ST_Point(1,1), ST_Point(-1,-1) ) ),
      ( ST_Point(1,1) )
  ) As foo(geomA);

  geomtype    | acontainsa | acontainspropa | acontainsba | acontainspropba
--------------+------------+----------------+-------------+-----------------
ST_Polygon    | t          | f              | f           | f
ST_LineString | t          | f              | f           | f
ST_Point      | t          | t              | f           | f
```

□□

ST_GeometryType, ST_Boundary, ST_Contains, ST_Covers, ST_CoveredBy, ST_Equals, ST_Relate, ST_Withi

7.11.1.4 ST_CoveredBy

ST_CoveredBy — Tests if every point of A lies in B

Synopsis

boolean **ST_CoveredBy**(geometry geomA, geometry geomB);
boolean **ST_CoveredBy**(geography geogA, geography geogB);

□□

Returns `true` if every point in Geometry/Geography A lies inside (i.e. intersects the interior or boundary of) Geometry/Geography B. Equivalently, tests that no point of A lies outside (in the exterior of) B.

In mathematical terms: *ST_CoveredBy(A, B) ⇔ A □ B = A*

ST_CoveredBy is the converse of ST_Covers. So, `ST_CoveredBy(A,B) = ST_Covers(B,A)`.

Generally this function should be used instead of ST_Within, since it has a simpler definition which does not have the quirk that ”boundaries are not within their geometry”.

Note
This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_CoveredBy`.

Important
Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

Important
Do not use this function with invalid geometries. You will get unexpected results.

GEOS ☒☒☒☒☒

1.2.2 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

NOTE: this is the ”allowable” version that returns a boolean, not an integer.

Not an OGC standard, but Oracle has it too.

☒☒

```
--a circle coveredby a circle
SELECT ST_CoveredBy(smallc,smallc) As smallinsmall,
  ST_CoveredBy(smallc, bigc) As smallcoveredbybig,
  ST_CoveredBy(ST_ExteriorRing(bigc), bigc) As exteriorcoveredbybig,
  ST_Within(ST_ExteriorRing(bigc),bigc) As exeriorwithinbig
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 2)'), 10) As smallc,
  ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As bigc) As foo;
  --Result
 smallinsmall | smallcoveredbybig | exteriorcoveredbybig | exeriorwithinbig
--------------+-------------------+----------------------+------------------
 t            | t                 | t                    | f
(1 row)
```

☒☒

ST_Contains, ST_Covers, ST_ExteriorRing, ST_Within

7.11.1.5 ST_Covers

ST_Covers — Tests if every point of B lies in A

Synopsis

boolean **ST_Covers**(geometry geomA, geometry geomB);
boolean **ST_Covers**(geography geogpolyA, geography geogpointB);

□□

Returns `true` if every point in Geometry/Geography B lies inside (i.e. intersects the interior or boundary of) Geometry/Geography A. Equivalently, tests that no point of B lies outside (in the exterior of) A.

In mathematical terms: *ST_Covers(A, B) ⇔ A □ B = B*

ST_Covers is the converse of ST_CoveredBy. So, `ST_Covers(A,B) = ST_CoveredBy(B,A)`.

Generally this function should be used instead of ST_Contains, since it has a simpler definition which does not have the quirk that "geometries do not contain their boundary".

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_Covers`.

> **Important**
> Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

> **Important**
> Do not use this function with invalid geometries. You will get unexpected results.

GEOS □□□□□□

Enhanced: 2.4.0 Support for polygon in polygon and line in polygon added for geography type

Enhanced: 2.3.0 Enhancement to PIP short-circuit for geometry extended to support MultiPoints with few points. Prior versions only supported point in polygon.

1.5.0 □□□□□□□□□□□□□□.

1.2.2 □□□□□□□□□□□□□.

NOTE: this is the "allowable" version that returns a boolean, not an integer.

Not an OGC standard, but Oracle has it too.

□□

Geometry example

```
--a circle covering a circle
SELECT ST_Covers(smallc,smallc) As smallinsmall,
  ST_Covers(smallc, bigc) As smallcoversbig,
  ST_Covers(bigc, ST_ExteriorRing(bigc)) As bigcoversexterior,
  ST_Contains(bigc, ST_ExteriorRing(bigc)) As bigcontainsexterior
```

```
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 2)'), 10) As smallc,
  ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As bigc) As foo;
  --Result
 smallinsmall | smallcoversbig | bigcoversexterior | bigcontainsexterior
--------------+----------------+-------------------+---------------------
 t            | f              | t                 | f
(1 row)
```

Geeography Example

```
-- a point with a 300 meter buffer compared to a point, a point and its 10 meter buffer
SELECT ST_Covers(geog_poly, geog_pt) As poly_covers_pt,
  ST_Covers(ST_Buffer(geog_pt,10), geog_pt) As buff_10m_covers_cent
  FROM (SELECT ST_Buffer(ST_GeogFromText('SRID=4326;POINT(-99.327 31.4821)'), 300) As ⤶
     geog_poly,
        ST_GeogFromText('SRID=4326;POINT(-99.33 31.483)') As geog_pt ) As foo;

 poly_covers_pt | buff_10m_covers_cent
----------------+------------------
 f              | t
```

☒☒

ST_Contains, ST_CoveredBy, ST_Within

7.11.1.6 ST_Crosses

ST_Crosses — Tests if two geometries have some, but not all, interior points in common

Synopsis

boolean **ST_Crosses**(geometry g1, geometry g2);

☒☒

Compares two geometry objects and returns `true` if their intersection "spatially crosses"; that is, the geometries have some, but not all interior points in common. The intersection of the interiors of the geometries must be non-empty and must have dimension less than the maximum dimension of the two input geometries, and the intersection of the two geometries must not equal either geometry. Otherwise, it returns `false`. The crosses relation is symmetric and irreflexive.

In mathematical terms: *ST_Crosses(A, B) ⇔ (dim(Int(A) ⋂ Int(B)) < max(dim(Int(A)), dim(Int(B)))) ∧ (A ⋂ B ≠ A) ∧ (A ⋂ B ≠ B)*

Geometries cross if their DE-9IM Intersection Matrix matches:

- `T*T******` for Point/Line, Point/Area, and Line/Area situations
- `T*****T**` for Line/Point, Area/Point, and Area/Line situations
- `0********` for Line/Line situations
- the result is `false` for Point/Point and Area/Area situations

> **Note**
> The OpenGIS Simple Features Specification defines this predicate only for Point/Line, Point/Area, Line/Line, and Line/Area situations. JTS / GEOS extends the definition to apply to Line/Point, Area/Point and Area/Line situations as well. This makes the relation symmetric.

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.

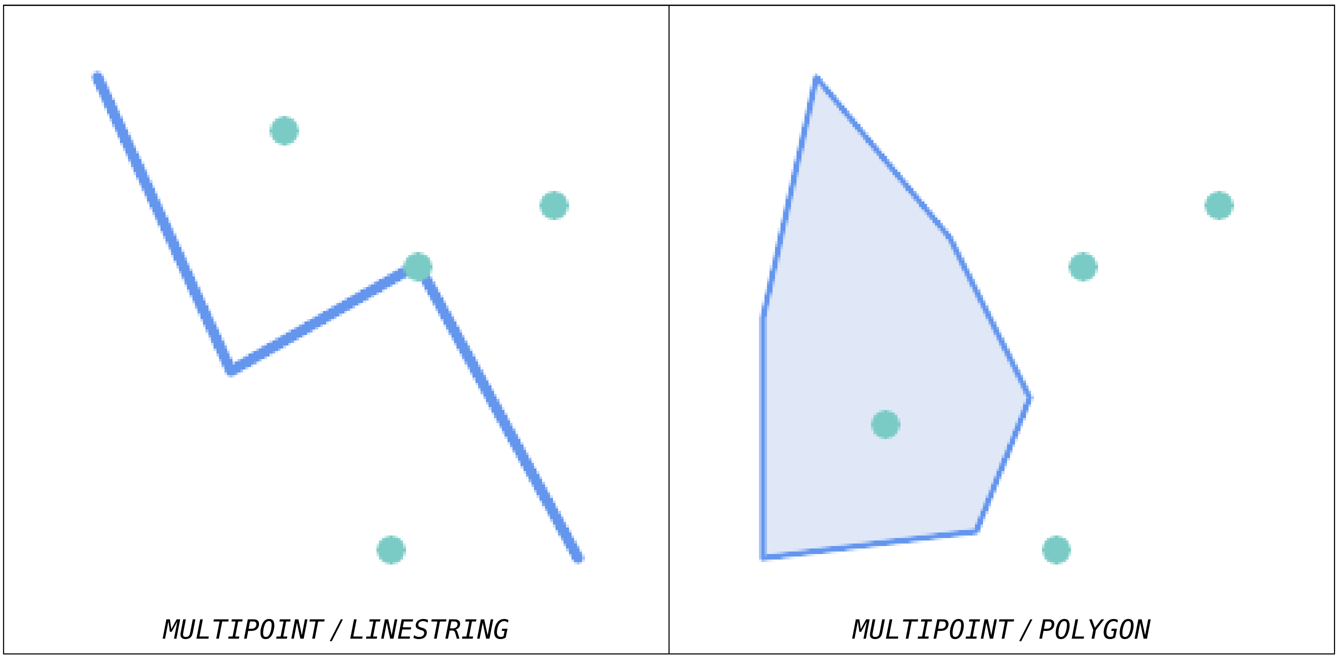
> **Important**
> Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

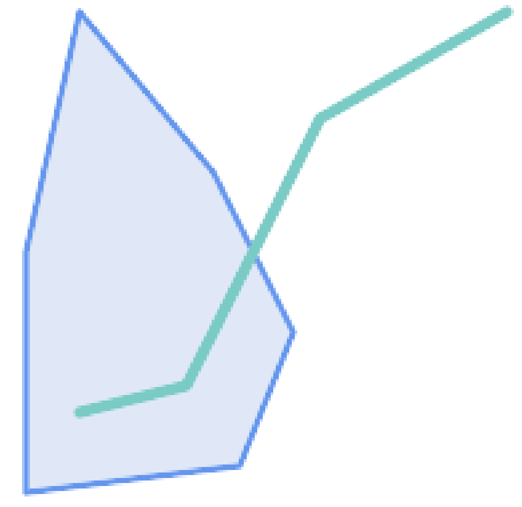
This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.13.3

This method implements the SQL/MM specification. SQL-MM 3: 5.1.29

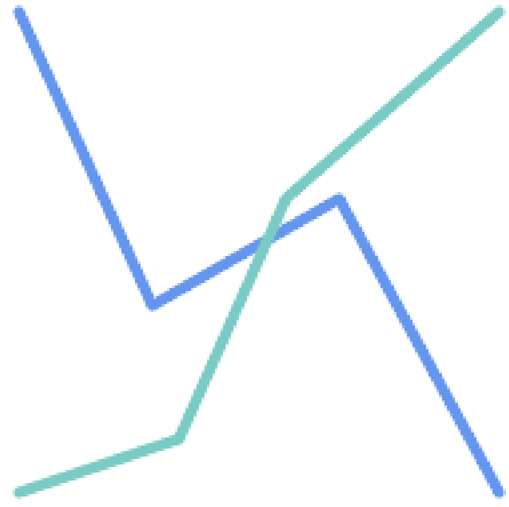
⊠⊠

The following situations all return `true`.





LINESTRING / POLYGON



LINESTRING / LINESTRING

Consider a situation where a user has two tables: a table of roads and a table of highways.

```
CREATE TABLE roads (
  id serial NOT NULL,
  geom geometry,
  CONSTRAINT roads_pkey PRIMARY KEY ( ↩
     road_id)
);
```

```
CREATE TABLE highways (
  id serial NOT NULL,
  the_gem geometry,
  CONSTRAINT roads_pkey PRIMARY KEY ( ↩
     road_id)
);
```

To determine a list of roads that cross a highway, use a query similar to:

```
SELECT roads.id
FROM roads, highways
WHERE ST_Crosses(roads.geom, highways.geom);
```

☒☒

ST_Contains, ST_Overlaps

7.11.1.7 ST_Disjoint

ST_Disjoint — Tests if two geometries have no points in common

Synopsis

boolean **ST_Disjoint**(geometry A , geometry B);

⊠⊠

Returns `true` if two geometries are disjoint. Geometries are disjoint if they have no point in common.

If any other spatial relationship is true for a pair of geometries, they are not disjoint. Disjoint implies that ST_Intersects is false.

In mathematical terms: *ST_Disjoint(A, B) ⇔ A □ B = □*

> **Important**
> Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

GEOS ⊠⊠⊠⊠⊠

> **Note**
> This function call does not use indexes. A negated ST_Intersects predicate can be used as a more performant alternative that uses indexes: `ST_Disjoint(A,B) = NOT ST_Intersects(A,B)`

> **Note**
> NOTE: this is the "allowable" version that returns a boolean, not an integer.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 //s2.1.13.3 - a.Relate(b, 'FF*FF****')

This method implements the SQL/MM specification. SQL-MM 3: 5.1.26

⊠⊠

```
SELECT ST_Disjoint('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )'::geometry);
 st_disjoint
---------------
 t
(1 row)
SELECT ST_Disjoint('POINT(0 0)'::geometry, 'LINESTRING ( 0 0, 0 2 )'::geometry);
 st_disjoint
---------------
 f
(1 row)
```

⊠⊠

ST_Intersects

7.11.1.8 ST_Equals

ST_Equals — Tests if two geometries include the same set of points

Synopsis

boolean **ST_Equals**(geometry A, geometry B);

⊠⊠

Returns `true` if the given geometries are "topologically equal". Use this for a 'better' answer than '='. Topological equality means that the geometries have the same dimension, and their point-sets occupy the same space. This means that the order of vertices may be different in topologically equal geometries. To verify the order of points is consistent use ST_OrderingEquals (it must be noted ST_OrderingEquals is a little more stringent than simply verifying order of points are the same).

In mathematical terms: *ST_Equals(A, B) ⇔ A = B*

The following relation holds: *ST_Equals(A, B) ⇔ ST_Within(A,B) ∧ ST_Within(B,A)*

> **Important**
> Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2

This method implements the SQL/MM specification. SQL-MM 3: 5.1.24

Changed: 2.2.0 Returns true even for invalid geometries if they are binary equal

⊠⊠

```
SELECT ST_Equals(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
    ST_GeomFromText('LINESTRING(0 0, 5 5, 10 10)'));
 st_equals
-----------
 t
(1 row)

SELECT ST_Equals(ST_Reverse(ST_GeomFromText('LINESTRING(0 0, 10 10)')),
    ST_GeomFromText('LINESTRING(0 0, 5 5, 10 10)'));
 st_equals
-----------
 t
(1 row)
```

⊠⊠

ST_IsValid, ST_OrderingEquals, ST_Reverse, ST_Within

7.11.1.9 ST_Intersects

ST_Intersects — Tests if two geometries intersect (they have at least one point in common)

Synopsis

boolean **ST_Intersects**(geometry geomA , geometry geomB);
boolean **ST_Intersects**(geography geogA , geography geogB);

⊠⊠

Returns `true` if two geometries intersect. Geometries intersect if they have any point in common.

For geography, a distance tolerance of 0.00001 meters is used (so points that are very close are considered to intersect).

In mathematical terms: *ST_Intersects(A, B) ⇔ A ⊠ B ≠ ⊠*

Geometries intersect if their DE-9IM Intersection Matrix matches one of:

- `T********`
- `*T*******`
- `***T*****`
- `****T****`

Spatial intersection is implied by all the other spatial relationship tests, except ST_Disjoint, which tests that geometries do NOT intersect.

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.

Changed: 3.0.0 SFCGAL version removed and native support for 2D TINS added.

Enhanced: 2.5.0 Supports GEOMETRYCOLLECTION.

Enhanced: 2.3.0 Enhancement to PIP short-circuit extended to support MultiPoints with few points. Prior versions only supported point in polygon.

Performed by the GEOS module (for geometry), geography is native

Availability: 1.5 support for geography was introduced.

> **Note**
> For geography, this function has a distance tolerance of about 0.00001 meters and uses the sphere rather than spheroid calculation.

> **Note**
> NOTE: this is the ”allowable” version that returns a boolean, not an integer.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 //s2.1.13.3 - ST_Intersects(g1, g2) --> Not (ST_Disjoint(g1, g2))

This method implements the SQL/MM specification. SQL-MM 3: 5.1.27

This method supports Circular Strings and Curves.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```
SELECT ST_Intersects('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )'::geometry);
 st_intersects
---------------
 f
(1 row)
SELECT ST_Intersects('POINT(0 0)'::geometry, 'LINESTRING ( 0 0, 0 2 )'::geometry);
 st_intersects
---------------
 t
(1 row)

-- Look up in table. Make sure table has a GiST index on geometry column for faster lookup.
SELECT id, name FROM cities WHERE ST_Intersects(geom, 'SRID=4326;POLYGON((28 53,27.707 52.293,27 52,26.293 52.293,26 53,26.293 53.707,27 54,27.707 53.707,28 53))');
 id | name
----+-------
  2 | Minsk
(1 row)
```

☒☒☒☒☒

```
SELECT ST_Intersects(
    'SRID=4326;LINESTRING(-43.23456 72.4567,-43.23456 72.4568)'::geography,
    'SRID=4326;POINT(-43.23456 72.4567772)'::geography
    );

 st_intersects
---------------
t
```

☒☒

&&, ST_3DIntersects, ST_Disjoint

7.11.1.10 ST_LineCrossingDirection

ST_LineCrossingDirection — Returns a number indicating the crossing behavior of two LineStrings

Synopsis

integer **ST_LineCrossingDirection**(geometry linestringA, geometry linestringB);

☒☒

Given two linestrings returns an integer between -3 and 3 indicating what kind of crossing behavior exists between them. 0 indicates no crossing. This is only supported for `LINESTRING`s.

The crossing number has the following meaning:

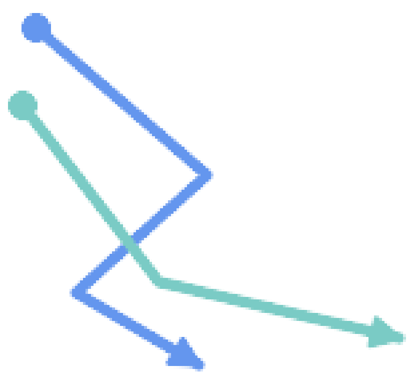
- 0: LINE NO CROSS
- -1: LINE CROSS LEFT

- 1: LINE CROSS RIGHT
- -2: LINE MULTICROSS END LEFT
- 2: LINE MULTICROSS END RIGHT
- -3: LINE MULTICROSS END SAME FIRST LEFT
- 3: LINE MULTICROSS END SAME FIRST RIGHT

Availability: 1.4

⊠⊠

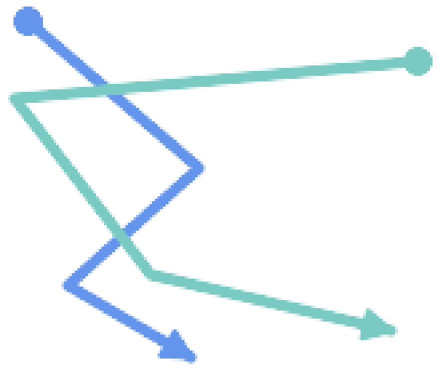
Example: LINE CROSS LEFT and LINE CROSS RIGHT



Blue: Line A; Green: Line B

```
SELECT ST_LineCrossingDirection(lineA, lineB) As A_cross_B,
       ST_LineCrossingDirection(lineB, lineA) As B_cross_A
FROM (SELECT
  ST_GeomFromText('LINESTRING(25 169,89 114,40 70,86 43)') As lineA,
  ST_GeomFromText('LINESTRING (20 140, 71 74, 161 53)') As lineB
  ) As foo;

 A_cross_B | B_cross_A
-----------+-----------
        -1 |         1
```

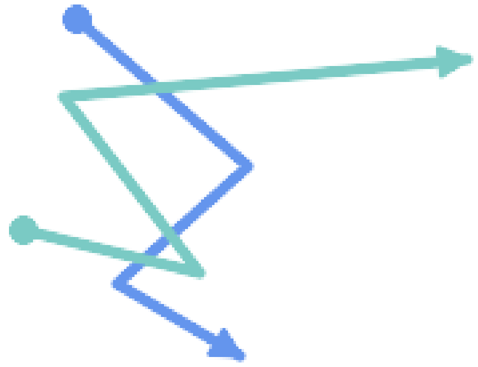
Example: LINE MULTICROSS END SAME FIRST LEFT and LINE MULTICROSS END SAME FIRST RIGHT



Blue: Line A; Green: Line B

```
SELECT ST_LineCrossingDirection(lineA, lineB) As A_cross_B,
       ST_LineCrossingDirection(lineB, lineA) As B_cross_A
FROM (SELECT
 ST_GeomFromText('LINESTRING(25 169,89 114,40 70,86 43)') As lineA,
 ST_GeomFromText('LINESTRING(171 154,20 140,71 74,161 53)') As lineB
  ) As foo;

 A_cross_B | B_cross_A
-----------+-----------
         3 |        -3
```

Example: LINE MULTICROSS END LEFT and LINE MULTICROSS END RIGHT



Blue: Line A; Green: Line B

```
SELECT ST_LineCrossingDirection(lineA, lineB) As A_cross_B,
       ST_LineCrossingDirection(lineB, lineA) As B_cross_A
FROM (SELECT
  ST_GeomFromText('LINESTRING(25 169,89 114,40 70,86 43)') As lineA,
  ST_GeomFromText('LINESTRING(5 90, 71 74, 20 140, 171 154)') As lineB
  ) As foo;
```

```
 A_cross_B | B_cross_A
-----------+-----------
        -2 |         2
```

Example: Finds all streets that cross

```
SELECT s1.gid, s2.gid, ST_LineCrossingDirection(s1.geom, s2.geom)
  FROM streets s1 CROSS JOIN streets s2
         ON (s1.gid != s2.gid AND s1.geom && s2.geom )
WHERE ST_LineCrossingDirection(s1.geom, s2.geom)
> 0;
```

□□

ST_Crosses

7.11.1.11 ST_OrderingEquals

ST_OrderingEquals — Tests if two geometries represent the same geometry and have points in the same directional order

Synopsis

boolean **ST_OrderingEquals**(geometry A, geometry B);

□□

ST_OrderingEquals compares two geometries and returns t (TRUE) if the geometries are equal and the coordinates are in the same order; otherwise it returns f (FALSE).

> **Note**
> This function is implemented as per the ArcSDE SQL specification rather than SQL-MM. http://edndoc.esri.com/arcsde/9.1/sql_api/sqlapi3.htm#ST_OrderingEquals

This method implements the SQL/MM specification. SQL-MM 3: 5.1.43

□□

```
SELECT ST_OrderingEquals(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
    ST_GeomFromText('LINESTRING(0 0, 5 5, 10 10)'));
 st_orderingequals
-----------
 f
(1 row)

SELECT ST_OrderingEquals(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
    ST_GeomFromText('LINESTRING(0 0, 0 0, 10 10)'));
 st_orderingequals
```

```
-----------
 t
(1 row)

SELECT ST_OrderingEquals(ST_Reverse(ST_GeomFromText('LINESTRING(0 0, 10 10)')),
    ST_GeomFromText('LINESTRING(0 0, 0 0, 10 10)'));
 st_orderingequals
-----------
 f
(1 row)
```

⊠⊠

&&, ST_Equals, ST_Reverse

7.11.1.12 ST_Overlaps

ST_Overlaps — Tests if two geometries have the same dimension and intersect, but each has at least one point not in the other

Synopsis

boolean **ST_Overlaps**(geometry A, geometry B);

⊠⊠

Returns TRUE if geometry A and B ”spatially overlap”. Two geometries overlap if they have the same dimension, their interiors intersect in that dimension. and each has at least one point inside the other (or equivalently, neither one covers the other). The overlaps relation is symmetric and irreflexive.

In mathematical terms: *ST_Overlaps(A, B) ⇔ (dim(A) = dim(B) = dim(Int(A) ⊠ Int(B))) ∧ (A ⊠ B ≠ A) ∧ (A ⊠ B ≠ B)*

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_Overlaps`.

GEOS ⊠⊠⊠⊠⊠

> **Important**
> Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

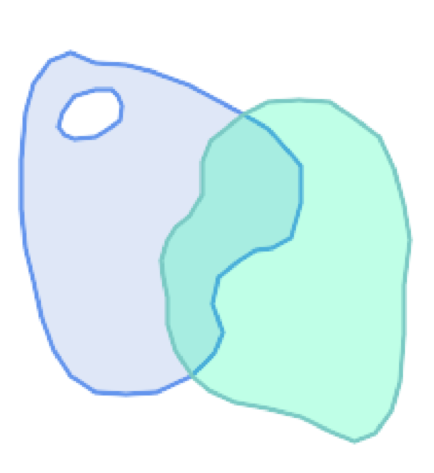
NOTE: this is the ”allowable” version that returns a boolean, not an integer.

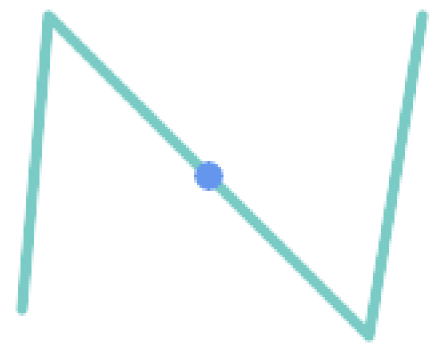
This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3

This method implements the SQL/MM specification. SQL-MM 3: 5.1.32

☒☒

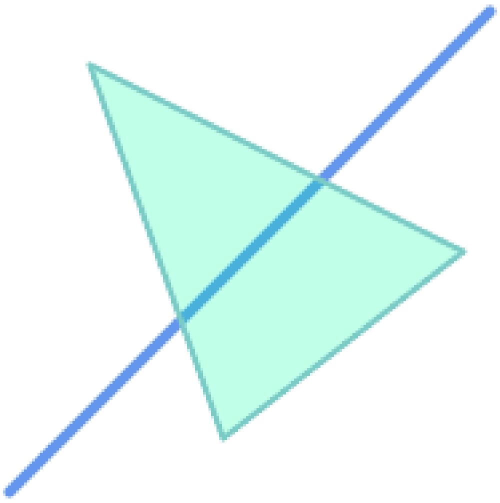
`ST_Overlaps` returns TRUE in the following situations:

 *MULTIPOINT / MULTIPOINT*	 *LINESTRING / LINESTRING*	 *POLYGON / POLYGON*



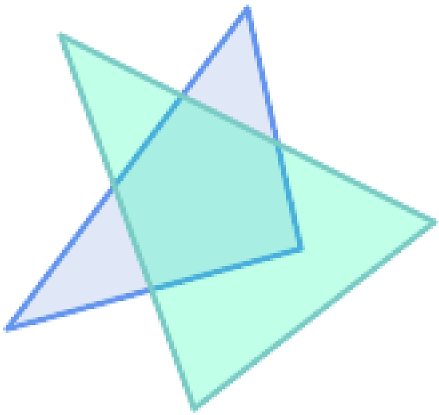
A Point on a LineString is contained, but since it has lower dimension it does not overlap or cross.

```
SELECT ST_Overlaps(a,b) AS overlaps,       ST_Crosses(a,b) AS crosses,
       ST_Intersects(a, b) AS intersects,  ST_Contains(b,a) AS b_contains_a
FROM (SELECT ST_GeomFromText('POINT (100 100)') As a,
             ST_GeomFromText('LINESTRING (30 50, 40 160, 160 40, 180 160)')  AS b) AS t

overlaps | crosses | intersects | b_contains_a
---------+----------------------+--------------
f        | f       | t          | t
```



A LineString that partly covers a Polygon intersects and crosses, but does not overlap since it has different dimension.

```
SELECT ST_Overlaps(a,b) AS overlaps,       ST_Crosses(a,b) AS crosses,
       ST_Intersects(a, b) AS intersects,   ST_Contains(a,b) AS contains
FROM (SELECT ST_GeomFromText('POLYGON ((40 170, 90 30, 180 100, 40 170))') AS a,
             ST_GeomFromText('LINESTRING(10 10, 190 190)') AS b) AS t;

 overlap | crosses | intersects | contains
---------+---------+------------+--------------
 f       | t       | t          | f
```



Two Polygons that intersect but with neither contained by the other overlap, but do not cross because their intersection has the same dimension.

```
SELECT ST_Overlaps(a,b) AS overlaps,       ST_Crosses(a,b) AS crosses,
       ST_Intersects(a, b) AS intersects,  ST_Contains(b, a) AS b_contains_a,
       ST_Dimension(a) AS dim_a, ST_Dimension(b) AS dim_b,
       ST_Dimension(ST_Intersection(a,b)) AS dim_int
FROM (SELECT ST_GeomFromText('POLYGON ((40 170, 90 30, 180 100, 40 170))') AS a,
             ST_GeomFromText('POLYGON ((110 180, 20 60, 130 90, 110 180))') AS b) As t;
```

```
 overlaps | crosses | intersects | b_contains_a | dim_a | dim_b | dim_int
----------+---------+------------+--------------+-------+-------+-----------
 t        | f       | t          | f            |     2 |     2 |       2
```

⊠⊠

ST_Contains, ST_Crosses, ST_Dimension, ST_Intersects

7.11.1.13 ST_Relate

ST_Relate — Tests if two geometries have a topological relationship matching an Intersection Matrix pattern, or computes their Intersection Matrix

Synopsis

boolean **ST_Relate**(geometry geomA, geometry geomB, text intersectionMatrixPattern);
text **ST_Relate**(geometry geomA, geometry geomB);
text **ST_Relate**(geometry geomA, geometry geomB, integer boundaryNodeRule);

⊠⊠

These functions allow testing and evaluating the spatial (topological) relationship between two geometries, as defined by the Dimensionally Extended 9-Intersection Model (DE-9IM).

The DE-9IM is specified as a 9-element matrix indicating the dimension of the intersections between the Interior, Boundary and Exterior of two geometries. It is represented by a 9-character text string using the symbols 'F', '0', '1', '2' (e.g. `'FF1FF0102'`).

A specific kind of spatial relationship can be tested by matching the intersection matrix to an *intersection matrix pattern*. Patterns can include the additional symbols 'T' (meaning "intersection is non-empty") and '*' (meaning "any value"). Common spatial relationships are provided by the named functions ST_Contains, ST_ContainsProperly, ST_Covers, ST_CoveredBy, ST_Crosses, ST_Disjoint, ST_Equals, ST_Intersects, ST_Overlaps, ST_Touches, and ST_Within. Using an explicit pattern allows testing multiple conditions of intersects, crosses, etc in one step. It also allows testing spatial relationships which do not have a named spatial relationship function. For example, the relationship "Interior-Intersects" has the DE-9IM pattern `T********`, which is not evaluated by any named predicate.

For more information refer to Section 5.1.

Variant 1: Tests if two geometries are spatially related according to the given `intersectionMatrixPattern`

> **Note**
> Unlike most of the named spatial relationship predicates, this does NOT automatically include an index call. The reason is that some relationships are true for geometries which do NOT intersect (e.g. Disjoint). If you are using a relationship pattern that requires intersection, then include the && index call.

> **Note**
> It is better to use a named relationship function if available, since they automatically use a spatial index where one exists. Also, they may implement performance optimizations which are not available with full relate evaluation.

Variant 2: Returns the DE-9IM matrix string for the spatial relationship between the two input geometries. The matrix string can be tested for matching a DE-9IM pattern using ST_RelateMatch.

Variant 3: Like variant 2, but allows specifying a **Boundary Node Rule**. A boundary node rule allows finer control over whether the endpoints of MultiLineStrings are considered to lie in the DE-9IM Interior or Boundary. The `boundaryNodeRule` values are:

- 1: **OGC-Mod2** - line endpoints are in the Boundary if they occur an odd number of times. This is the rule defined by the OGC SFS standard, and is the default for `ST_Relate`.
- 2: **Endpoint** - all endpoints are in the Boundary.
- 3: **MultivalentEndpoint** - endpoints are in the Boundary if they occur more than once. In other words, the boundary is all the ”attached” or ”inner” endpoints (but not the ”unattached/outer” ones).
- 4: **MonovalentEndpoint** - endpoints are in the Boundary if they occur only once. In other words, the boundary is all the ”unattached” or ”outer” endpoints.

This function is not in the OGC spec, but is implied. see s2.1.13.2

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3

This method implements the SQL/MM specification. SQL-MM 3: 5.1.25

GEOS ⊠⊠⊠⊠⊠

Enhanced: 2.0.0 - added support for specifying boundary node rule.

> **Important**
> Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

⊠⊠

Using the boolean-valued function to test spatial relationships.

```
SELECT ST_Relate('POINT(1 2)', ST_Buffer( 'POINT(1 2)', 2), '0FFFFF212');
st_relate
-----------
t

SELECT ST_Relate(POINT(1 2)', ST_Buffer( 'POINT(1 2)', 2), '*FF*FF212');
st_relate
-----------
t
```

Testing a custom spatial relationship pattern as a query condition, with && to enable using a spatial index.

```
-- Find compounds that properly intersect (not just touch) a poly (Interior Intersects)

SELECT c.* , p.name As poly_name
    FROM polys AS p
    INNER JOIN compounds As c
          ON c.geom && p.geom
             AND ST_Relate(p.geom, c.geom,'T********');
```

Computing the intersection matrix for spatial relationships.

```
SELECT ST_Relate( 'POINT(1 2)',
                  ST_Buffer( 'POINT(1 2)', 2));
-----------
0FFFFF212

SELECT ST_Relate( 'LINESTRING(1 2, 3 4)',
                  'LINESTRING(5 6, 7 8)' );
-----------
FF1FF0102
```

Using different Boundary Node Rules to compute the spatial relationship between a LineString and a MultiLineString with a duplicate endpoint `(3 3)`:

- Using the **OGC-Mod2** rule (1) the duplicate endpoint is in the **interior** of the MultiLineString, so the DE-9IM matrix entry [aB:bI] is `0` and [aB:bB] is `F`.
- Using the **Endpoint** rule (2) the duplicate endpoint is in the **boundary** of the MultiLineString, so the DE-9IM matrix entry [aB:bI] is `F` and [aB:bB] is `0`.

```
WITH data AS (SELECT
  'LINESTRING(1 1, 3 3)'::geometry AS a_line,
  'MULTILINESTRING((3 3, 3 5), (3 3, 5 3))':: geometry AS b_multiline
)
SELECT ST_Relate( a_line, b_multiline, 1) AS bnr_mod2,
       ST_Relate( a_line, b_multiline, 2) AS bnr_endpoint
    FROM data;

 bnr_mod2  | bnr_endpoint
-----------+--------------
 FF10F0102 | FF1F00102
```

□□

Section 5.1, ST_RelateMatch, ST_Contains, ST_ContainsProperly, ST_Covers, ST_CoveredBy, ST_Crosses, ST_Disjoint, ST_Equals, ST_Intersects, ST_Overlaps, ST_Touches, ST_Within

7.11.1.14 ST_RelateMatch

ST_RelateMatch — Tests if a DE-9IM Intersection Matrix matches an Intersection Matrix pattern

Synopsis

boolean **ST_RelateMatch**(text intersectionMatrix, text intersectionMatrixPattern);

□□

Tests if a Dimensionally Extended 9-Intersection Model (DE-9IM) `intersectionMatrix` value satisfies an `intersectionMatrixPattern`. Intersection matrix values can be computed by ST_Relate.

For more information refer to Section 5.1.

GEOS □□□□□□

2.0.0 □□□□□□□□□□□□.

□□

```
SELECT ST_RelateMatch('101202FFF', 'TTTTTTFFF') ;
-- result --
t
```

Patterns for common spatial relationships matched against intersection matrix values, for a line in various positions relative to a polygon

```
SELECT pat.name AS relationship, pat.val AS pattern,
       mat.name AS position, mat.val AS matrix,
       ST_RelateMatch(mat.val, pat.val) AS match
    FROM (VALUES ( 'Equality', 'T1FF1FFF1' ),
                 ( 'Overlaps', 'T*T***T**' ),
                 ( 'Within',   'T*F**F***' ),
                 ( 'Disjoint', 'FF*FF****' )) AS pat(name,val)
    CROSS JOIN
        (VALUES  ('non-intersecting', 'FF1FF0212'),
                 ('overlapping',      '1010F0212'),
                 ('inside',           '1FF0FF212')) AS mat(name,val);

 relationship |  pattern  |     position     |  matrix   | match
--------------+-----------+------------------+-----------+-------
 Equality     | T1FF1FFF1 | non-intersecting | FF1FF0212 | f
 Equality     | T1FF1FFF1 | overlapping      | 1010F0212 | f
 Equality     | T1FF1FFF1 | inside           | 1FF0FF212 | f
 Overlaps     | T*T***T** | non-intersecting | FF1FF0212 | f
 Overlaps     | T*T***T** | overlapping      | 1010F0212 | t
 Overlaps     | T*T***T** | inside           | 1FF0FF212 | f
 Within       | T*F**F*** | non-intersecting | FF1FF0212 | f
 Within       | T*F**F*** | overlapping      | 1010F0212 | f
 Within       | T*F**F*** | inside           | 1FF0FF212 | t
 Disjoint     | FF*FF**** | non-intersecting | FF1FF0212 | t
 Disjoint     | FF*FF**** | overlapping      | 1010F0212 | f
 Disjoint     | FF*FF**** | inside           | 1FF0FF212 | f
```

□□

Section 5.1, ST_Relate

7.11.1.15 ST_Touches

ST_Touches — Tests if two geometries have at least one point in common, but their interiors do not intersect

Synopsis

boolean **ST_Touches**(geometry A, geometry B);

□□

Returns `TRUE` if A and B intersect, but their interiors do not intersect. Equivalently, A and B have at least one point in common, and the common points lie in at least one boundary. For Point/Point inputs the relationship is always `FALSE`, since points do not have a boundary.

In mathematical terms: *ST_Touches(A, B) ⇔ (Int(A) □ Int(B) = □) ∧ (A □ B ≠ □)*

This relationship holds if the DE-9IM Intersection Matrix for the two geometries matches one of:

- FT*******
- F**T*****
- F***T****

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid using an index, use _ST_Touches instead.

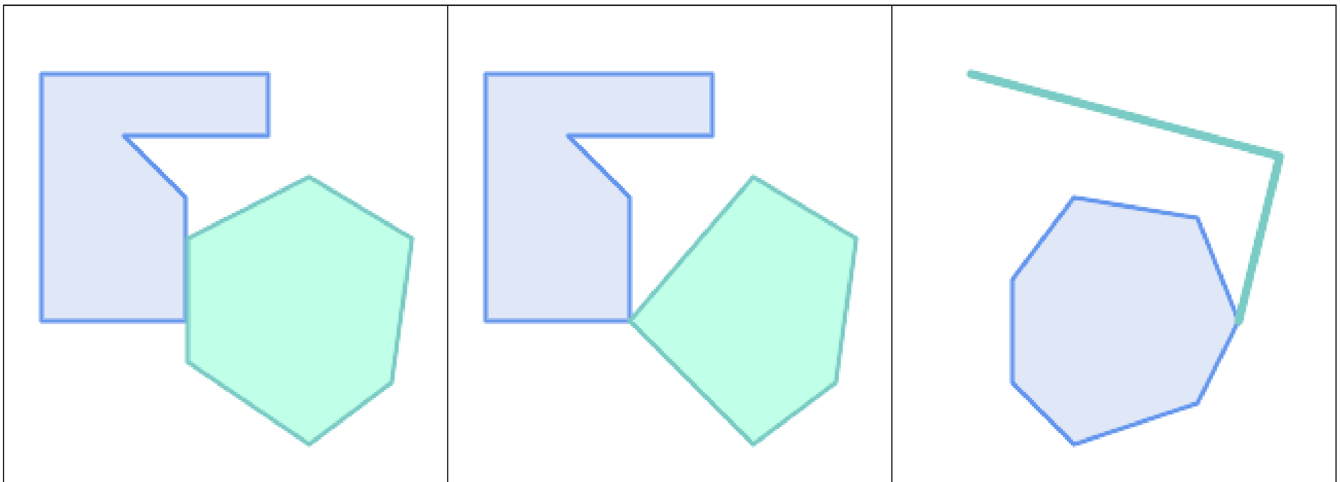
> **Important**
> Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3

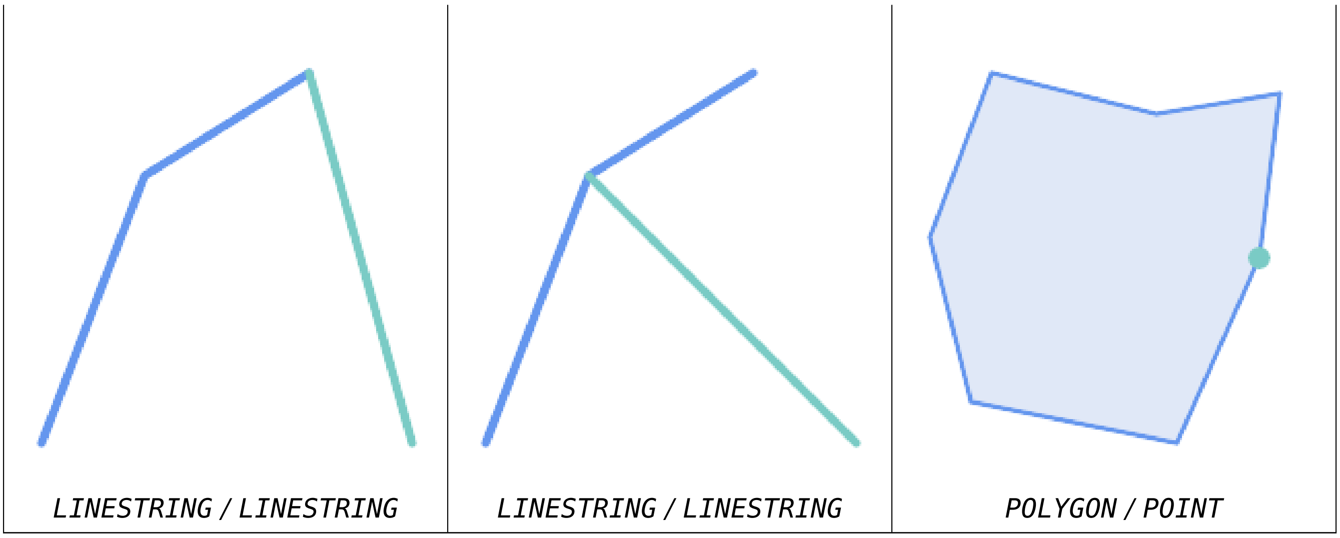
This method implements the SQL/MM specification. SQL-MM 3: 5.1.28

⊠⊠

The `ST_Touches` predicate returns `TRUE` in the following examples.



POLYGON / POLYGON | *POLYGON / POLYGON* | *POLYGON / LINESTRING*




```
SELECT ST_Touches('LINESTRING(0 0, 1 1, 0 2)'::geometry, 'POINT(1 1)'::geometry);
 st_touches
------------
 f
(1 row)

SELECT ST_Touches('LINESTRING(0 0, 1 1, 0 2)'::geometry, 'POINT(0 2)'::geometry);
 st_touches
------------
 t
(1 row)
```

7.11.1.16 ST_Within

ST_Within — Tests if every point of A lies in B, and their interiors have a point in common

Synopsis

boolean **ST_Within**(geometry A, geometry B);

☒☒

Returns TRUE if geometry A is within geometry B. A is within B if and only if all points of A lie inside (i.e. in the interior or boundary of) B (or equivalently, no points of A lie in the exterior of B), and the interiors of A and B have at least one point in common.

For this function to make sense, the source geometries must both be of the same coordinate projection, having the same SRID.

In mathematical terms: $ST\_Within(A, B) \Leftrightarrow (A \cap B = A) \wedge (Int(A) \cap Int(B) \neq \emptyset)$

The within relation is reflexive: every geometry is within itself. The relation is antisymmetric: if `ST_Within(A,B) = true` and `ST_Within(B,A) = true`, then the two geometries must be topologically equal (`ST_Equals(A,B) = true`).

ST_Within is the converse of ST_Contains. So, `ST_Within(A,B) = ST_Contains(B,A)`.

Note
Because the interiors must have a common point, a subtlety of the definition is that lines and points lying fully in the boundary of polygons or lines are *not* within the geometry. For further details see Subtleties of OGC Covers, Contains, Within. The ST_CoveredBy predicate provides a more inclusive relationship.

Note
This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_Within`.

GEOS ⊠⊠⊠⊠⊠

Enhanced: 2.3.0 Enhancement to PIP short-circuit for geometry extended to support MultiPoints with few points. Prior versions only supported point in polygon.

Important
Enhanced: 3.0.0 enabled support for `GEOMETRYCOLLECTION`

Important
Do not use this function with invalid geometries. You will get unexpected results.

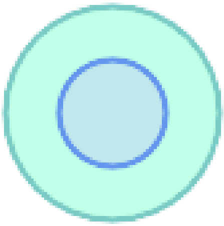
NOTE: this is the "allowable" version that returns a boolean, not an integer.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3 - a.Relate(b, 'T*F**F***')

This method implements the SQL/MM specification. SQL-MM 3: 5.1.30

⊠⊠

```
--a circle within a circle
SELECT ST_Within(smallc,smallc) As smallinsmall,
  ST_Within(smallc, bigc) As smallinbig,
  ST_Within(bigc,smallc) As biginsmall,
  ST_Within(ST_Union(smallc, bigc), bigc) as unioninbig,
  ST_Within(bigc, ST_Union(smallc, bigc)) as biginunion,
  ST_Equals(bigc, ST_Union(smallc, bigc)) as bigisunion
FROM
(
SELECT ST_Buffer(ST_GeomFromText('POINT(50 50)'), 20) As smallc,
  ST_Buffer(ST_GeomFromText('POINT(50 50)'), 40) As bigc) As foo;
--Result
 smallinsmall | smallinbig | biginsmall | unioninbig | biginunion | bigisunion
--------------+------------+------------+------------+------------+------------
 t            | t          | f          | t          | t          | t
(1 row)
```



☒☒

ST_Contains, ST_CoveredBy, ST_Equals, ST_IsValid

7.11.2 Distance Relationships

7.11.2.1 ST_3DDWithin

ST_3DDWithin — Tests if two 3D geometries are within a given 3D distance

Synopsis

boolean **ST_3DDWithin**(geometry g1, geometry g2, double precision distance_of_srid);

☒☒

Returns true if the 3D distance between two geometry values is no larger than distance `distance_of_srid`. The distance is specified in units defined by the spatial reference system of the geometries. For this function to make sense the source geometries must be in the same coordinate system (have the same SRID).

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This method implements the SQL/MM specification. SQL-MM ?

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

⊠⊠

```
-- Geometry example - units in meters (SRID: 2163 US National Atlas Equal area) (3D point ↩
   and line compared 2D point and line)
-- Note: currently no vertical datum support so Z is not transformed and assumed to be same ↩
    units as final.
SELECT ST_3DDWithin(
      ST_Transform(ST_GeomFromEWKT('SRID=4326;POINT(-72.1235 42.3521 4)'),2163),
      ST_Transform(ST_GeomFromEWKT('SRID=4326;LINESTRING(-72.1260 42.45 15, -72.123 42.1546 ↩
          20)'),2163),
      126.8
    ) As within_dist_3d,
ST_DWithin(
      ST_Transform(ST_GeomFromEWKT('SRID=4326;POINT(-72.1235 42.3521 4)'),2163),
      ST_Transform(ST_GeomFromEWKT('SRID=4326;LINESTRING(-72.1260 42.45 15, -72.123 42.1546 ↩
          20)'),2163),
      126.8
    ) As within_dist_2d;

 within_dist_3d | within_dist_2d
----------------+----------------
 f              | t
```

⊠⊠

ST_3DDFullyWithin, ST_DWithin, ST_DFullyWithin, ST_3DDistance, ST_Distance, ST_3DMaxDistance, ST_Transform

7.11.2.2 ST_3DDFullyWithin

ST_3DDFullyWithin — Tests if two 3D geometries are entirely within a given 3D distance

Synopsis

boolean **ST_3DDFullyWithin**(geometry g1, geometry g2, double precision distance);

⊠⊠

Returns true if the 3D geometries are fully within the specified distance of one another. The distance is specified in units defined by the spatial reference system of the geometries. For this function to make sense, the source geometries must both be of the same coordinate projection, having the same SRID.

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

□□

```
-- This compares the difference between fully within and distance within as well
    -- as the distance fully within for the 2D footprint of the line/point vs. the 3d fully within
    SELECT ST_3DDFullyWithin(geom_a, geom_b, 10) as D3DFullyWithin10, ST_3DDWithin(geom_a, geom_b, 10) as D3DWithin10,
  ST_DFullyWithin(geom_a, geom_b, 20) as D2DFullyWithin20,
  ST_3DDFullyWithin(geom_a, geom_b, 20) as D3DFullyWithin20 from
    (select ST_GeomFromEWKT('POINT(1 1 2)') as geom_a,
    ST_GeomFromEWKT('LINESTRING(1 5 2, 2 7 20, 1 9 100, 14 12 3)') as geom_b) t1;
 d3dfullywithin10 | d3dwithin10 | d2dfullywithin20 | d3dfullywithin20
------------------+-------------+------------------+------------------
 f                | t           | t                | f
```

□□

ST_3DDWithin, ST_DWithin, ST_DFullyWithin, ST_3DMaxDistance

7.11.2.3 ST_DFullyWithin

ST_DFullyWithin — Tests if a geometry is entirely inside a distance of another

Synopsis

boolean **ST_DFullyWithin**(geometry g1, geometry g2, double precision distance);

□□

Returns true if g2 is entirely within distance of g1. Visually, the condition is true if g2 is contained within a distance buffer of g1. The distance is specified in units defined by the spatial reference system of the geometries.

> **Note**
> This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.

1.5.0 □□□□□□□□□□□□.

Changed: 3.5.0 : the logic behind the function now uses a test of containment within a buffer, rather than the ST_MaxDistance algorithm. Results will differ from prior versions, but should be closer to user expectations.

□□

```
SELECT
    ST_DFullyWithin(geom_a, geom_b, 10) AS DFullyWithin10,
    ST_DWithin(geom_a, geom_b, 10) AS DWithin10,
    ST_DFullyWithin(geom_a, geom_b, 20) AS DFullyWithin20
FROM (VALUES
    ('POINT(1 1)', 'LINESTRING(1 5, 2 7, 1 9, 14 12)')
    ) AS v(geom_a, geom_b)
```

```
 dfullywithin10 | dwithin10 | dfullywithin20
----------------+-----------+---------------
 f              | t         | t
```

⊠⊠

ST_MaxDistance, ST_DWithin, ST_3DDWithin, ST_3DDFullyWithin

7.11.2.4 ST_DWithin

ST_DWithin — Tests if two geometries are within a given distance

Synopsis

boolean **ST_DWithin**(geometry g1, geometry g2, double precision distance_of_srid);
boolean **ST_DWithin**(geography gg1, geography gg2, double precision distance_meters, boolean use_spheroid = true);

⊠⊠

Returns true if the geometries are within a given distance

For geometry: The distance is specified in units defined by the spatial reference system of the geometries. For this function to make sense, the source geometries must be in the same coordinate system (have the same SRID).

For geography: units are in meters and distance measurement defaults to `use_spheroid = true`. For faster evaluation use `use_spheroid = false` to measure on the sphere.

> **Note**
> Use ST_3DDWithin for 3D geometries.

> **Note**
> This function call includes a bounding box comparison that makes use of any indexes that are available on the geometries.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

Availability: 1.5.0 support for geography was introduced

Enhanced: 2.1.0 improved speed for geography. See Making Geography faster for details.

Enhanced: 2.1.0 support for curved geometries was introduced.

Prior to 1.3, ST_Expand was commonly used in conjunction with && and ST_Distance to test for distance, and in pre-1.3.4 this function used that logic. From 1.3.4, ST_DWithin uses a faster short-circuit distance function.

☒☒

```
-- Find the nearest hospital to each school
-- that is within 3000 units of the school.
--  We do an ST_DWithin search to utilize indexes to limit our search list
--  that the non-indexable ST_Distance needs to process
-- If the units of the spatial reference is meters then units would be meters
SELECT DISTINCT ON (s.gid) s.gid, s.school_name, s.geom, h.hospital_name
  FROM schools s
    LEFT JOIN hospitals h ON ST_DWithin(s.geom, h.geom, 3000)
  ORDER BY s.gid, ST_Distance(s.geom, h.geom);

-- The schools with no close hospitals
-- Find all schools with no hospital within 3000 units
-- away from the school.  Units is in units of spatial ref (e.g. meters, feet, degrees)
SELECT s.gid, s.school_name
  FROM schools s
    LEFT JOIN hospitals h ON ST_DWithin(s.geom, h.geom, 3000)
  WHERE h.gid IS NULL;

-- Find broadcasting towers that receiver with limited range can receive.
-- Data is geometry in Spherical Mercator (SRID=3857), ranges are approximate.

-- Create geometry index that will check proximity limit of user to tower
CREATE INDEX ON broadcasting_towers using gist (geom);

-- Create geometry index that will check proximity limit of tower to user
CREATE INDEX ON broadcasting_towers using gist (ST_Expand(geom, sending_range));

-- Query towers that 4-kilometer receiver in Minsk Hackerspace can get
-- Note: two conditions, because shorter LEAST(b.sending_range, 4000) will not use index.
SELECT b.tower_id, b.geom
  FROM broadcasting_towers b
  WHERE ST_DWithin(b.geom, 'SRID=3857;POINT(3072163.4 7159374.1)', 4000)
    AND ST_DWithin(b.geom, 'SRID=3857;POINT(3072163.4 7159374.1)', b.sending_range);
```

☒☒

ST_Distance, ST_3DDWithin

7.11.2.5 ST_PointInsideCircle

ST_PointInsideCircle — Tests if a point geometry is inside a circle defined by a center and radius

Synopsis

boolean **ST_PointInsideCircle**(geometry a_point, float center_x, float center_y, float radius);

☒☒

Returns true if the geometry is a point and is inside the circle with center `center_x`,`center_y` and radius `radius`.

Warning
Does not use spatial indexes. Use ST_DWithin instead.

Availability: 1.2

Changed: 2.2.0 In prior versions this was called ST_Point_Inside_Circle

⊠⊠

```
SELECT ST_PointInsideCircle(ST_Point(1,2), 0.5, 2, 3);
 st_pointinsidecircle
------------------------
 t
```

⊠⊠

ST_DWithin

7.12 Measurement Functions

7.12.1 ST_Area

ST_Area — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_Area**(geometry g1);
float **ST_Area**(geography geog, boolean use_spheroid = true);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ - ST_Surface ⊠⊠ ST_MultiSurface ⊠⊠⊠⊠⊠⊠⊠⊠⊠ - ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, SRID ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ (curved surface) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Area(geog,false) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GeographicLib ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Proj 4.9.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Changed: 3.0.0 - does not depend on SFCGAL anymore.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 8.1.2, 9.5.3

This function supports Polyhedral surfaces.

Note
□□□□□□□□□, (2.5 □□□□□□□) 2 □□□□□□□□□□□□□□. 2.5 □□□□□ 0 □□□ (non-zero) □□□□□□□□□□□, XY □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

□□

□□□□□□□□□□□ (plot) □□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□. EPSG:2249 □□.

```
select ST_Area(geom) sqft,
    ST_Area(geom) * 0.3048 ^ 2 sqm
from (
         select 'SRID=2249;POLYGON((743238 2967416,743238 2967450,
                                 743265 2967450,743265.625 2967416,743238 2967416))' :: ↩
                                     geometry geom
     ) subquery;
b''┌b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┬b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┐b''
b''│b''  sqft   b''│b''     sqm     b''│b''
b''├b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┼b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┤b''
b''│b'' 928.625 b''│b'' 86.27208552 b''│b''
b''└b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┴b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┘b''
```

□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□ ((EPSG:26986)) □□□□□□□□□□. EPSG:2249 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ EPSG:26986 □□□.

```
select ST_Area(geom) sqft,
    ST_Area(ST_Transform(geom, 26986)) As sqm
from (
         select
             'SRID=2249;POLYGON((743238 2967416,743238 2967450,
             743265 2967450,743265.625 2967416,743238 2967416))' :: geometry geom
     ) subquery;
b''┌b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┬b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b ↩
    '─b''b''─b''b''─b''b''┐b''
b''│b''  sqft   b''│b''       sqm       b''│b''
b''├b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┼b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b ↩
    '─b''b''─b''b''─b''b''┤b''
b''│b'' 928.625 b''│b'' 86.272430607008 b''│b''
b''└b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┴b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b ↩
    '─b''b''─b''b''─b''b''┘b''
```

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□ (□□□□□□□□□□□□□□□□□□ WGS84 4326 □□□□□□□□□□□□□□□□□). □□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□.

```
select ST_Area(geog) / 0.3048 ^ 2 sqft_spheroid,
    ST_Area(geog, false) / 0.3048 ^ 2 sqft_sphere,
    ST_Area(geog) sqm_spheroid
from (
```

```
         select ST_Transform(
                    'SRID=2249;POLYGON((743238 2967416,743238 2967450,743265 ↩
                        2967450,743265.625 2967416,743238 2967416))'::geometry,
                    4326
             ) :: geography geog
     ) as subquery;
b''┌b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┬b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''┬b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┐b''
b''│b''  sqft_spheroid   b''│b''   sqft_sphere    b''│b''   sqm_spheroid   b''│b''
b''├b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┼b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''┼b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┤b''
b''│b'' 928.684405784452 b''│b'' 927.049336105925 b''│b'' 86.2776044979692 b''│b''
b''└b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┴b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''┴b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''┘b''
```

If your data is in geography already:

```
select ST_Area(geog) / 0.3048 ^ 2 sqft,
    ST_Area(the_geog) sqm
from somegeogtable;
```

□□

ST_3DArea, ST_GeomFromEWKT, ST_LengthSpheroid, ST_Perimeter, ST_Transform

7.12.2 ST_Azimuth

ST_Azimuth — □□□□□□ 2 □□□□□□□□□□□□.

Synopsis

float **ST_Azimuth**(geometry origin, geometry target);
float **ST_Azimuth**(geography origin, geography target);

□□

Returns the azimuth in radians of the target point from the origin point, or NULL if the two points are coincident. The azimuth angle is a positive clockwise angle referenced from the positive Y axis (geometry) or the North meridian (geography): North = 0; Northeast = π/4; East = π/2; Southeast = 3π/4; South = π; Southwest 5π/4; West = 3π/2; Northwest = 7π/4.

For the geography type, the azimuth solution is known as the inverse geodesic problem.

The azimuth is a mathematical concept defined as the angle between a reference vector and a point, with angular units in radians. The result value in radians can be converted to degrees using the PostgreSQL function `degrees()`.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Translate ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Plpgsqlfunctions PostGIS wiki section ⊠ upgis_lineshift ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

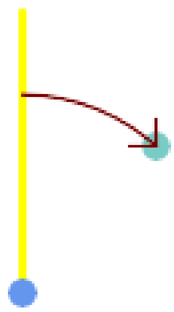
⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GeographicLib ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Proj 4.9.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

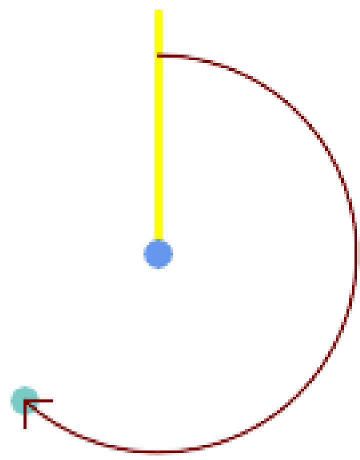
⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT degrees(ST_Azimuth( ST_Point(25, 45),  ST_Point(75, 100))) AS degA_B,
       degrees(ST_Azimuth( ST_Point(75, 100), ST_Point(25, 45) )) AS degB_A;

      dega_b       |     degb_a
------------------+------------------
 42.2736890060937 | 222.273689006094
```



Blue: origin Point(25,45); Green: target Point(75, 100); Yellow: Y axis or North; Red: azimuth angle.



Blue: origin Point(75, 100); Green: target Point(25, 45); Yellow: Y axis or North; Red: azimuth angle.

⊠⊠

ST_Angle, ST_Translate, ST_Project, PostgreSQL Math Functions

7.12.3 ST_Angle

ST_Angle — ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_Angle**(geometry point1, geometry point2, geometry point3, geometry point4);
float **ST_Angle**(geometry line1, geometry line2);

⊠⊠

⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.

Variant 1: computes the angle enclosed by the points P1-P2-P3. If a 4th point provided computes the angle points P1-P2 and P3-P4

Variant 2: computes the angle between two vectors S1-E1 and S2-E2, defined by the start and end points of the input lines

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL ⊠⊠⊠⊠⊠ degrees() ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note that `ST_Angle(P1,P2,P3) = ST_Angle(P2,P1,P2,P3)`.

Availability: 2.5.0

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT degrees( ST_Angle('POINT(0 0)', 'POINT(10 10)', 'POINT(20 0)') );

 degrees
---------
     270
```

Angle between vectors defined by four points

```
SELECT degrees( ST_Angle('POINT (10 10)', 'POINT (0 0)', 'POINT(90 90)', 'POINT (100 80)') ↩
    );

      degrees
-------------------
 269.9999999999999
```

Angle between vectors defined by the start and end points of lines

```
SELECT degrees( ST_Angle('LINESTRING(0 0, 0.3 0.7, 1 1)', 'LINESTRING(0 0, 0.2 0.5, 1 0)') ↩
    );

      degrees
--------------
           45
```

⊠⊠

ST_Azimuth

7.12.4 ST_ClosestPoint

ST_ClosestPoint — Returns the 2D point on g1 that is closest to g2. This is the first point of the shortest line from one geometry to the other.

Synopsis

geometry **ST_ClosestPoint**(geometry geom1, geometry geom2);
geography **ST_ClosestPoint**(geography geom1, geography geom2, boolean use_spheroid = true);

□□

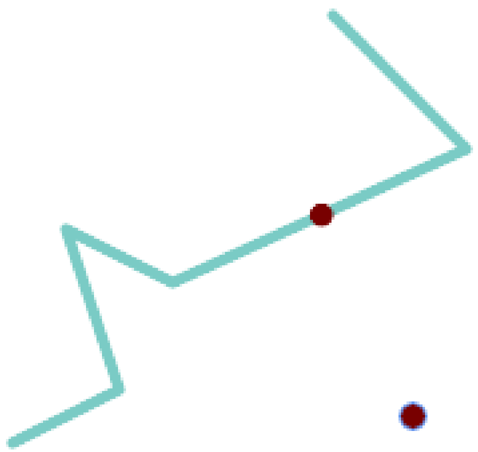
Returns the 2-dimensional point on `geom1` that is closest to `geom2`. This is the first point of the shortest line between the geometries (as computed by ST_ShortestLine).

> **Note**
> 3 □□□□□□□□ ST_3DClosestPoint □□□□□□□□□□□□□.

Enhanced: 3.4.0 - Support for geography.

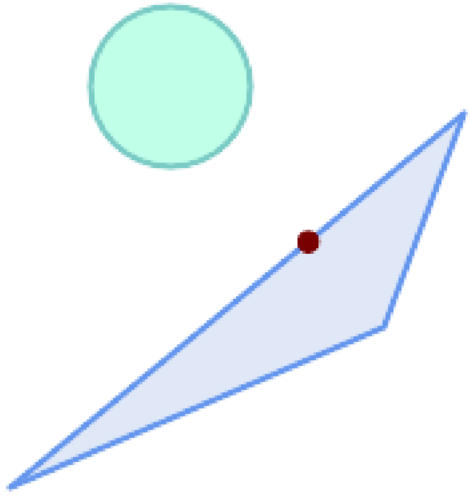
1.5.0 □□□□□□□□□□□□.

□□



The closest point for a Point and a LineString is the point itself. The closest point for a LineString and a Point is a point on the line.

```
SELECT ST_AsText( ST_ClosestPoint(pt,line)) AS cp_pt_line,
       ST_AsText( ST_ClosestPoint(line,pt)) AS cp_line_pt
    FROM (SELECT 'POINT (160 40)'::geometry AS pt,
                 'LINESTRING (10 30, 50 50, 30 110, 70 90, 180 140, 130 190)'::geometry AS ↵
                     line ) AS t;

   cp_pt_line   |                cp_line_pt
----------------+------------------------------------------
 POINT(160 40)  | POINT(125.75342465753425 115.34246575342466)
```



The closest point on polygon A to polygon B

```
SELECT ST_AsText( ST_ClosestPoint(
                'POLYGON ((190 150, 20 10, 160 70, 190 150))',
                ST_Buffer('POINT(80 160)', 30)        )) As ptwkt;
------------------------------------------
 POINT(131.59149149528952 101.89887534906197)
```

⊠⊠

ST_3DClosestPoint, ST_Distance, ST_LongestLine, ST_ShortestLine, ST_MaxDistance

7.12.5 ST_3DClosestPoint

ST_3DClosestPoint — g2 ⊠⊠⊠⊠⊠⊠ g1 ⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 3D ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_3DClosestPoint**(geometry g1, geometry g2);

⊠⊠

g2 ⊠⊠⊠⊠⊠⊠ g1 ⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 3D ⊠⊠⊠⊠⊠ 3D ⊠⊠⊠ 3D ⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, (⊠⊠⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) 2D ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. 2D ⊠ 3D ⊠⊠⊠, ⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ -- 3D, 2D ⊠⊠⊠⊠⊠⊠⊠ (closest point)

```
SELECT ST_AsEWKT(ST_3DClosestPoint(line,pt)) AS cp3d_line_pt,
                ST_AsEWKT(ST_ClosestPoint(line,pt)) As cp2d_line_pt
        FROM (SELECT 'POINT(100 100 30)'::geometry As pt,
                        'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 1000)'::geometry As line
                ) As foo;


 cp3d_line_pt                                              |                cp2d_line_pt
-----------------------------------------------------------+------------------------------------------
 POINT(54.6993798867619 128.935022917228 11.5475869506606) | POINT(73.0769230769231 115.384615384615)
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ -- 3D, 2D ⊠⊠⊠⊠⊠⊠⊠ (closest point)

```
SELECT ST_AsEWKT(ST_3DClosestPoint(line,pt)) AS cp3d_line_pt,
                ST_AsEWKT(ST_ClosestPoint(line,pt)) As cp2d_line_pt
        FROM (SELECT 'MULTIPOINT(100 100 30, 50 74 1000)'::geometry As pt,
                        'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 900)'::geometry As line
                ) As foo;


                       cp3d_line_pt                        | cp2d_line_pt
-----------------------------------------------------------+--------------
 POINT(54.6993798867619 128.935022917228 11.5475869506606) | POINT(50 75)
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ -- 3D, 2D ⊠⊠⊠⊠⊠⊠⊠ (closest point)

```
SELECT ST_AsEWKT(ST_3DClosestPoint(poly, mline)) As cp3d,
    ST_AsEWKT(ST_ClosestPoint(poly, mline)) As cp2d
        FROM (SELECT  ST_GeomFromEWKT('POLYGON((175 150 5, 20 40 5, 35 45 5, 50 60 5, 100 100 5, 175 150 5))') As poly,
                ST_GeomFromEWKT('MULTILINESTRING((175 155 2, 20 40 20, 50 60 -2, 125 100 1, 175 155 1),
                (1 10 2, 5 20 1))') As mline ) As foo;
                   cp3d                   |     cp2d
-------------------------------------------+--------------
 POINT(39.993580415989 54.1889925532825 5) | POINT(20 40)
```

⊠⊠

ST_AsEWKT, ST_ClosestPoint, ST_3DDistance, ST_3DShortestLine

7.12.6 ST_Distance

ST_Distance — ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_Distance**(geometry g1, geometry g2);
float **ST_Distance**(geography geog1, geography geog2, boolean use_spheroid = true);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠.

For geography types defaults to return the minimum geodesic distance between two geographies in meters, compute on the spheroid determined by the SRID. If `use_spheroid` is false, a faster spherical calculation is used.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.23

This method supports Circular Strings and Curves.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ Making Geography faster ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GeographicLib ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Proj 4.9.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Changed: 3.0.0 - does not depend on SFCGAL anymore.

⊠⊠⊠⊠

Geometry example - units in planar degrees 4326 is WGS 84 long lat, units are degrees.

```
SELECT ST_Distance(
    'SRID=4326;POINT(-72.1235 42.3521)'::geometry,
    'SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)'::geometry );
-----------------
0.00150567726382282
```

Geometry example - units in meters (SRID: 3857, proportional to pixels on popular web maps). Although the value is off, nearby ones can be compared correctly, which makes it a good choice for algorithms like KNN or KMeans.

```
SELECT ST_Distance(
    ST_Transform('SRID=4326;POINT(-72.1235 42.3521)'::geometry, 3857),
    ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)'::geometry, 3857) ) ↩
        ;
-----------------
167.441410065196
```

Geometry example - units in meters (SRID: 3857 as above, but corrected by cos(lat) to account for distortion)

```
SELECT ST_Distance(
    ST_Transform('SRID=4326;POINT(-72.1235 42.3521)'::geometry, 3857),
    ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)'::geometry, 3857)
            ) * cosd(42.3521);
-----------------
123.742351254151
```

Geometry example - units in meters (SRID: 26986 Massachusetts state plane meters) (most accurate for Massachusetts)

```
SELECT ST_Distance(
    ST_Transform('SRID=4326;POINT(-72.1235 42.3521)'::geometry, 26986),
    ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)'::geometry, 26986) ↩
        );
-----------------
123.797937878454
```

Geometry example - units in meters (SRID: 2163 US National Atlas Equal area) (least accurate)

```
SELECT ST_Distance(
    ST_Transform('SRID=4326;POINT(-72.1235 42.3521)'::geometry, 2163),
    ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)'::geometry, 2163) ) ↩
        ;
------------------
126.664256056812
```

⊠⊠⊠⊠⊠

Same as geometry example but note units in meters - use sphere for slightly faster and less accurate computation.

```
SELECT ST_Distance(gg1, gg2) As spheroid_dist, ST_Distance(gg1, gg2, false) As sphere_dist
FROM (SELECT
    'SRID=4326;POINT(-72.1235 42.3521)'::geography as gg1,
    'SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)'::geography as gg2
        ) As foo  ;

  spheroid_dist   |   sphere_dist
------------------+------------------
 123.802076746848 | 123.475736916397
```

⊠⊠

ST_3DDistance, ST_DWithin, ST_DistanceSphere, ST_DistanceSpheroid, ST_MaxDistance, ST_HausdorffDis
ST_FrechetDistance, ST_Transform

7.12.7 ST_3DDistance

ST_3DDistance — ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

Synopsis

float **ST_3DDistance**(geometry g1, geometry g2);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠) ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This method implements the SQL/MM specification. SQL-MM ISO/IEC 13249-3

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠, 2D ⊠ 3D ⊠⊠⊠⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Changed: 3.0.0 - SFCGAL version removed

⊠⊠

```
-- Geometry example - units in meters (SRID: 2163 US National Atlas Equal area) (3D point ↩
   and line compared 2D point and line)
-- Note: currently no vertical datum support so Z is not transformed and assumed to be same ↩
     units as final.
SELECT ST_3DDistance(
                        ST_Transform('SRID=4326;POINT(-72.1235 42.3521 4)'::geometry,2163),
                        ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45 15, -72.123  ↩
                            42.1546 20)'::geometry,2163)
                ) As dist_3d,
                ST_Distance(
                        ST_Transform('SRID=4326;POINT(-72.1235 42.3521)'::geometry,2163),
                        ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546) ↩
                            '::geometry,2163)
                ) As dist_2d;

     dist_3d      |     dist_2d
------------------+-----------------
 127.295059324629 | 126.66425605671
```

```
-- Multilinestring and polygon both 3d and 2d distance
-- Same example as 3D closest point example
SELECT ST_3DDistance(poly, mline) As dist3d,
    ST_Distance(poly, mline) As dist2d
        FROM (SELECT  'POLYGON((175 150 5, 20 40 5, 35 45 5, 50 60 5, 100 100 5, 175 150 5) ↩
            )'::geometry as poly,
               'MULTILINESTRING((175 155 2, 20 40 20, 50 60 -2, 125 100 1, 175 155 1), (1  ↩
                   10 2, 5 20 1))'::geometry as mline) as foo;
      dist3d       | dist2d
-------------------+--------
 0.716635696066337 |      0
```

⊠⊠

ST_Distance, ST_3DClosestPoint, ST_3DDWithin, ST_3DMaxDistance, ST_3DShortestLine, ST_Transform

7.12.8 ST_DistanceSphere

ST_DistanceSphere — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 1.5 ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_DistanceSphere**(geometry geomlonlatA, geometry geomlonlatB, float8 radius=6371008);

⊠⊠

⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_DistanceSpheroid ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Distance_Sphere ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT round(CAST(ST_DistanceSphere(ST_Centroid(geom), ST_GeomFromText('POINT(-118 38)',4326)) As numeric),2) As dist_meters,
round(CAST(ST_Distance(ST_Transform(ST_Centroid(geom),32611),
                ST_Transform(ST_GeomFromText('POINT(-118 38)', 4326),32611)) As numeric),2) As dist_utm11_meters,
round(CAST(ST_Distance(ST_Centroid(geom), ST_GeomFromText('POINT(-118 38)', 4326)) As numeric),5) As dist_degrees,
round(CAST(ST_Distance(ST_Transform(geom,32611),
                ST_Transform(ST_GeomFromText('POINT(-118 38)', 4326),32611)) As numeric),2) As min_dist_line_point_meters
FROM
        (SELECT ST_GeomFromText('LINESTRING(-118.584 38.374,-118.583 38.5)', 4326) As geom) as foo;
         dist_meters | dist_utm11_meters | dist_degrees | min_dist_line_point_meters
        -------------+-------------------+--------------+----------------------------
                70424.47 |          70438.00 |      0.72900 |                   65871.18
```

⊠⊠

ST_Distance, ST_DistanceSpheroid

7.12.9 ST_DistanceSpheroid

ST_DistanceSpheroid — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_DistanceSpheroid**(geometry geomlonlatA, geometry geomlonlatB, spheroid measurement_sphero

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_LengthSphero ⊠⊠⊠⊠⊠⊠⊠. PostGIS 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.5 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. 1.5 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

□□□□: 2.2.0 □□□□□□□□ ST_Distance_Spheroid □□□□□□□□□□.

□□

```
SELECT round(CAST(
                ST_DistanceSpheroid(ST_Centroid(geom), ST_GeomFromText('POINT(-118 38) ↩
                    ',4326), 'SPHEROID["WGS 84",6378137,298.257223563]')
                        As numeric),2) As dist_meters_spheroid,
                round(CAST(ST_DistanceSphere(ST_Centroid(geom), ST_GeomFromText('POINT(-118 ↩
                     38)',4326)) As numeric),2) As dist_meters_sphere,
round(CAST(ST_Distance(ST_Transform(ST_Centroid(geom),32611),
                ST_Transform(ST_GeomFromText('POINT(-118 38)', 4326),32611)) As numeric),2) ↩
                     As dist_utm11_meters
FROM
        (SELECT ST_GeomFromText('LINESTRING(-118.584 38.374,-118.583 38.5)', 4326) As geom) ↩
             as foo;
 dist_meters_spheroid | dist_meters_sphere | dist_utm11_meters
----------------------+--------------------+-------------------
                         70454.92 |           70424.47 |          70438.00
```

□□

ST_Distance, ST_DistanceSphere

7.12.10 ST_FrechetDistance

ST_FrechetDistance — □□□□□□ 3 □□□□ (shortest) □□□□□□□□□.

Synopsis

float **ST_FrechetDistance**(geometry g1, geometry g2, float densifyFrac = -1);

□□

Implements algorithm for computing the Fréchet distance restricted to discrete points for both geometries, based on Computing Discrete Fréchet Distance. The Fréchet distance is a measure of similarity between curves that takes into account the location and ordering of the points along the curves. Therefore it is often better than the Hausdorff distance.

When the optional densifyFrac is specified, this function performs a segment densification before computing the discrete Fréchet distance. The densifyFrac parameter sets the fraction by which to densify each segment. Each segment will be split into a number of equal-length subsegments, whose fraction of the total length is closest to the given fraction.

Units are in the units of the spatial reference system of the geometries.

> **Note**
> □□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

Note
The smaller densifyFrac we specify, the more accurate Fréchet distance we get. But, the computation time and the memory usage increase with the square of the number of subsegments.

GEOS ⊠⊠⊠⊠⊠

Availability: 2.4.0 - requires GEOS >= 3.7.0

⊠⊠

```
postgres=# SELECT st_frechetdistance('LINESTRING (0 0, 100 0)'::geometry, 'LINESTRING (0 0, ↩
     50 50, 100 0)'::geometry);
 st_frechetdistance
--------------------
   70.7106781186548
(1 row)
```

```
SELECT st_frechetdistance('LINESTRING (0 0, 100 0)'::geometry, 'LINESTRING (0 0, 50 50, 100 ↩
     0)'::geometry, 0.5);
 st_frechetdistance
--------------------
                  50
(1 row)
```

⊠⊠

ST_HausdorffDistance

7.12.11 ST_HausdorffDistance

ST_HausdorffDistance — ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (shortest) ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_HausdorffDistance**(geometry g1, geometry g2);
float **ST_HausdorffDistance**(geometry g1, geometry g2, float densifyFrac);

⊠⊠

Returns the Hausdorff distance between two geometries. The Hausdorff distance is a measure of how similar or dissimilar 2 geometries are.

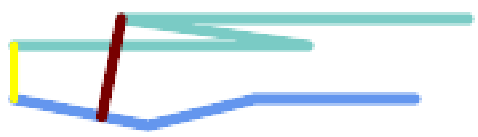
The function actually computes the "Discrete Hausdorff Distance". This is the Hausdorff distance computed at discrete points on the geometries. The *densifyFrac* parameter can be specified, to provide a more accurate answer by densifying segments before computing the discrete Hausdorff distance. Each segment is split into a number of equal-length subsegments whose fraction of the segment length is closest to the given fraction.

Units are in the units of the spatial reference system of the geometries.

> **Note**
> This algorithm is NOT equivalent to the standard Hausdorff distance. However, it computes an approximation that is correct for a large subset of useful cases. One important case is Linestrings that are roughly parallel to each other, and roughly equal in length. This is a useful metric for line matching.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠



Hausdorff distance (red) and distance (yellow) between two lines

```
SELECT ST_HausdorffDistance(geomA, geomB),
       ST_Distance(geomA, geomB)
    FROM (SELECT 'LINESTRING (20 70, 70 60, 110 70, 170 70)'::geometry AS geomA,
                 'LINESTRING (20 90, 130 90, 60 100, 190 100)'::geometry AS geomB) AS t;
 st_hausdorffdistance | st_distance
----------------------+-------------
    37.26206567625497 |          20
```

Example: Hausdorff distance with densification.

```
SELECT ST_HausdorffDistance(
            'LINESTRING (130 0, 0 0, 0 150)'::geometry,
            'LINESTRING (10 10, 10 150, 130 10)'::geometry,
            0.5);
 ----------------------
          70
```

Example: For each building, find the parcel that best represents it. First we require that the parcel intersect with the building geometry. `DISTINCT ON` guarantees we get each building listed only once. `ORDER BY .. ST_HausdorffDistance` selects the parcel that is most similar to the building.

```
SELECT DISTINCT ON (buildings.gid) buildings.gid, parcels.parcel_id
   FROM buildings
       INNER JOIN parcels
       ON ST_Intersects(buildings.geom, parcels.geom)
   ORDER BY buildings.gid, ST_HausdorffDistance(buildings.geom, parcels.geom);
```

⊠⊠

ST_FrechetDistance

7.12.12 ST_Length

ST_Length — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_Length**(geometry a_2dlinestring);
float **ST_Length**(geography geog, boolean use_spheroid = true);

⊠⊠

⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠, ST_Curve, ST_MultiCurve ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Perimeter ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

For geography types: computation is performed using the inverse geodesic calculation. Units of length are in meters. If PostGIS is compiled with PROJ version 4.8.0 or later, the spheroid is specified by the SRID, otherwise it is exclusive to WGS84. If `use_spheroid = false`, then the calculation is based on a sphere instead of a spheroid.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Length2D ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Warning
⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Perimeter ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Length(gg,false); ⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.5.1

This method implements the SQL/MM specification. SQL-MM 3: 7.1.2, 9.3.4

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ EPSG:2249 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_Length(ST_GeomFromText('LINESTRING(743238 2967416,743238 2967450,743265 2967450,
743265.625 2967416,743238 2967416)',2249));

st_length
---------
 122.630744000095


--Transforming WGS 84 LineString to Massachusetts state plane meters
SELECT ST_Length(
        ST_Transform(
                ST_GeomFromEWKT('SRID=4326;LINESTRING(-72.1260 42.45, -72.1240 42.45666,  ↩
                    -72.123 42.1546)'),
                26986
        )
);

st_length
---------
34309.4563576191
```

⊠⊠⊠⊠⊠

WGS84 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
-- the default calculation uses a spheroid
SELECT ST_Length(the_geog) As length_spheroid,  ST_Length(the_geog,false) As length_sphere
FROM (SELECT ST_GeographyFromText(
'SRID=4326;LINESTRING(-72.1260 42.45, -72.1240 42.45666, -72.123 42.1546)') As the_geog)
 As foo;

 length_spheroid  |  length_sphere
------------------+------------------
 34310.5703627288 | 34346.2060960742
```

⊠⊠

ST_GeographyFromText, ST_GeomFromEWKT, ST_LengthSpheroid, ST_Perimeter, ST_Transform

7.12.13 ST_Length2D

ST_Length2D — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_Length ⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_Length2D**(geometry a_2dlinestring);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_Length ⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_Length, ST_3DLength

7.12.14 ST_3DLength

ST_3DLength — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_3DLength**(geometry a_3dlinestring);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2 ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (ST_Length ⊠ ST_Length2D ⊠⊠⊠⊠⊠⊠).

This function supports 3d and will not drop the z-index.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 7.1, 10.3

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ ST_Length3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ EPSG:2249 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_3DLength(ST_GeomFromText('LINESTRING(743238 2967416 1,743238 2967450 1,743265 ↩
    2967450 3,
743265.625 2967416 3,743238 2967416 3)',2249));
ST_3DLength
-----------
122.704716741457
```

⊠⊠

ST_Length, ST_Length2D

7.12.15 ST_LengthSpheroid

ST_LengthSpheroid — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_LengthSpheroid**(geometry a_geometry, spheroid a_spheroid);

□□

□□□□□□□□□□□□/□□□□□□□□. □□□□□□□□□□□□/□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□:

```
SPHEROID[<NAME
>,<SEMI-MAJOR AXIS
>,<INVERSE FLATTENING
>]
```

□□□□

```
SPHEROID["GRS_1980",6378137,298.257222101]
```

1.2.2 □□□□□□□□□□□□□.

□□□□: 2.2.0 □□□□□□□□ ST_Length_Spheroid □□□□□□□□□, ST_3DLength_Spheroid □□□□□□□□□□□□□.

This function supports 3d and will not drop the z-index.

□□

```
SELECT ST_LengthSpheroid( geometry_column,
                          'SPHEROID["GRS_1980",6378137,298.257222101]' )
                          FROM geometry_table;

SELECT ST_LengthSpheroid( geom, sph_m ) As tot_len,
ST_LengthSpheroid(ST_GeometryN(geom,1), sph_m) As len_line1,
ST_LengthSpheroid(ST_GeometryN(geom,2), sph_m) As len_line2
                          FROM (SELECT ST_GeomFromText('MULTILINESTRING((-118.584  ↩
                              38.374,-118.583 38.5),
        (-71.05957 42.3589 , -71.061 43))') As geom,
CAST('SPHEROID["GRS_1980",6378137,298.257222101]' As spheroid) As sph_m)  as foo;
        tot_len      |    len_line1     |    len_line2
------------------+------------------+------------------
 85204.5207562955 | 13986.8725229309 | 71217.6482333646

 --3D
SELECT ST_LengthSpheroid( geom, sph_m ) As tot_len,
ST_LengthSpheroid(ST_GeometryN(geom,1), sph_m) As len_line1,
ST_LengthSpheroid(ST_GeometryN(geom,2), sph_m) As len_line2
                          FROM (SELECT ST_GeomFromEWKT('MULTILINESTRING((-118.584 38.374  ↩
                              20,-118.583 38.5 30),
        (-71.05957 42.3589 75, -71.061 43 90))') As geom,
CAST('SPHEROID["GRS_1980",6378137,298.257222101]' As spheroid) As sph_m)  as foo;

         tot_len      |    len_line1    |    len_line2
------------------+-----------------+------------------
 85204.5259107402 | 13986.876097711 | 71217.6498130292
```

□□

ST_GeometryN, ST_Length

7.12.16 ST_LongestLine

ST_LongestLine — ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_LongestLine**(geometry g1, geometry g2);

⊠⊠

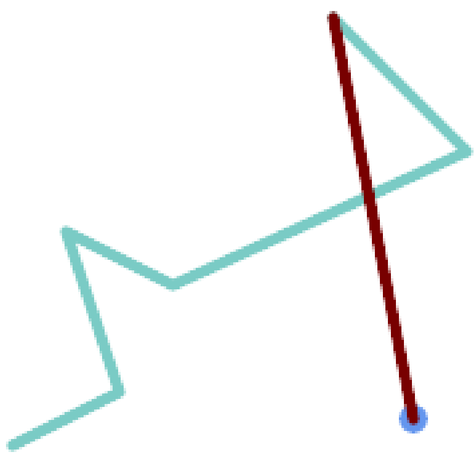
Returns the 2-dimensional longest line between the points of two geometries. The line returned starts on g1 and ends on g2.

The longest line always occurs between two vertices. The function returns the first longest line if more than one is found. The length of the line is equal to the distance returned by ST_MaxDistance.

If g1 and g2 are the same geometry, returns the line between the two vertices farthest apart in the geometry. The endpoints of the line lie on the circle computed by ST_MinimumBoundingCircle.

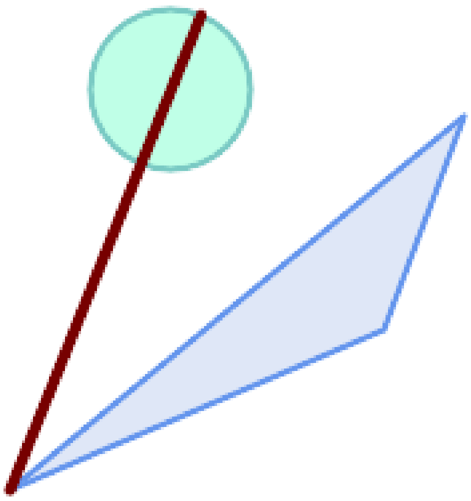
1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠



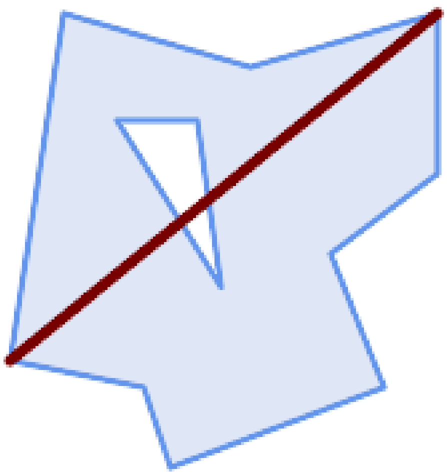
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsText( ST_LongestLine(
        'POINT (160 40)',
        'LINESTRING (10 30, 50 50, 30 110, 70 90, 180 140, 130 190)' )
        ) AS lline;
-----------------
LINESTRING(160 40,130 190)
```



☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒

```
SELECT ST_AsText( ST_LongestLine(
        'POLYGON ((190 150, 20 10, 160 70, 190 150))',
        ST_Buffer('POINT(80 160)', 30)
            ) ) AS llinewkt;
-----------------
LINESTRING(20 10,105.3073372946034 186.95518130045156)
```



Longest line across a single geometry. The length of the line is equal to the Maximum Distance. The endpoints of the line lie on the Minimum Bounding Circle.

```
SELECT ST_AsText( ST_LongestLine( geom, geom)) AS llinewkt,
                  ST_MaxDistance( geom, geom) AS max_dist,
                  ST_Length( ST_LongestLine(geom, geom)) AS lenll
FROM (SELECT 'POLYGON ((40 180, 110 160, 180 180, 180 120, 140 90, 160 40, 80 10, 70 40, 20 ←
     50, 40 180),
              (60 140, 99 77.5, 90 140, 60 140))'::geometry AS geom) AS t;

         llinewkt          |      max_dist      |       lenll
---------------------------+--------------------+--------------------
 LINESTRING(20 50,180 180) | 206.15528128088303 | 206.15528128088303
```

⊠⊠

ST_MaxDistance, ST_ShortestLine, ST_3DLongestLine, ST_MinimumBoundingCircle

7.12.17 ST_3DLongestLine

ST_3DLongestLine — ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_3DLongestLine**(geometry g1, geometry g2);

⊠⊠

⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ g1 ⊠⊠⊠⊠⊠⊠ g2 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ ⊠ ST_3DMaxDistance ⊠⊠⊠ g1 ⊠ g2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, (⊠⊠⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) 2D ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. 2D ⊠ 3D ⊠⊠⊠, ⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ -- 3D, 2D ⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsEWKT(ST_3DLongestLine(line,pt)) AS lol3d_line_pt,
                ST_AsEWKT(ST_LongestLine(line,pt)) As lol2d_line_pt
        FROM (SELECT 'POINT(100 100 30)'::geometry As pt,
                        'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 1000)':: ←
     geometry As line
                ) As foo;


           lol3d_line_pt           |       lol2d_line_pt
-----------------------------------+---------------------------
 LINESTRING(50 75 1000,100 100 30) | LINESTRING(98 190,100 100)
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ -- 3D, 2D ⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsEWKT(ST_3DLongestLine(line,pt)) AS lol3d_line_pt,
                ST_AsEWKT(ST_LongestLine(line,pt)) As lol2d_line_pt
        FROM (SELECT 'MULTIPOINT(100 100 30, 50 74 1000)'::geometry As pt,
                        'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 900)':: ↩
     geometry As line
                ) As foo;


          lol3d_line_pt          |      lol2d_line_pt
---------------------------------+--------------------------
 LINESTRING(98 190 1,50 74 1000) | LINESTRING(98 190,50 74)
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ -- 3D, 2D ⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsEWKT(ST_3DLongestLine(poly, mline)) As lol3d,
    ST_AsEWKT(ST_LongestLine(poly, mline)) As lol2d
        FROM (SELECT  ST_GeomFromEWKT('POLYGON((175 150 5, 20 40 5, 35 45 5, 50 60 5,  ↩
     100 100 5, 175 150 5))') As poly,
                ST_GeomFromEWKT('MULTILINESTRING((175 155 2, 20 40 20, 50 60 -2, 125  ↩
     100 1, 175 155 1),
                (1 10 2, 5 20 1))') As mline ) As foo;
            lol3d             |          lol2d
------------------------------+--------------------------
 LINESTRING(175 150 5,1 10 2) | LINESTRING(175 150,1 10)
```

⊠⊠

ST_3DClosestPoint, ST_3DDistance, ST_LongestLine, ST_3DShortestLine, ST_3DMaxDistance

7.12.18 ST_MaxDistance

ST_MaxDistance — ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_MaxDistance**(geometry g1, geometry g2);

⊠⊠

⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. g1 ⊠ g2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. g1 ⊠ g2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_MaxDistance('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )'::geometry);
-----------------
 2

SELECT ST_MaxDistance('POINT(0 0)'::geometry, 'LINESTRING ( 2 2, 2 2 )'::geometry);
------------------
 2.82842712474619
```

Maximum distance between vertices of a single geometry.

```
SELECT ST_MaxDistance('POLYGON ((10 10, 10 0, 0 0, 10 10))'::geometry,
                      'POLYGON ((10 10, 10 0, 0 0, 10 10))'::geometry);
------------------
 14.142135623730951
```

⊠⊠

ST_Distance, ST_LongestLine, ST_DFullyWithin

7.12.19 ST_3DMaxDistance

ST_3DMaxDistance — ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.

Synopsis

float **ST_3DMaxDistance**(geometry g1, geometry g2);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠) ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠, 2D ⊠ 3D ⊠⊠⊠⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- Geometry example - units in meters (SRID: 2163 US National Atlas Equal area) (3D point and line compared 2D point and line)
-- Note: currently no vertical datum support so Z is not transformed and assumed to be same units as final.
SELECT ST_3DMaxDistance(
                        ST_Transform(ST_GeomFromEWKT('SRID=4326;POINT(-72.1235 42.3521 10000)'),2163),
                        ST_Transform(ST_GeomFromEWKT('SRID=4326;LINESTRING(-72.1260 42.45 15, -72.123 42.1546 20)'),2163)
                ) As dist_3d,
                ST_MaxDistance(
```

```
                        ST_Transform(ST_GeomFromEWKT('SRID=4326;POINT(-72.1235 42.3521 ↩
                            10000)'),2163),
                        ST_Transform(ST_GeomFromEWKT('SRID=4326;LINESTRING(-72.1260 42.45 ↩
                            15, -72.123 42.1546 20)'),2163)
                ) As dist_2d;

     dist_3d      |     dist_2d
------------------+------------------
 24383.7467488441 | 22247.8472107251
```

⊠⊠

ST_Distance, ST_3DDWithin, ST_3DMaxDistance, ST_Transform

7.12.20 ST_MinimumClearance

ST_MinimumClearance — ⊠⊠⊠⊠⊠⊠ (robustness) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (clearance) ⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_MinimumClearance**(geometry g);

⊠⊠

(⊠⊠⊠⊠⊠⊠⊠) ST_IsValid ⊠⊠ (⊠⊠⊠⊠⊠) ST_IsSimple ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ (WKT, KML, GML GeoJSON ⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (MapInfo TAB ⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

The minimum clearance is a quantitative measure of a geometry's robustness to change in coordinate precision. It is the largest distance by which vertices of the geometry can be moved without creating an invalid geometry. Larger values of minimum clearance indicate greater robustness.

⊠⊠⊠ e ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠ e ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ e ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ST_MinimumClearance ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

To avoid validity issues caused by precision loss, ST_ReducePrecision can reduce coordinate precision while ensuring that polygonal geometry remains valid.

2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_MinimumClearance('POLYGON ((0 0, 1 0, 1 1, 0.5 3.2e-4, 0 0))');
 st_minimumclearance
---------------------
             0.00032
```

⊠⊠

ST_MinimumClearanceLine, ST_Crosses, ST_Dimension, ST_Intersects

7.12.21 ST_MinimumClearanceLine

ST_MinimumClearanceLine — ⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

Geometry **ST_MinimumClearanceLine**(geometry g);

⊠⊠

Returns the two-point LineString spanning a geometry's minimum clearance. If the geometry does not have a minimum clearance, `LINESTRING EMPTY` is returned.

GEOS ⊠⊠⊠⊠⊠

2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GEOS 3.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_AsText(ST_MinimumClearanceLine('POLYGON ((0 0, 1 0, 1 1, 0.5 3.2e-4, 0 0))'));
-------------------------------
LINESTRING(0.5 0.00032,0.5 0)
```

⊠⊠

ST_MinimumClearance

7.12.22 ST_Perimeter

ST_Perimeter — Returns the length of the boundary of a polygonal geometry or geography.

Synopsis

float **ST_Perimeter**(geometry g1);
float **ST_Perimeter**(geography geog, boolean use_spheroid = true);

⊠⊠

⊠⊠/⊠⊠⊠⊠ ST_Surface, ST_MultiSurface(⊠⊠⊠, ⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠/⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ST_Length ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

For geography types, the calculations are performed using the inverse geodesic problem, where perimeter units are in meters. If PostGIS is compiled with PROJ version 4.8.0 or later, the spheroid is specified by the SRID, otherwise it is exclusive to WGS84. If `use_spheroid = false`, then calculations will approximate a sphere instead of a spheroid.

⊠⊠⊠⊠⊠⊠ ST_Perimeter2D ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.5.1

This method implements the SQL/MM specification. SQL-MM 3: 8.1.3, 9.5.4

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ EPSG:2249 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_Perimeter(ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,743265 2967450,
743265.625 2967416,743238 2967416))', 2249));
st_perimeter
---------
 122.630744000095
(1 row)

SELECT ST_Perimeter(ST_GeomFromText('MULTIPOLYGON(((763104.471273676 2949418.44119003,
763104.477769673 2949418.42538203,
763104.189609677 2949418.22343004,763104.471273676 2949418.44119003)),
((763104.471273676 2949418.44119003,763095.804579742 2949436.33850239,
763086.132105649 2949451.46730207,763078.452329651 2949462.11549407,
763075.354136904 2949466.17407812,763064.362142565 2949477.64291974,
763059.953961626 2949481.28983009,762994.637609571 2949532.04103014,
762990.568508415 2949535.06640477,762986.710889563 2949539.61421415,
763117.237897679 2949709.50493431,763235.236617789 2949617.95619822,
763287.718121842 2949562.20592617,763111.553321674 2949423.91664605,
763104.471273676 2949418.44119003)))', 2249));
st_perimeter
---------
 845.227713366825
(1 row)
```

⊠⊠: ⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ WGS84 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT  ST_Perimeter(geog) As per_meters, ST_Perimeter(geog)/0.3048 As per_ft
FROM ST_GeogFromText('POLYGON((-71.1776848522251 42.3902896512902,-71.1776843766326 ↩
    42.3903829478009,
-71.1775844305465 42.3903826677917,-71.1775825927231 42.3902893647987,-71.1776848522251 ↩
    42.3902896512902))') As geog;

   per_meters    |      per_ft
-----------------+------------------
37.3790462565251 | 122.634666195949


-- MultiPolygon example --
SELECT  ST_Perimeter(geog) As per_meters, ST_Perimeter(geog,false) As per_sphere_meters,  ↩
    ST_Perimeter(geog)/0.3048 As per_ft
```

```
FROM ST_GeogFromText('MULTIPOLYGON(((-71.1044543107478 42.340674480411,-71.1044542869917 ↵
    42.3406744369506,
-71.1044553562977 42.340673886454,-71.1044543107478 42.340674480411)),
((-71.1044543107478 42.340674480411,-71.1044860600303 42.3407237015564,-71.1045215770124 ↵
    42.3407653385914,
-71.1045498002983 42.3407946553165,-71.1045611902745 42.3408058316308,-71.1046016507427 ↵
    42.340837442371,
-71.104617893173 42.3408475056957,-71.1048586153981 42.3409875993595,-71.1048736143677 ↵
    42.3409959528211,
-71.1048878050242 42.3410084812078,-71.1044020965803 42.3414730072048,
-71.1039672113619 42.3412202916693,-71.1037740497748 42.3410666421308,
-71.1044280218456 42.3406894151355,-71.1044543107478 42.340674480411)))') As geog;

    per_meters    | per_sphere_meters |      per_ft
------------------+-------------------+------------------
 257.634283683311 |  257.412311446337 | 845.256836231335
```

⊠⊠

ST_GeogFromText, ST_GeomFromText, ST_Length

7.12.23 ST_Perimeter2D

ST_Perimeter2D — Returns the 2D perimeter of a polygonal geometry. Alias for `ST_Perimeter`.

Synopsis

float **ST_Perimeter2D**(geometry geomA);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠ `ST_Perimeter` ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ `ST_Perimeter` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_Perimeter

7.12.24 ST_3DPerimeter

ST_3DPerimeter — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_3DPerimeter**(geometry geomA);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2 ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method implements the SQL/MM specification. SQL-MM ISO/IEC 13249-3: 8.1, 10.5

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ ST_Perimeter3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_3DPerimeter(geom), ST_Perimeter2d(geom), ST_Perimeter(geom) FROM
                        (SELECT ST_GeomFromEWKT('SRID=2249;POLYGON((743238 2967416 2,743238 ↵
                             2967450 1,
743265.625 2967416 1,743238 2967416 2))') As geom) As foo;

  ST_3DPerimeter  |  st_perimeter2d  |   st_perimeter
------------------+------------------+------------------
 105.465793597674 | 105.432997272188 | 105.432997272188
```

⊠⊠

ST_GeomFromEWKT, ST_Perimeter, ST_Perimeter2D

7.12.25 ST_ShortestLine

ST_ShortestLine — ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_ShortestLine**(geometry geom1, geometry geom2);
geography **ST_ShortestLine**(geography geom1, geography geom2, boolean use_spheroid = true);

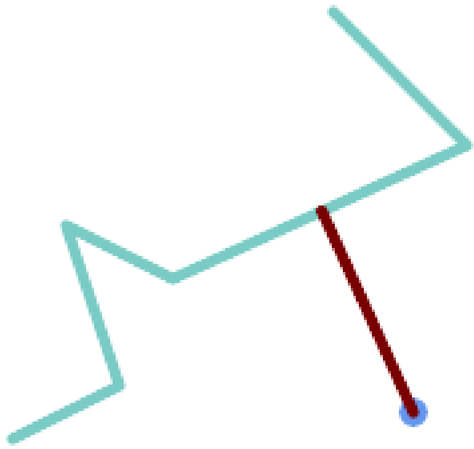
⊠⊠

Returns the 2-dimensional shortest line between two geometries. The line returned starts in `geom1` and ends in `geom2`. If `geom1` and `geom2` intersect the result is a line with start and end at an intersection point. The length of the line is the same as ST_Distance returns for g1 and g2.

Enhanced: 3.4.0 - support for geography.

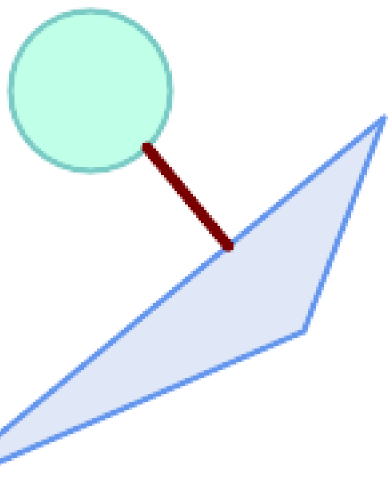
1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□



Shortest line between Point and LineString

```
SELECT ST_AsText(  ST_ShortestLine(
        'POINT (160 40)',
        'LINESTRING (10 30, 50 50, 30 110, 70 90, 180 140, 130 190)')
        ) As sline;
---------------------------------------------------------
 LINESTRING(160 40,125.75342465753425 115.34246575342466)
```



Shortest line between Polygons

```
SELECT ST_AsText( ST_ShortestLine(
         'POLYGON ((190 150, 20 10, 160 70, 190 150))',
         ST_Buffer('POINT(80 160)', 30)
              ) ) AS llinewkt;
-----------------
LINESTRING(131.59149149528952 101.89887534906197,101.21320343559644 138.78679656440357)
```

⊠⊠

ST_ClosestPoint, ST_Distance, ST_LongestLine, ST_MaxDistance

7.12.26 ST_3DShortestLine

ST_3DShortestLine — ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (shortest) ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_3DShortestLine**(geometry g1, geometry g2);

⊠⊠

⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (shortest) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. g1 ⊠ g2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. g1 ⊠ g2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ g1 ⊠⊠⊠⊠⊠⊠ g2 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠ ST_3DDistance ⊠⊠⊠ g1 ⊠ g2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, (⊠⊠⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2D ⊠ 3D ⊠⊠⊠, ⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ -- 3D, 2D ⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsEWKT(ST_3DShortestLine(line,pt)) AS shl3d_line_pt,
                ST_AsEWKT(ST_ShortestLine(line,pt)) As shl2d_line_pt
        FROM (SELECT 'POINT(100 100 30)'::geometry As pt,
                        'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 1000)':: ↩
    geometry As line
                ) As foo;


 shl3d_line_pt                                                              |  ↩
                 shl2d_line_pt
----------------------------------------------------------------------------+------------------------

 LINESTRING(54.6993798867619 128.935022917228 11.5475869506606,100 100 30)  |  ↩
    LINESTRING(73.0769230769231 115.384615384615,100 100)
```

□□□□□□□□□□□ -- 3D, 2D □□□□□□□

```
SELECT ST_AsEWKT(ST_3DShortestLine(line,pt)) AS shl3d_line_pt,
                ST_AsEWKT(ST_ShortestLine(line,pt)) As shl2d_line_pt
        FROM (SELECT 'MULTIPOINT(100 100 30, 50 74 1000)'::geometry As pt,
                        'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 900)':: ↩
    geometry As line
                ) As foo;


                       shl3d_line_pt                                       |  ↩
    shl2d_line_pt
---------------------------------------------------------------------------+------------------------

 LINESTRING(54.6993798867619 128.935022917228 11.5475869506606,100 100 30) | LINESTRING ↩
    (50 75,50 74)
```

□□□□□□□□□□□ -- 3D, 2D □□□□□□□

```
SELECT ST_AsEWKT(ST_3DShortestLine(poly, mline)) As shl3d,
    ST_AsEWKT(ST_ShortestLine(poly, mline)) As shl2d
        FROM (SELECT  ST_GeomFromEWKT('POLYGON((175 150 5, 20 40 5, 35 45 5, 50 60 5,  ↩
    100 100 5, 175 150 5))') As poly,
                ST_GeomFromEWKT('MULTILINESTRING((175 155 2, 20 40 20, 50 60 -2, 125  ↩
    100 1, 175 155 1),
                (1 10 2, 5 20 1))') As mline ) As foo;
                   shl3d  ↩
                                                                               |     shl2d
--------------------------------------------------------------------------------------------------

 LINESTRING(39.993580415989 54.1889925532825 5,40.4078575708294 53.6052383805529  ↩
    5.03423778139177) | LINESTRING(20 40,20 40)
```

□□

ST_3DClosestPoint, ST_3DDistance, ST_LongestLine, ST_ShortestLine, ST_3DMaxDistance

7.13 Overlay Functions

7.13.1 ST_ClipByBox2D

ST_ClipByBox2D — Computes the portion of a geometry falling within a rectangle.

Synopsis

geometry **ST_ClipByBox2D**(geometry geom, box2d box);

□□

Clips a geometry by a 2D box in a fast and tolerant but possibly invalid way. Topologically invalid input geometries do not result in exceptions being thrown. The output geometry is not guaranteed to be valid (in particular, self-intersections for a polygon may be introduced).

GEOS □□□□□

2.2.0 □□□□□□□□□□□□.

⊠⊠

```
-- Rely on implicit cast from geometry to box2d for the second parameter
SELECT ST_ClipByBox2D(geom, ST_MakeEnvelope(0,0,10,10)) FROM mytab;
```

⊠⊠

ST_Intersection, ST_MakeBox2D, ST_MakeEnvelope

7.13.2 ST_Difference

ST_Difference — Computes a geometry representing the part of geometry A that does not intersect geometry B.

Synopsis

geometry **ST_Difference**(geometry geomA, geometry geomB, float8 gridSize = -1);

⊠⊠

Returns a geometry representing the part of geometry A that does not intersect geometry B. This is equivalent to `A - ST_Intersection(A,B)`. If A is completely contained in B then an empty atomic geometry of appropriate type is returned.

> **Note**
> This is the only overlay function where input order matters. ST_Difference(A, B) always returns a portion of A.

If the optional `gridSize` argument is provided, the inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)

GEOS ⊠⊠⊠⊠⊠

Enhanced: 3.1.0 accept a gridSize parameter.

Requires GEOS >= 3.9.0 to use the gridSize parameter.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3

This method implements the SQL/MM specification. SQL-MM 3: 5.1.20

This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

⊠⊠

The input linestrings

The difference of the two linestrings

The difference of 2D linestrings.

```
SELECT ST_AsText(
    ST_Difference(
            'LINESTRING(50 100, 50 200)'::geometry,
            'LINESTRING(50 50, 50 150)'::geometry
        )
    );

st_astext
---------
LINESTRING(50 150,50 200)
```

The difference of 3D points.

```
SELECT ST_AsEWKT( ST_Difference(
                   'MULTIPOINT(-118.58 38.38 5,-118.60 38.329 6,-118.614 38.281 7)' :: ↩
                       geometry,
                   'POINT(-118.614 38.281 5)' :: geometry
                  ) );

st_asewkt
---------
MULTIPOINT(-118.6 38.329 6,-118.58 38.38 5)
```

⊠⊠

ST_SymDifference, ST_Intersection, ST_Union

7.13.3 ST_Intersection

ST_Intersection — Computes a geometry representing the shared portion of geometries A and B.

Synopsis

geometry **ST_Intersection**(geometry geomA , geometry geomB , float8 gridSize = -1);
geography **ST_Intersection**(geography geogA , geography geogB);

☒☒

Returns a geometry representing the point-set intersection of two geometries. In other words, that portion of geometry A and geometry B that is shared between the two geometries.

If the geometries have no points in common (i.e. are disjoint) then an empty atomic geometry of appropriate type is returned.

If the optional `gridSize` argument is provided, the inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)

ST_Intersection in conjunction with ST_Intersects is useful for clipping geometries such as in bounding box, buffer, or region queries where you only require the portion of a geometry that is inside a country or region of interest.

Note

For geography this is a thin wrapper around the geometry implementation. It first determines the best SRID that fits the bounding box of the 2 geography objects (if geography objects are within one half zone UTM but not same UTM will pick one of those) (favoring UTM or Lambert Azimuthal Equal Area (LAEA) north/south pole, and falling back on mercator in worst case scenario) and then intersection in that best fit planar spatial ref and retransforms back to WGS84 geography.

Warning

This function will drop the M coordinate values if present.

Warning

If working with 3D geometries, you may want to use SFGCAL based ST_3DIntersection which does a proper 3D intersection for 3D geometries. Although this function works with Z-coordinate, it does an averaging of Z-Coordinate.

GEOS ☒☒☒☒☒☒

Enhanced: 3.1.0 accept a gridSize parameter

Requires GEOS >= 3.9.0 to use the gridSize parameter

Changed: 3.0.0 does not depend on SFCGAL.

Availability: 1.5 support for geography data type was introduced.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3

This method implements the SQL/MM specification. SQL-MM 3: 5.1.18

This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

□□

```
SELECT ST_AsText(ST_Intersection('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )'::geometry));
 st_astext
---------------
GEOMETRYCOLLECTION EMPTY

SELECT ST_AsText(ST_Intersection('POINT(0 0)'::geometry, 'LINESTRING ( 0 0, 0 2 )'::geometry));
 st_astext
---------------
POINT(0 0)
```

Clip all lines (trails) by country. Here we assume country geom are POLYGON or MULTIPOLYGONS. NOTE: we are only keeping intersections that result in a LINESTRING or MULTILINESTRING because we don't care about trails that just share a point. The dump is needed to expand a geometry collection into individual single MULT* parts. The below is fairly generic and will work for polys, etc. by just changing the where clause.

```
select clipped.gid, clipped.f_name, clipped_geom
from (
         select trails.gid, trails.f_name,
             (ST_Dump(ST_Intersection(country.geom, trails.geom))).geom clipped_geom
         from country
              inner join trails on ST_Intersects(country.geom, trails.geom)
     ) as clipped
where ST_Dimension(clipped.clipped_geom) = 1;
```

For polys e.g. polygon landmarks, you can also use the sometimes faster hack that buffering anything by 0.0 except a polygon results in an empty geometry collection. (So a geometry collection containing polys, lines and points buffered by 0.0 would only leave the polygons and dissolve the collection shell.)

```
select poly.gid,
    ST_Multi(
        ST_Buffer(
            ST_Intersection(country.geom, poly.geom),
            0.0
        )
    ) clipped_geom
from country
     inner join poly on ST_Intersects(country.geom, poly.geom)
where not ST_IsEmpty(ST_Buffer(ST_Intersection(country.geom, poly.geom), 0.0));
```

Examples: 2.5Dish

Note this is not a true intersection, compare to the same example using ST_3DIntersection.

```
select ST_AsText(ST_Intersection(linestring, polygon)) As wkt
from  ST_GeomFromText('LINESTRING Z (2 2 6,1.5 1.5 7,1 1 8,0.5 0.5 8,0 0 10)') AS linestring
 CROSS JOIN ST_GeomFromText('POLYGON((0 0 8, 0 1 8, 1 1 8, 1 0 8, 0 0 8))') AS polygon;

               st_astext
---------------------------------------
 LINESTRING Z (1 1 8,0.5 0.5 8,0 0 10)
```

□□

ST_3DIntersection, ST_Difference, ST_Union, ST_Dimension, ST_Dump, ST_Force2D, ST_SymDifference, ST_Intersects, ST_Multi

7.13.4 ST_MemUnion

ST_MemUnion — Aggregate function which unions geometries in a memory-efficent but slower way

Synopsis

geometry **ST_MemUnion**(geometry set geomfield);

□□

An aggregate function that unions the input geometries, merging them to produce a result geometry with no overlaps. The output may be a single geometry, a MultiGeometry, or a Geometry Collection.

> **Note**
> Produces the same result as ST_Union, but uses less memory and more processor time. This aggregate function works by unioning the geometries incrementally, as opposed to the ST_Union aggregate which first accumulates an array and then unions the contents using a fast algorithm.

This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

□□

```
SELECT id,
       ST_MemUnion(geom) as singlegeom
FROM sometable f
GROUP BY id;
```

□□

ST_Union

7.13.5 ST_Node

ST_Node — Nodes a collection of lines.

Synopsis

geometry **ST_Node**(geometry geom);

⊠⊠

Returns a (Multi)LineString representing the fully noded version of a collection of linestrings. The noding preserves all of the input nodes, and introduces the least possible number of new nodes. The resulting linework is dissolved (duplicate lines are removed).

This is a good way to create fully-noded linework suitable for use as input to ST_Polygonize.

ST_UnaryUnion can also be used to node and dissolve linework. It provides an option to specify a gridSize, which can provide simpler and more robust output. See also ST_Union for an aggregate variant.

This function supports 3d and will not drop the z-index.

GEOS ⊠⊠⊠⊠⊠

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Changed: 2.4.0 this function uses GEOSNode internally instead of GEOSUnaryUnion. This may cause the resulting linestrings to have a different order and direction compared to PostGIS < 2.4.

⊠⊠

Noding a 3D LineString which self-intersects

```
SELECT ST_AsText(
        ST_Node('LINESTRINGZ(0 0 0, 10 10 10, 0 10 5, 10 0 3)'::geometry)
    ) As  output;
output
-----------
MULTILINESTRING Z ((0 0 0,5 5 4.5),(5 5 4.5,10 10 10,0 10 5,5 5 4.5),(5 5 4.5,10 0 3))
```

Noding two LineStrings which share common linework. Note that the result linework is dissolved.

```
SELECT ST_AsText(
        ST_Node('MULTILINESTRING ((2 5, 2 1, 7 1), (6 1, 4 1, 2 3, 2 5))'::geometry)
    ) As  output;
output
-----------
MULTILINESTRING((2 5,2 3),(2 3,2 1,4 1),(4 1,2 3),(4 1,6 1),(6 1,7 1))
```

⊠⊠

ST_UnaryUnion, ST_AsBinary

7.13.6 ST_Split

ST_Split — Returns a collection of geometries created by splitting a geometry by another geometry.

Synopsis

geometry **ST_Split**(geometry input, geometry blade);

⊠⊠

The function supports splitting a LineString by a (Multi)Point, (Multi)LineString or (Multi)Polygon boundary, or a (Multi)Polygon by a LineString. When a (Multi)Polygon is used as as the blade, its linear components (the boundary) are used for splitting the input. The result geometry is always a collection.

This function is in a sense the opposite of ST_Union. Applying ST_Union to the returned collection should theoretically yield the original geometry (although due to numerical rounding this may not be exactly the case).

> **Note**
> If the the input and blade do not intersect due to numerical precision issues, the input may not be split as expected. To avoid this situation it may be necessary to snap the input to the blade first, using ST_Snap with a small tolerance.

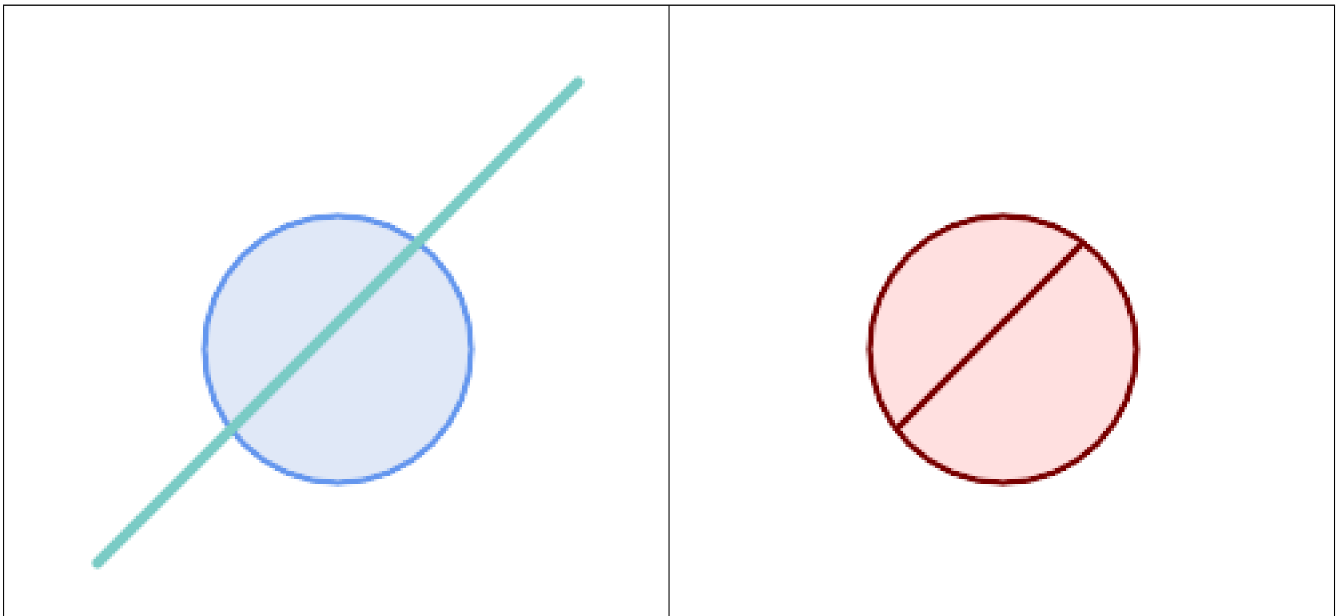
Availability: 2.0.0 requires GEOS

Enhanced: 2.2.0 support for splitting a line by a multiline, a multipoint or (multi)polygon boundary was introduced.

Enhanced: 2.5.0 support for splitting a polygon by a multiline was introduced.

⊠⊠

Split a Polygon by a Line.

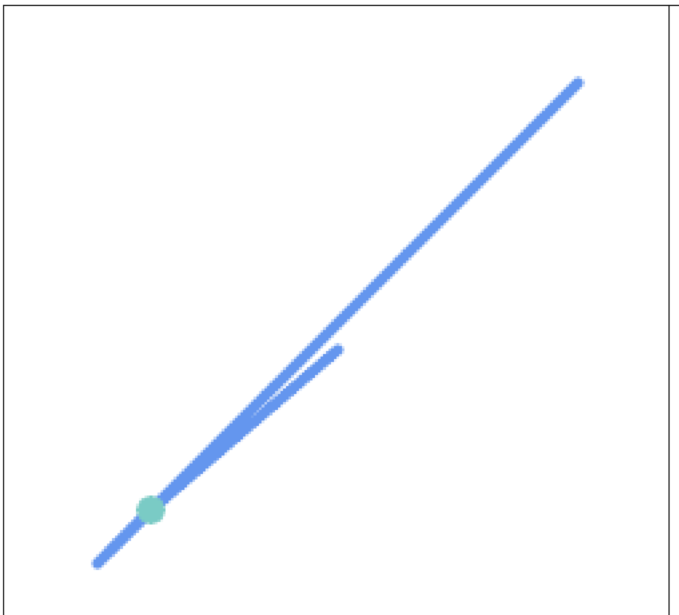


Before Split | *After split*

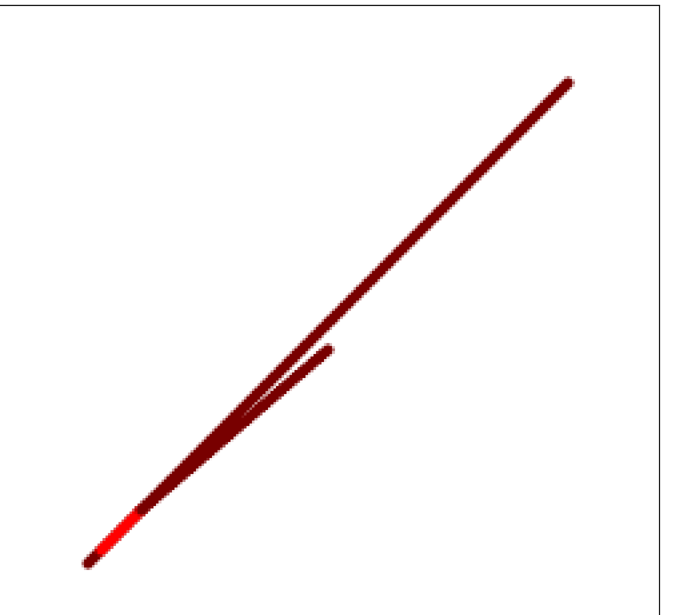
```
SELECT ST_AsText( ST_Split(
                ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50), -- circle
                ST_MakeLine(ST_Point(10, 10),ST_Point(190, 190)) -- line
    ));

-- result --
 GEOMETRYCOLLECTION(
```

```
            POLYGON((150 90,149.039264020162 80.2454838991936,146.193976625564  ↩
                70.8658283817455,..),
            POLYGON(..))
)
```

Split a MultiLineString by a Point, where the point lies exactly on both LineStrings elements.



Before Split



After split

```
SELECT ST_AsText(ST_Split(
    'MULTILINESTRING((10 10, 190 190), (15 15, 30 30, 100 90))',
    ST_Point(30,30))) As split;

split
------
GEOMETRYCOLLECTION(
    LINESTRING(10 10,30 30),
    LINESTRING(30 30,190 190),
    LINESTRING(15 15,30 30),
    LINESTRING(30 30,100 90)
)
```

Split a LineString by a Point, where the point does not lie exactly on the line. Shows using ST_Snap to snap the line to the point to allow it to be split.

```
WITH data AS (SELECT
  'LINESTRING(0 0, 100 100)'::geometry AS line,
  'POINT(51 50)':: geometry AS point
)
SELECT ST_AsText( ST_Split( ST_Snap(line, point, 1), point)) AS snapped_split,
       ST_AsText( ST_Split(line, point)) AS not_snapped_not_split
       FROM data;

                            snapped_split                             |              ↩
                                not_snapped_not_split
---------------------------------------------------------------------+-----------------------------

 GEOMETRYCOLLECTION(LINESTRING(0 0,51 50),LINESTRING(51 50,100 100)) | GEOMETRYCOLLECTION( ↩
    LINESTRING(0 0,100 100))
```

⊠⊠

ST_Snap, ST_AsBinary

7.13.7 ST_Subdivide

ST_Subdivide — Computes a rectilinear subdivision of a geometry.

Synopsis

setof geometry **ST_Subdivide**(geometry geom, integer max_vertices=256, float8 gridSize = -1);

⊠⊠

Returns a set of geometries that are the result of dividing `geom` into parts using rectilinear lines, with each part containing no more than `max_vertices`.

`max_vertices` must be 5 or more, as 5 points are needed to represent a closed box. `gridSize` can be specified to have clipping work in fixed-precision space (requires GEOS-3.9.0+).

Point-in-polygon and other spatial operations are normally faster for indexed subdivided datasets. Since the bounding boxes for the parts usually cover a smaller area than the original geometry bbox, index queries produce fewer "hit" cases. The "hit" cases are faster because the spatial operations executed by the index recheck process fewer points.

> **Note**
> This is a set-returning function (SRF) that return a set of rows containing single geometry values. It can be used in a SELECT list or a FROM clause to produce a result set with one record for each result geometry.

GEOS ⊠⊠⊠⊠⊠

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

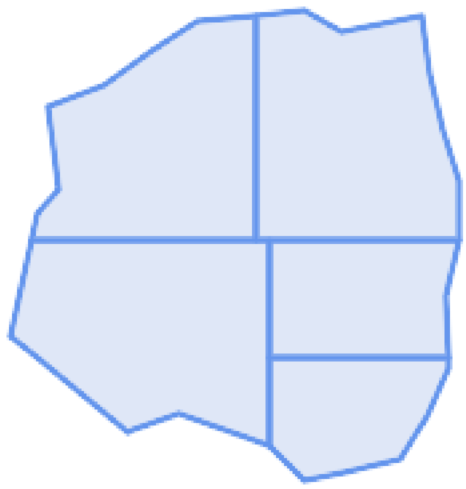
Enhanced: 2.5.0 reuses existing points on polygon split, vertex count is lowered from 8 to 5.

Enhanced: 3.1.0 accept a gridSize parameter.

Requires GEOS >= 3.9.0 to use the gridSize parameter

⊠⊠

Example: Subdivide a polygon into parts with no more than 10 vertices, and assign each part a unique id.

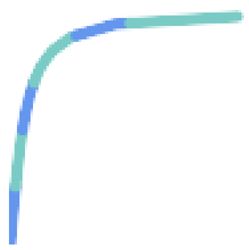


Subdivided to maximum 10 vertices

```
SELECT row_number() OVER() As rn, ST_AsText(geom) As wkt
    FROM (SELECT ST_SubDivide(
        'POLYGON((132 10,119 23,85 35,68 29,66 28,49 42,32 56,22 64,32 110,40 119,36 150,
        57 158,75 171,92 182,114 184,132 186,146 178,176 184,179 162,184 141,190 122,
        190 100,185 79,186 56,186 52,178 34,168 18,147 13,132 10))'::geometry,10))  AS f( ↩
            geom);
```

```
rn b''|b''                                                          wkt
b''─b''b''─b''b''─b''b''─b''b''┼b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b'' ↩
    b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b'' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b' ↩
    '─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''b''─b''
  1 b''|b'' POLYGON((119 23,85 35,68 29,66 28,32 56,22 64,29.8260869565217 100,119 100,119 ↩
      23))
  2 b''|b'' POLYGON((132 10,119 23,119 56,186 56,186 52,178 34,168 18,147 13,132 10))
  3 b''|b'' POLYGON((119 56,119 100,190 100,185 79,186 56,119 56))
  4 b''|b'' POLYGON((29.8260869565217 100,32 110,40 119,36 150,57 158,75 171,92 182,114 ↩
      184,114 100,29.8260869565217 100))
  5 b''|b'' POLYGON((114 184,132 186,146 178,176 184,179 162,184 141,190 122,190 100,114 ↩
      100,114 184))
```

Example: Densify a long geography line using ST_Segmentize(geography, distance), and use ST_Subdivide to split the resulting line into sublines of 8 vertices.



The densified and split lines.

```
SELECT ST_AsText( ST_Subdivide(
            ST_Segmentize('LINESTRING(0 0, 85 85)'::geography,
                          1200000)::geometry,    8));
```

```
LINESTRING(0 0,0.487578359029357 5.57659056746196,0.984542144675897 ↩
    11.1527721155093,1.50101059639722 16.7281035483571,1.94532113630331 21.25)
LINESTRING(1.94532113630331 21.25,2.04869538062779 22.3020741387339,2.64204641967673 ↩
    27.8740533545155,3.29994062412787 33.443216802941,4.04836719489742 ↩
    39.0084282520239,4.59890468420694 42.5)
LINESTRING(4.59890468420694 42.5,4.92498503922732 44.5680389206321,5.98737409390639 ↩
    50.1195229244701,7.3290919767674 55.6587646879025,8.79638749938413 60.1969505994924)
LINESTRING(8.79638749938413 60.1969505994924,9.11375579533779 ↩
    61.1785363177625,11.6558166691368 66.6648504160202,15.642041247655 ↩
    72.0867690601745,22.8716627200212 77.3609628116894,24.6991785131552 77.8939011989848)
LINESTRING(24.6991785131552 77.8939011989848,39.4046096622744 ↩
    82.1822848017636,44.7994523421035 82.5156766227011)
LINESTRING(44.7994523421035 82.5156766227011,85 85)
```

Example: Subdivide the complex geometries of a table in-place. The original geometry records are deleted from the source table, and new records for each subdivided result geometry are inserted.

```
WITH complex_areas_to_subdivide AS (
    DELETE from polygons_table
    WHERE ST_NPoints(geom)
> 255
    RETURNING id, column1, column2, column3, geom
)
INSERT INTO polygons_table (fid, column1, column2, column3, geom)
    SELECT fid, column1, column2, column3,
           ST_Subdivide(geom, 255) as geom
    FROM complex_areas_to_subdivide;
```

Example: Create a new table containing subdivided geometries, retaining the key of the original geometry so that the new table can be joined to the source table. Since ST_Subdivide is a set-returning (table) function that returns a set of single-value rows, this syntax automatically produces a table with one row for each result part.

```
CREATE TABLE subdivided_geoms AS
```

```
SELECT pkey, ST_Subdivide(geom) AS geom
FROM original_geoms;
```

⊠⊠

ST_ClipByBox2D, ST_Segmentize, ST_Split, ST_NPoints

7.13.8 ST_SymDifference

ST_SymDifference — Computes a geometry representing the portions of geometries A and B that do not intersect.

Synopsis

geometry **ST_SymDifference**(geometry geomA, geometry geomB, float8 gridSize = -1);

⊠⊠

Returns a geometry representing the portions of geonetries A and B that do not intersect. This is equivalent to `ST_Union(A,B) - ST_Intersection(A,B)`. It is called a symmetric difference because `ST_SymDifference(A,B) = ST_SymDifference(B,A)`.

If the optional `gridSize` argument is provided, the inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)

GEOS ⊠⊠⊠⊠⊠

Enhanced: 3.1.0 accept a gridSize parameter.

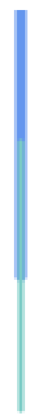
Requires GEOS >= 3.9.0 to use the gridSize parameter

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3

This method implements the SQL/MM specification. SQL-MM 3: 5.1.21

This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

⊠⊠

	
The original linestrings shown together	*The symmetric difference of the two linestrings*

```
--Safe for 2d - symmetric difference of 2 linestrings
SELECT ST_AsText(
    ST_SymDifference(
        ST_GeomFromText('LINESTRING(50 100, 50 200)'),
        ST_GeomFromText('LINESTRING(50 50, 50 150)')
    )
);

st_astext
---------
MULTILINESTRING((50 150,50 200),(50 50,50 100))
```

```
--When used in 3d doesn't quite do the right thing
SELECT ST_AsEWKT(ST_SymDifference(ST_GeomFromEWKT('LINESTRING(1 2 1, 1 4 2)'),
    ST_GeomFromEWKT('LINESTRING(1 1 3, 1 3 4)')))

st_astext
------------
MULTILINESTRING((1 3 2.75,1 4 2),(1 1 3,1 2 2.25))
```

□□

ST_Difference, ST_Intersection, ST_Union

7.13.9 ST_UnaryUnion

ST_UnaryUnion — Computes the union of the components of a single geometry.

Synopsis

geometry **ST_UnaryUnion**(geometry geom, float8 gridSize = -1);

⊠⊠

A single-input variant of ST_Union. The input may be a single geometry, a MultiGeometry, or a GeometryCollection. The union is applied to the individual elements of the input.

This function can be used to fix MultiPolygons which are invalid due to overlapping components. However, the input components must each be valid. An invalid input component such as a bow-tie polygon may cause an error. For this reason it may be better to use ST_MakeValid.

Another use of this function is to node and dissolve a collection of linestrings which cross or overlap to make them simple. (ST_Node also does this, but it does not provide the `gridSize` option.)

It is possible to combine ST_UnaryUnion with ST_Collect to fine-tune how many geometries are be unioned at once. This allows trading off between memory usage and compute time, striking a balance between ST_Union and ST_MemUnion.

If the optional `gridSize` argument is provided, the inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)

This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

Enhanced: 3.1.0 accept a gridSize parameter.

Requires GEOS >= 3.9.0 to use the gridSize parameter

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_Union, ST_MemUnion, ST_MakeValid, ST_Collect, ST_Node

7.13.10 ST_Union

ST_Union — Computes a geometry representing the point-set union of the input geometries.

Synopsis

geometry **ST_Union**(geometry g1, geometry g2);
geometry **ST_Union**(geometry g1, geometry g2, float8 gridSize);
geometry **ST_Union**(geometry[] g1_array);
geometry **ST_Union**(geometry set g1field);
geometry **ST_Union**(geometry set g1field, float8 gridSize);

⊠⊠

Unions the input geometries, merging geometry to produce a result geometry with no overlaps. The output may be an atomic geometry, a MultiGeometry, or a Geometry Collection. Comes in several variants:

Two-input variant: returns a geometry that is the union of two input geometries. If either input is NULL, then NULL is returned.

Array variant: returns a geometry that is the union of an array of geometries.

Aggregate variant: returns a geometry that is the union of a rowset of geometries. The ST_Union() function is an "aggregate" function in the terminology of PostgreSQL. That means that it operates on rows of data, in the same way the SUM() and AVG() functions do and like most aggregates, it also ignores NULL geometries.

See ST_UnaryUnion for a non-aggregate, single-input variant.

The ST_Union array and set variants use the fast Cascaded Union algorithm described in http://blog.cleverele 2009/01/must-faster-unions-in-postgis-14.html

A `gridSize` can be specified to work in fixed-precision space. The inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)

Note
ST_Collect may sometimes be used in place of ST_Union, if the result is not required to be non-overlapping. ST_Collect is usually faster than ST_Union because it performs no processing on the collected geometries.

GEOS ⊠⊠⊠⊠⊠

ST_Union creates MultiLineString and does not sew LineStrings into a single LineString. Use ST_LineMerge to sew LineStrings.

NOTE: this function was formerly called GeomUnion(), which was renamed from "Union" because UNION is an SQL reserved word.

Enhanced: 3.1.0 accept a gridSize parameter.

Requires GEOS >= 3.9.0 to use the gridSize parameter

Changed: 3.0.0 does not depend on SFCGAL.

Availability: 1.4.0 - ST_Union was enhanced. ST_Union(geomarray) was introduced and also faster aggregate collection in PostgreSQL.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3

Note
Aggregate version is not explicitly defined in OGC SPEC.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.19 the z-index (elevation) when polygons are involved.

This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

⊠⊠

Aggregate example

```
SELECT id,
       ST_Union(geom) as singlegeom
FROM sometable f
GROUP BY id;
```

Non-Aggregate example

```
select ST_AsText(ST_Union('POINT(1 2)' :: geometry, 'POINT(-2 3)' :: geometry))

st_astext
----------
MULTIPOINT(-2 3,1 2)

select ST_AsText(ST_Union('POINT(1 2)' :: geometry, 'POINT(1 2)' :: geometry))

st_astext
----------
POINT(1 2)
```

3D example - sort of supports 3D (and with mixed dimensions!)

```
select ST_AsEWKT(ST_Union(geom))
from (
         select 'POLYGON((-7 4.2,-7.1 4.2,-7.1 4.3, -7 4.2))'::geometry geom
         union all
         select 'POINT(5 5 5)'::geometry geom
         union all
         select 'POINT(-2 3 1)'::geometry geom
         union all
         select 'LINESTRING(5 5 5, 10 10 10)'::geometry geom
     ) as foo;

st_asewkt
---------
GEOMETRYCOLLECTION(POINT(-2 3 1),LINESTRING(5 5 5,10 10 10),POLYGON((-7 4.2 5,-7.1 4.2  ↩
    5,-7.1 4.3 5,-7 4.2 5)));
```

3d example not mixing dimensions

```
select ST_AsEWKT(ST_Union(geom))
from (
         select 'POLYGON((-7 4.2 2,-7.1 4.2 3,-7.1 4.3 2, -7 4.2 2))'::geometry geom
         union all
         select 'POINT(5 5 5)'::geometry geom
         union all
         select 'POINT(-2 3 1)'::geometry geom
         union all
         select 'LINESTRING(5 5 5, 10 10 10)'::geometry geom
     ) as foo;

st_asewkt
---------
GEOMETRYCOLLECTION(POINT(-2 3 1),LINESTRING(5 5 5,10 10 10),POLYGON((-7 4.2 2,-7.1 4.2  ↩
    3,-7.1 4.3 2,-7 4.2 2)))

--Examples using new Array construct
SELECT ST_Union(ARRAY(SELECT geom FROM sometable));

SELECT ST_AsText(ST_Union(ARRAY[ST_GeomFromText('LINESTRING(1 2, 3 4)'),
            ST_GeomFromText('LINESTRING(3 4, 4 5)')])) As wktunion;

--wktunion---
MULTILINESTRING((3 4,4 5),(1 2,3 4))
```

⊠⊠

ST_Collect, ST_UnaryUnion, ST_MemUnion, ST_Intersection, ST_Difference, ST_SymDifference

7.14 ⊠⊠⊠⊠⊠⊠

7.14.1 ST_Buffer

ST_Buffer — Computes a geometry covering all points within a given distance from a geometry.

Synopsis

geometry **ST_Buffer**(geometry g1, float radius_of_buffer, text buffer_style_parameters = ”);
geometry **ST_Buffer**(geometry g1, float radius_of_buffer, integer num_seg_quarter_circle);
geography **ST_Buffer**(geography g1, float radius_of_buffer, text buffer_style_parameters);
geography **ST_Buffer**(geography g1, float radius_of_buffer, integer num_seg_quarter_circle);

⊠⊠

Computes a POLYGON or MULTIPOLYGON that represents all points whose distance from a geometry/geography is less than or equal to a given distance. A negative distance shrinks the geometry rather than expanding it. A negative distance may shrink a polygon completely, in which case POLYGON EMPTY is returned. For points and lines negative distances always return empty results.

For geometry, the distance is specified in the units of the Spatial Reference System of the geometry. For geography, the distance is specified in meters.

The optional third parameter controls the buffer accuracy and style. The accuracy of circular arcs in the buffer is specified as the number of line segments used to approximate a quarter circle (default is 8). The buffer style can be specified by providing a list of blank-separated key=value pairs as follows:

- 'quad_segs=#' : number of line segments used to approximate a quarter circle (default is 8).
- 'endcap=round|flat|square' : endcap style (defaults to "round"). 'butt' is accepted as a synonym for 'flat'.
- 'join=round|mitre|bevel' : join style (defaults to "round"). 'miter' is accepted as a synonym for 'mitre'.
- 'mitre_limit=#.#' : mitre ratio limit (only affects mitered join style). 'miter_limit' is accepted as a synonym for 'mitre_limit'.
- 'side=both|left|right' : 'left' or 'right' performs a single-sided buffer on the geometry, with the buffered side relative to the direction of the line. This is only applicable to LINESTRING geometry and does not affect POINT or POLYGON geometries. By default end caps are square.

> **Note**
> For geography this is a thin wrapper around the geometry implementation. It determines a planar spatial reference system that best fits the bounding box of the geography object (trying UTM, Lambert Azimuthal Equal Area (LAEA) North/South pole, and finally Mercator). The buffer is computed in the planar space, and then transformed back to WGS84. This may not produce the desired behavior if the input object is much larger than a UTM zone or crosses the dateline

Note
Buffer output is always a valid polygonal geometry. Buffer can handle invalid inputs, so buffering by distance 0 is sometimes used as a way of repairing invalid polygons. ST_MakeValid can also be used for this purpose.

Note
Buffering is sometimes used to perform a within-distance search. For this use case it is more efficient to use ST_DWithin.

Note
This function ignores the Z dimension. It always gives a 2D result even when used on a 3D geometry.

Enhanced: 2.5.0 - ST_Buffer geometry support was enhanced to allow for side buffering specification `side=both|left|right`.

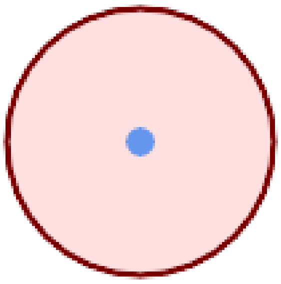
Availability: 1.5 - ST_Buffer was enhanced to support different endcaps and join types. These are useful for example to convert road linestrings into polygon roads with flat or square edges instead of rounded edges. Thin wrapper for geography was added.

GEOS ⊠⊠⊠⊠⊠

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3

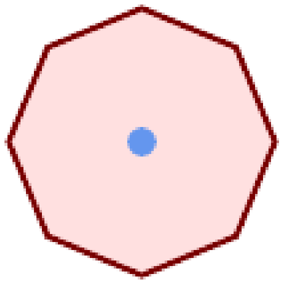
This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1.30

⊠⊠



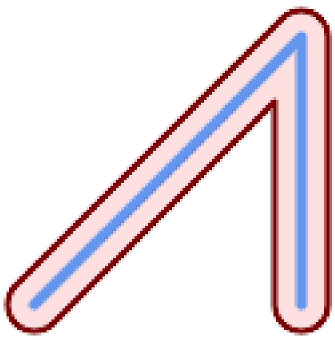
quad_segs=8 (□□□)

```
SELECT ST_Buffer(
 ST_GeomFromText('POINT(100 90)'),
 50, 'quad_segs=8');
```



quad_segs=2 (□□)

```
SELECT ST_Buffer(
 ST_GeomFromText('POINT(100 90)'),
 50, 'quad_segs=2');
```

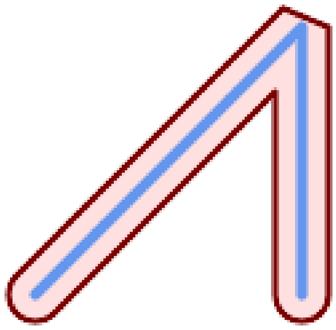


endcap=round join=round (□□□)

```
SELECT ST_Buffer(
 ST_GeomFromText(
  'LINESTRING(50 50,150 150,150 50)'
 ), 10, 'endcap=round join=round');
```

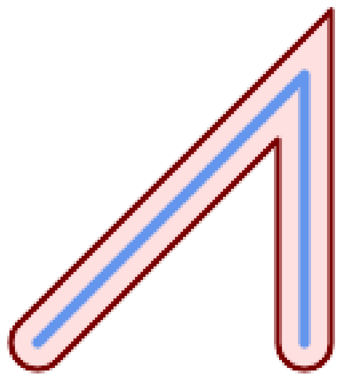
endcap=square

```
SELECT ST_Buffer(
 ST_GeomFromText(
  'LINESTRING(50 50,150 150,150 50)'
 ), 10, 'endcap=square join=round');
```



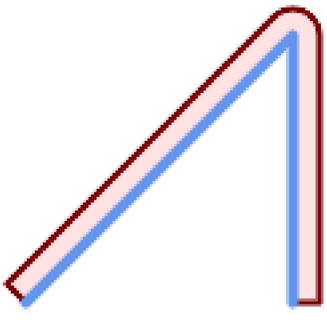
join=bevel

```
SELECT ST_Buffer(
 ST_GeomFromText(
  'LINESTRING(50 50,150 150,150 50)'
 ), 10, 'join=bevel');
```



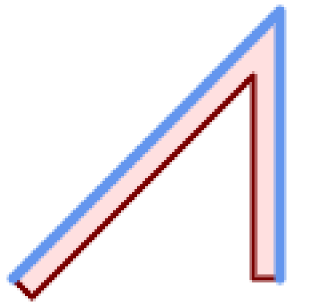
join=mitre mitre_limit=5.0 (☒☒☒☒☒☒☒☒)

```
SELECT ST_Buffer(
 ST_GeomFromText(
  'LINESTRING(50 50,150 150,150 50)'
 ), 10, 'join=mitre mitre_limit=5.0');
```



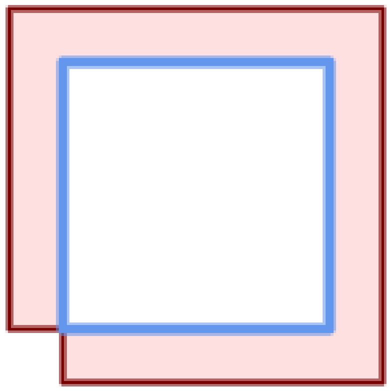
side=left

```
SELECT ST_Buffer(
 ST_GeomFromText(
  'LINESTRING(50 50,150 150,150 50)'
 ), 10, 'side=left');
```



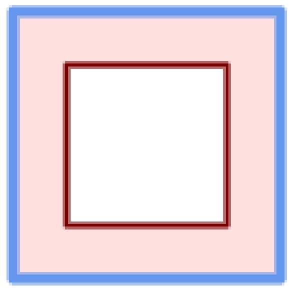
side=right

```
SELECT ST_Buffer(
 ST_GeomFromText(
  'LINESTRING(50 50,150 150,150 50)'
 ), 10, 'side=right');
```



right-hand-winding, polygon boundary side=left

```
SELECT ST_Buffer(
ST_ForceRHR(
ST_Boundary(
 ST_GeomFromText(
'POLYGON ((50 50, 50 150, 150 150, 150 50, 50 50))'))),
 ), 20, 'side=left');
```



right-hand-winding, polygon boundary side=right

```
SELECT ST_Buffer(
ST_ForceRHR(
ST_Boundary(
 ST_GeomFromText(
'POLYGON ((50 50, 50 150, 150 150, 150 50, 50 50))'))
), 20,'side=right')
```

```
--A buffered point approximates a circle
-- A buffered point forcing approximation of (see diagram)
-- 2 points per quarter circle is poly with 8 sides (see diagram)
SELECT ST_NPoints(ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50)) As promisingcircle_pcount,
ST_NPoints(ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50, 2)) As lamecircle_pcount;

promisingcircle_pcount | lamecircle_pcount
------------------------+-------------------
             33 |                9

--A lighter but lamer circle
-- only 2 points per quarter circle is an octagon
--Below is a 100 meter octagon
-- Note coordinates are in NAD 83 long lat which we transform
to Mass state plane meter and then buffer to get measurements in meters;
SELECT ST_AsText(ST_Buffer(
ST_Transform(
ST_SetSRID(ST_Point(-71.063526, 42.35785),4269), 26986)
,100,2)) As octagon;
----------------------
POLYGON((236057.59057465 900908.759918696,236028.301252769 900838.049240578,235
957.59057465 900808.759918696,235886.879896532 900838.049240578,235857.59057465
900908.759918696,235886.879896532 900979.470596815,235957.59057465 901008.759918
696,236028.301252769 900979.470596815,236057.59057465 900908.759918696))
```

⊠⊠

ST_Collect, ST_DWithin, ST_SetSRID, ST_Transform, ST_Union, ST_MakeValid

7.14.2 ST_BuildArea

ST_BuildArea — Creates a polygonal geometry formed by the linework of a geometry.

Synopsis

geometry **ST_BuildArea**(geometry geom);

⊠⊠

Creates an areal geometry formed by the constituent linework of the input geometry. The input can be a LineString, MultiLineString, Polygon, MultiPolygon or a GeometryCollection. The result is a Polygon or MultiPolygon, depending on input. If the input linework does not form polygons, NULL is returned.

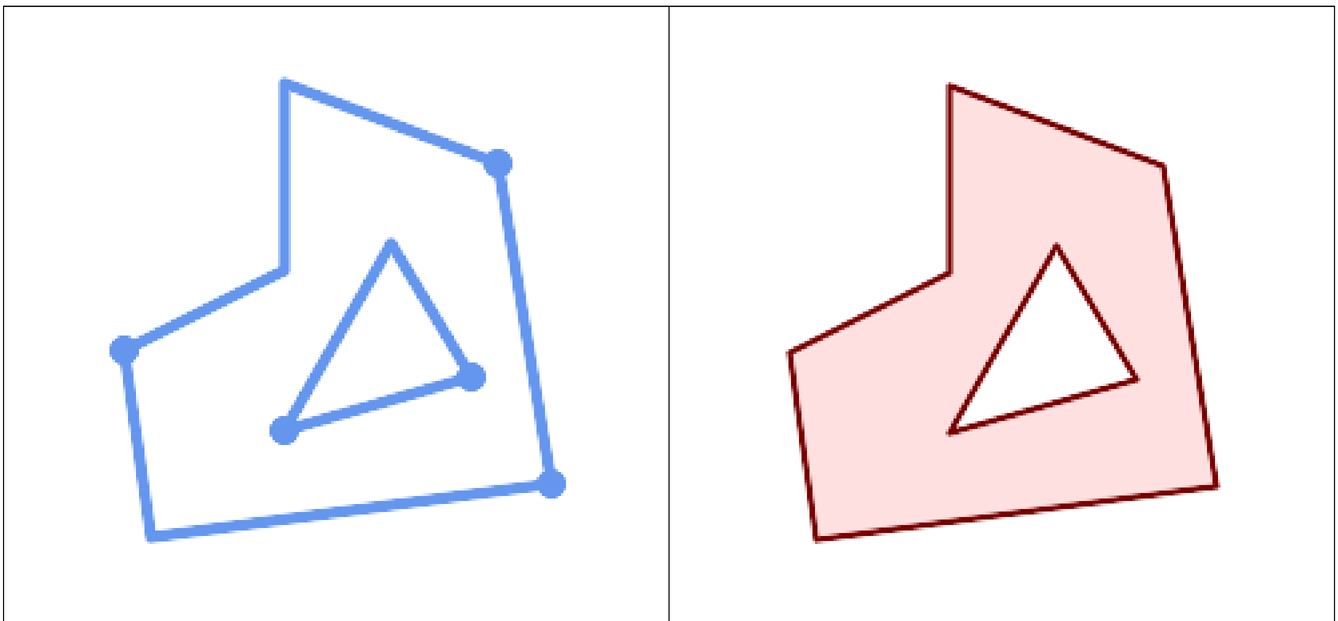
Unlike ST_MakePolygon, this function accepts rings formed by multiple lines, and can form any number of polygons.

This function converts inner rings into holes. To turn inner rings into polygons as well, use ST_Polygonize.

> **Note**
> Input linework must be correctly noded for this function to work properly. ST_Node can be used to node lines.
> If the input linework crosses, this function will produce invalid polygons. ST_MakeValid can be used to ensure the output is valid.

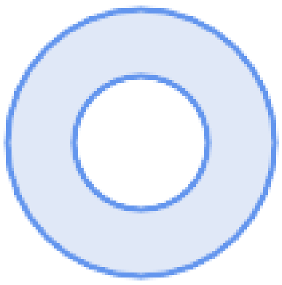
1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠



Input lines *Area result*

```
WITH data(geom) AS (VALUES
   ('LINESTRING (180 40, 30 20, 20 90)'::geometry)
  ,('LINESTRING (180 40, 160 160)'::geometry)
  ,('LINESTRING (160 160, 80 190, 80 120, 20 90)'::geometry)
  ,('LINESTRING (80 60, 120 130, 150 80)'::geometry)
  ,('LINESTRING (80 60, 150 80)'::geometry)
)
SELECT ST_AsText( ST_BuildArea( ST_Collect( geom )))
    FROM data;

------------------------------------------------------------------------------------------
POLYGON((180 40,30 20,20 90,80 120,80 190,160 160,180 40),(150 80,120 130,80 60,150 80))
```



Create a donut from two circular polygons

```
SELECT ST_BuildArea(ST_Collect(inring,outring))
FROM (SELECT
    ST_Buffer('POINT(100 90)', 25) As inring,
    ST_Buffer('POINT(100 90)', 50) As outring) As t;
```

⊠⊠

ST_Collect, ST_MakePolygon, ST_MakeValid, ST_Node, ST_Polygonize, ST_BdPolyFromText, ST_BdMPolyFr
(wrappers to this function with standard OGC interface)

7.14.3 ST_Centroid

ST_Centroid — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Centroid**(geometry g1);
geography **ST_Centroid**(geography g1, boolean use_spheroid = true);

⊠⊠

Computes a point which is the geometric center of mass of a geometry. For `[MULTI]POINT`s, the centroid is the arithmetic mean of the input coordinates. For `[MULTI]LINESTRING`s, the centroid is computed using the weighted length of each line segment. For `[MULTI]POLYGON`s, the centroid is computed in terms of area. If an empty geometry is supplied, an empty `GEOMETRYCOLLECTION` is returned. If `NULL` is supplied, `NULL` is returned. If `CIRCULARSTRING` or `COMPOUNDCURVE` are supplied, they are converted to linestring with CurveToLine first, then same than for `LINESTRING`

For mixed-dimension input, the result is equal to the centroid of the component Geometries of highest dimension (since the lower-dimension geometries contribute zero "weight" to the centroid).

Note that for polygonal geometries the centroid does not necessarily lie in the interior of the polygon. For example, see the diagram below of the centroid of a C-shaped polygon. To construct a point guaranteed to lie in the interior of a polygon use ST_PointOnSurface.

New in 2.3.0 : supports `CIRCULARSTRING` and `COMPOUNDCURVE` (using CurveToLine)

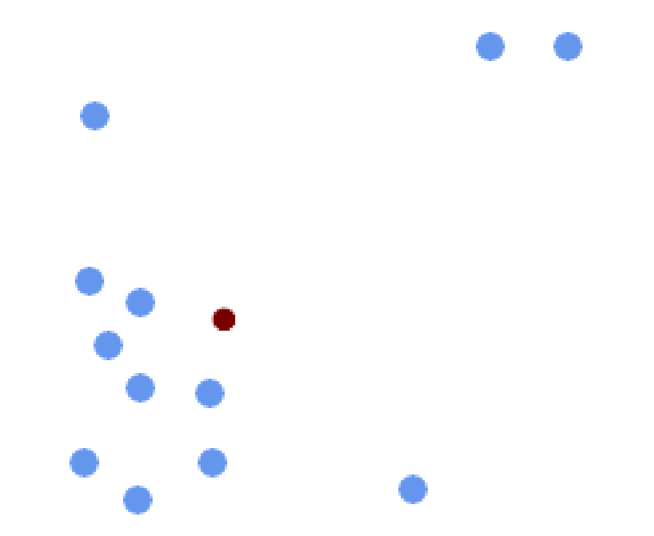
Availability: 2.4.0 support for geography was introduced.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1.

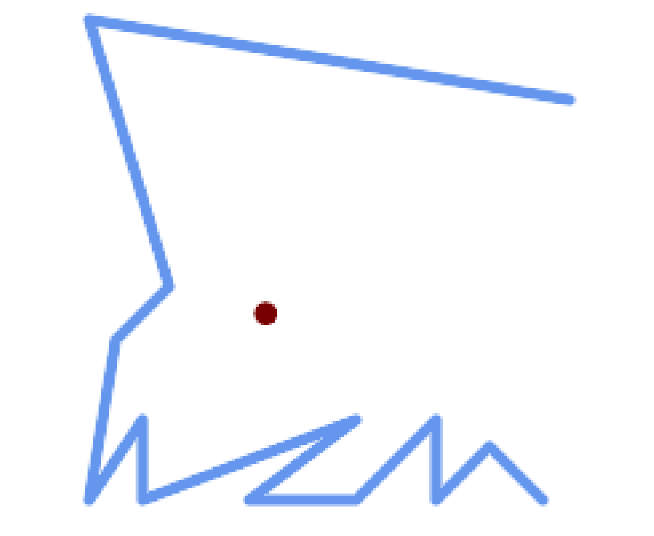
This method implements the SQL/MM specification. SQL-MM 3: 8.1.4, 9.5.5

⊠⊠

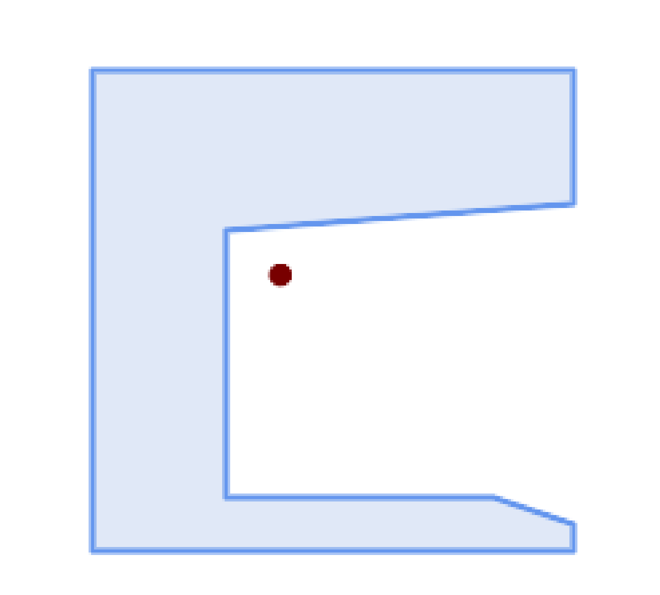
In the following illustrations the red dot is the centroid of the source geometry.



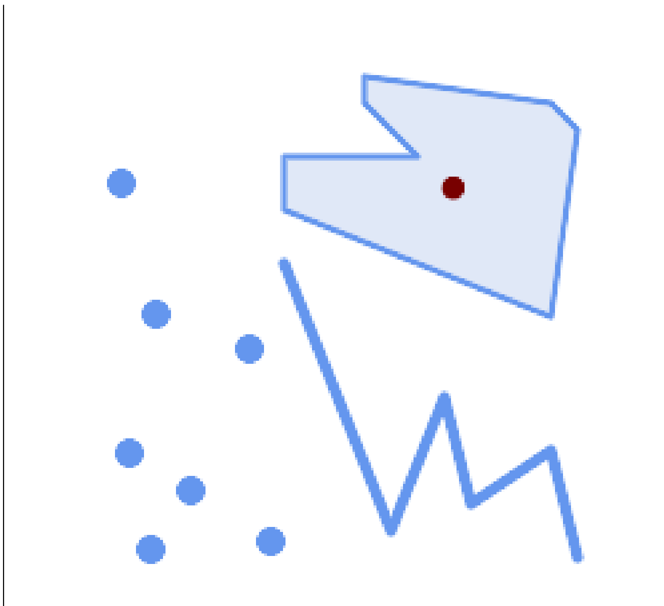
MULTIPOINT ⊠⊠⊠⊠



LINESTRING ⊠⊠⊠⊠



POLYGON □□□□



GEOMETRYCOLLECTION □□□□

```
SELECT ST_AsText(ST_Centroid('MULTIPOINT ( -1 0, -1 2, -1 3, -1 4, -1 7, 0 1, 0 3, 1 1, 2 0, 6 0, 7 8, 9 8, 10 6 )'));
                st_astext
------------------------------------------
 POINT(2.30769230769231 3.30769230769231)
(1 row)

SELECT ST_AsText(ST_centroid(g))
FROM  ST_GeomFromText('CIRCULARSTRING(0 2, -1 1,0 0, 0.5 0, 1 0, 2 1, 1 2, 0.5 2, 0 2)') AS g ;
------------------------------------------
POINT(0.5 1)


SELECT ST_AsText(ST_centroid(g))
FROM  ST_GeomFromText('COMPOUNDCURVE(CIRCULARSTRING(0 2, -1 1,0 0),(0 0, 0.5 0, 1 0), CIRCULARSTRING( 1 0, 2 1, 1 2),(1 2, 0.5 2, 0 2))' ) AS g;
------------------------------------------
POINT(0.5 1)
```

□□

ST_PointOnSurface, ST_GeometricMedian

7.14.4 ST_ChaikinSmoothing

ST_ChaikinSmoothing — Returns a smoothed version of a geometry, using the Chaikin algorithm

Synopsis

geometry **ST_ChaikinSmoothing**(geometry geom, integer nIterations = 1, boolean preserveEndPoints = false);

☒☒

Smoothes a linear or polygonal geometry using Chaikin's algorithm. The degree of smoothing is controlled by the `nIterations` parameter. On each iteration, each interior vertex is replaced by two vertices located at 1/4 of the length of the line segments before and after the vertex. A reasonable degree of smoothing is provided by 3 iterations; the maximum is limited to 5.

If `preserveEndPoints` is true, the endpoints of Polygon rings are not smoothed. The endpoints of LineStrings are always preserved.

> **Note**
> The number of vertices doubles with each iteration, so the result geometry may have many more points than the input. To reduce the number of points use a simplification function on the result (see ST_Simplify, ST_SimplifyPreserveTopology and ST_SimplifyVW).

The result has interpolated values for the Z and M dimensions when present.

This function supports 3d and will not drop the z-index.

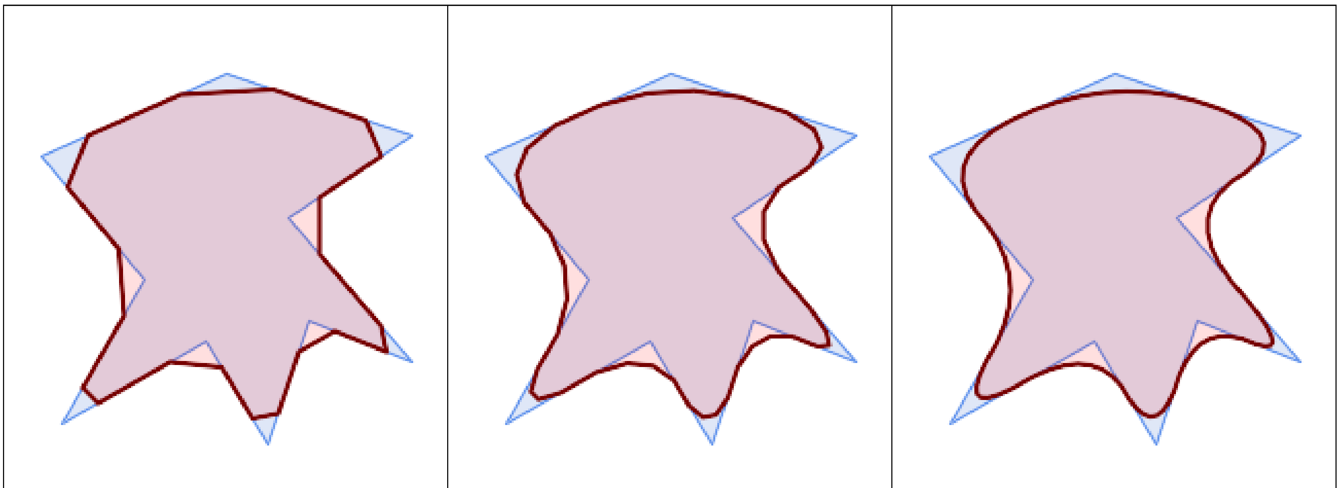
Availability: 2.5.0

☒☒

Smoothing a triangle:

```
SELECT ST_AsText(ST_ChaikinSmoothing(geom)) smoothed
FROM (SELECT  'POLYGON((0 0, 8 8, 0 16, 0 0))'::geometry geom) AS foo;

                  smoothed
b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b'' ↩
    b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b' ↩
    '–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b''–b''b' ↩
    '–b''b''–b''b''–b''b''–b''b''–b''b''–b''
 POLYGON((2 2,6 6,6 10,2 14,0 12,0 4,2 2))
```

Smoothing a Polygon using 1, 2 and 3 iterations:

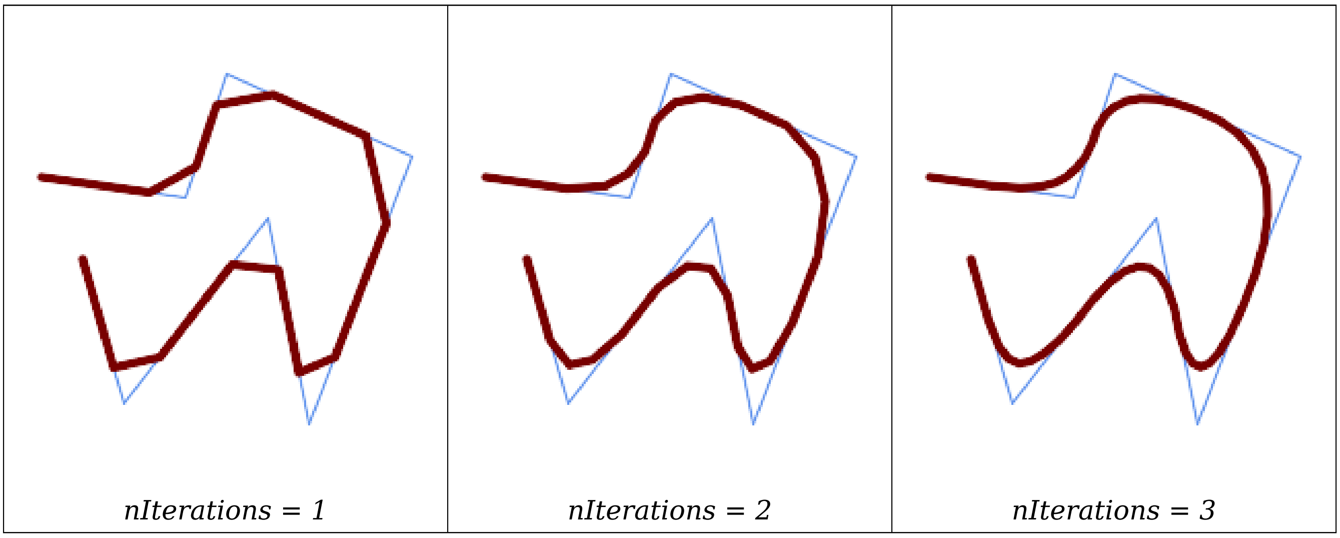


nIterations = 1 | *nIterations = 2* | *nIterations = 3*

```
SELECT ST_ChaikinSmoothing(
```

```
            'POLYGON ((20 20, 60 90, 10 150, 100 190, 190 160, 130 120, 190 50, 140 70, 120 ↩
                10, 90 60, 20 20))',
            generate_series(1, 3) );
```

Smoothing a LineString using 1, 2 and 3 iterations:




```
SELECT ST_ChaikinSmoothing(
            'LINESTRING (10 140, 80 130, 100 190, 190 150, 140 20, 120 120, 50 30, 30 100) ↩
                ',
            generate_series(1, 3) );
```

⊠⊠

ST_Simplify, ST_SimplifyPreserveTopology, ST_SimplifyVW

7.14.5 ST_ConcaveHull

ST_ConcaveHull — Computes a possibly concave geometry that contains all input geometry vertices

Synopsis

geometry **ST_ConcaveHull**(geometry param_geom, float param_pctconvex, boolean param_allow_holes = false);

⊠⊠

A concave hull is a (usually) concave geometry which contains the input, and whose vertices are a subset of the input vertices. In the general case the concave hull is a Polygon. The concave hull of two or more collinear points is a two-point LineString. The concave hull of one or more identical points is a Point. The polygon will not contain holes unless the optional `param_allow_holes` argument is specified as true.

One can think of a concave hull as "shrink-wrapping" a set of points. This is different to the convex hull, which is more like wrapping a rubber band around the points. A concave hull generally has a smaller area and represents a more natural boundary for the input points.

The `param_pctconvex` controls the concaveness of the computed hull. A value of 1 produces the convex hull. Values between 1 and 0 produce hulls of increasing concaveness. A value of 0 produces a hull with maximum concaveness (but still a single polygon). Choosing a suitable value depends on the nature of the input data, but often values between 0.3 and 0.1 produce reasonable results.

> **Note**
> Technically, the `param_pctconvex` determines a length as a fraction of the difference between the longest and shortest edges in the Delaunay Triangulation of the input points. Edges longer than this length are "eroded" from the triangulation. The triangles remaining form the concave hull.

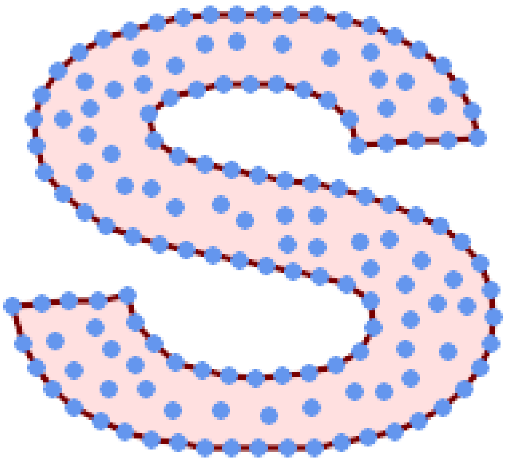
For point and linear inputs, the hull will enclose all the points of the inputs. For polygonal inputs, the hull will enclose all the points of the input *and also* all the areas covered by the input. If you want a point-wise hull of a polygonal input, convert it to points first using ST_Points.

This is not an aggregate function. To compute the concave hull of a set of geometries use ST_Collect (e.g. `ST_ConcaveHull( ST_Collect( geom ), 0.80)`.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 3.3.0, GEOS native implementation enabled for GEOS 3.11+

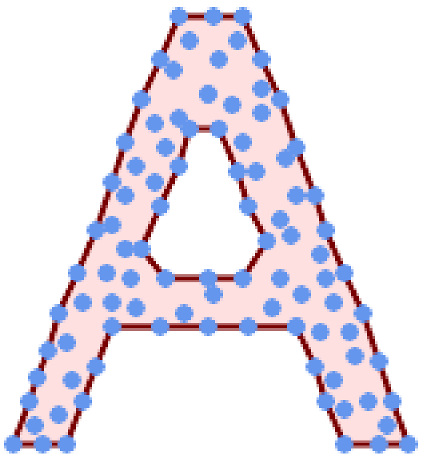
⊠⊠



Concave Hull of a MultiPoint

```
SELECT ST_AsText( ST_ConcaveHull(
        'MULTIPOINT ((10 72), (53 76), (56 66), (63 58), (71 51), (81 48), (91 46), (101  ↩
            45), (111 46), (121 47), (131 50), (140 55), (145 64), (144 74), (135 80), (125  ↩
            83), (115 85), (105 87), (95 89), (85 91), (75 93), (65 95), (55 98), (45 102),  ↩
            (37 107), (29 114), (22 122), (19 132), (18 142), (21 151), (27 160), (35 167),  ↩
            (44 172), (54 175), (64 178), (74 180), (84 181), (94 181), (104 181), (114 181) ↩
            , (124 181), (134 179), (144 177), (153 173), (162 168), (171 162), (177 154),  ↩
            (182 145), (184 135), (139 132), (136 142), (128 149), (119 153), (109 155), (99 ↩
             155), (89 155), (79 153), (69 150), (61 144), (63 134), (72 128), (82 125), (92 ↩
             123), (102 121), (112 119), (122 118), (132 116), (142 113), (151 110), (161  ↩
            106), (170 102), (178 96), (185 88), (189 78), (190 68), (189 58), (185 49),  ↩
            (179 41), (171 34), (162 29), (153 25), (143 23), (133 21), (123 19), (113 19),  ↩
            (102 19), (92 19), (82 19), (72 21), (62 22), (52 25), (43 29), (33 34), (25 41) ↩
```

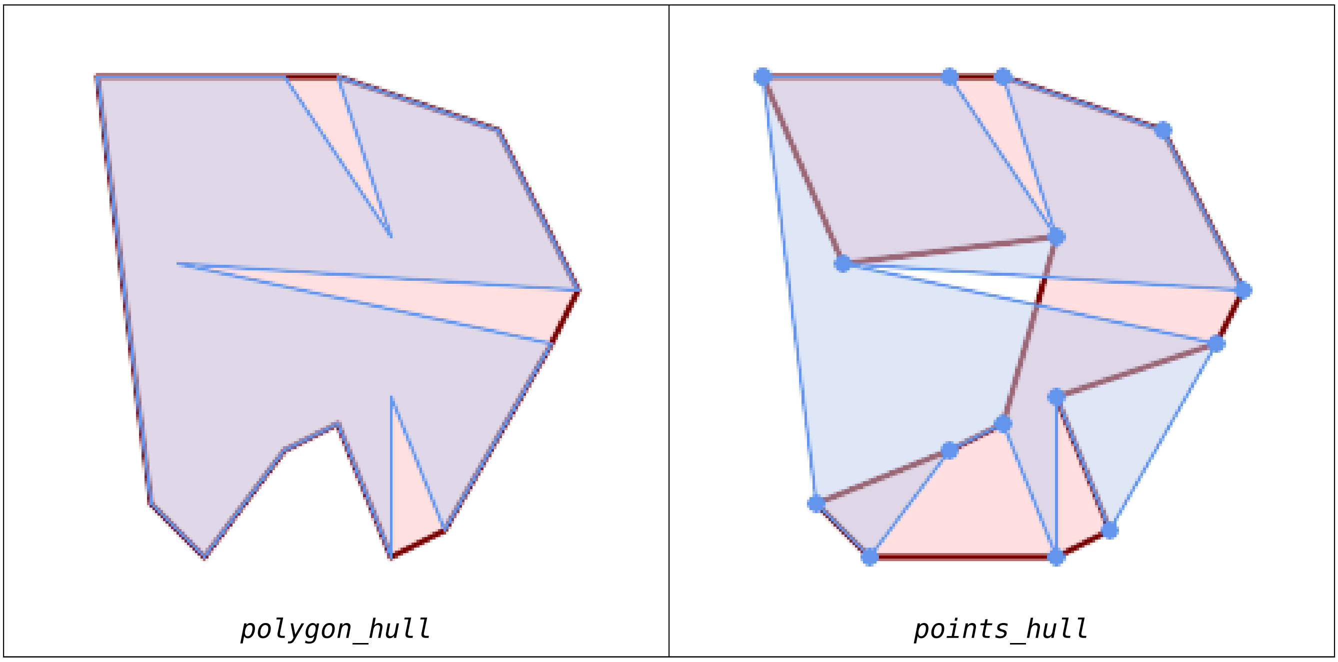
```
            , (19 49), (14 58), (21 73), (31 74), (42 74), (173 134), (161 134), (150 133), ↩
            (97 104), (52 117), (157 156), (94 171), (112 106), (169 73), (58 165), (149 40) ↩
            , (70 33), (147 157), (48 153), (140 96), (47 129), (173 55), (144 86), (159 67) ↩
            , (150 146), (38 136), (111 170), (124 94), (26 59), (60 41), (71 162), (41 64), ↩
             (88 110), (122 34), (151 97), (157 56), (39 146), (88 33), (159 45), (47 56), ↩
            (138 40), (129 165), (33 48), (106 31), (169 147), (37 122), (71 109), (163 89), ↩
             (37 156), (82 170), (180 72), (29 142), (46 41), (59 155), (124 106), (157 80), ↩
             (175 82), (56 50), (62 116), (113 95), (144 167))',
         0.1 ) );
---st_astext--
POLYGON ((18 142, 21 151, 27 160, 35 167, 44 172, 54 175, 64 178, 74 180, 84 181, 94 181, ↩
    104 181, 114 181, 124 181, 134 179, 144 177, 153 173, 162 168, 171 162, 177 154, 182 ↩
    145, 184 135, 173 134, 161 134, 150 133, 139 132, 136 142, 128 149, 119 153, 109 155, 99 ↩
     155, 89 155, 79 153, 69 150, 61 144, 63 134, 72 128, 82 125, 92 123, 102 121, 112 119, ↩
    122 118, 132 116, 142 113, 151 110, 161 106, 170 102, 178 96, 185 88, 189 78, 190 68, ↩
    189 58, 185 49, 179 41, 171 34, 162 29, 153 25, 143 23, 133 21, 123 19, 113 19, 102 19, ↩
    92 19, 82 19, 72 21, 62 22, 52 25, 43 29, 33 34, 25 41, 19 49, 14 58, 10 72, 21 73, 31 ↩
    74, 42 74, 53 76, 56 66, 63 58, 71 51, 81 48, 91 46, 101 45, 111 46, 121 47, 131 50, 140 ↩
     55, 145 64, 144 74, 135 80, 125 83, 115 85, 105 87, 95 89, 85 91, 75 93, 65 95, 55 98, ↩
    45 102, 37 107, 29 114, 22 122, 19 132, 18 142))
```



Concave Hull of a MultiPoint, allowing holes

```
SELECT ST_AsText( ST_ConcaveHull(
        'MULTIPOINT ((132 64), (114 64), (99 64), (81 64), (63 64), (57 49), (52 36), (46 ↩
            20), (37 20), (26 20), (32 36), (39 55), (43 69), (50 84), (57 100), (63 118), ↩
            (68 133), (74 149), (81 164), (88 180), (101 180), (112 180), (119 164), (126 ↩
            149), (132 131), (139 113), (143 100), (150 84), (157 69), (163 51), (168 36), ↩
            (174 20), (163 20), (150 20), (143 36), (139 49), (132 64), (99 151), (92 138), ↩
            (88 124), (81 109), (74 93), (70 82), (83 82), (99 82), (112 82), (126 82), (121 ↩
             96), (114 109), (110 122), (103 138), (99 151), (34 27), (43 31), (48 44), (46 ↩
            58), (52 73), (63 73), (61 84), (72 71), (90 69), (101 76), (123 71), (141 62), ↩
            (166 27), (150 33), (159 36), (146 44), (154 53), (152 62), (146 73), (134 76), ↩
            (143 82), (141 91), (130 98), (126 104), (132 113), (128 127), (117 122), (112 ↩
            133), (119 144), (108 147), (119 153), (110 171), (103 164), (92 171), (86 160), ↩
             (88 142), (79 140), (72 124), (83 131), (79 118), (68 113), (63 102), (68 93), ↩
            (35 45))',
         0.15, true ) );
---st_astext--
POLYGON ((43 69, 50 84, 57 100, 63 118, 68 133, 74 149, 81 164, 88 180, 101 180, 112 180, ↩
    119 164, 126 149, 132 131, 139 113, 143 100, 150 84, 157 69, 163 51, 168 36, 174 20, 163 ↩
```

```
    20, 150 20, 143 36, 139 49, 132 64, 114 64, 99 64, 81 64, 63 64, 57 49, 52 36, 46 20, ↩
   37 20, 26 20, 32 36, 35 45, 39 55, 43 69), (88 124, 81 109, 74 93, 83 82, 99 82, 112 82, ↩
    121 96, 114 109, 110 122, 103 138, 92 138, 88 124))
```



Comparing a concave hull of a Polygon to the concave hull of the constituent points. The hull respects the boundary of the polygon, whereas the points-based hull does not.

```
WITH data(geom) AS (VALUES
   ('POLYGON ((10 90, 39 85, 61 79, 50 90, 80 80, 95 55, 25 60, 90 45, 70 16, 63 38, 60 10, ↩
        50 30, 43 27, 30 10, 20 20, 10 90))'::geometry)
)
SELECT  ST_ConcaveHull( geom,            0.1) AS polygon_hull,
        ST_ConcaveHull( ST_Points(geom), 0.1) AS points_hull
    FROM data;
```

Using with ST_Collect to compute the concave hull of a geometry set.

```
-- Compute estimate of infected area based on point observations
SELECT disease_type,
    ST_ConcaveHull( ST_Collect(obs_pnt), 0.3 ) AS geom
  FROM disease_obs
  GROUP BY disease_type;
```

⊠⊠

ST_ConvexHull, ST_Collect, ST_AlphaShape, ST_OptimalAlphaShape

7.14.6 ST_ConvexHull

ST_ConvexHull — Computes the convex hull of a geometry.

Synopsis

geometry **ST_ConvexHull**(geometry geomA);

⊠⊠

Computes the convex hull of a geometry. The convex hull is the smallest convex geometry that encloses all geometries in the input.

One can think of the convex hull as the geometry obtained by wrapping an rubber band around a set of geometries. This is different from a concave hull which is analogous to ”shrink-wrapping” the geometries. A convex hull is often used to determine an affected area based on a set of point observations.

In the general case the convex hull is a Polygon. The convex hull of two or more collinear points is a two-point LineString. The convex hull of one or more identical points is a Point.

This is not an aggregate function. To compute the convex hull of a set of geometries, use ST_Collect to aggregate them into a geometry collection (e.g. `ST_ConvexHull(ST_Collect(geom))`).

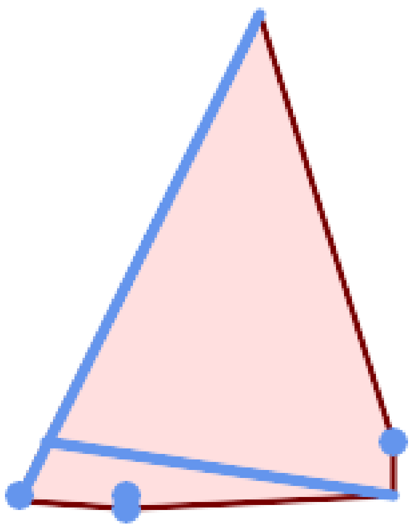
GEOS ⊠⊠⊠⊠⊠

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1.16

This function supports 3d and will not drop the z-index.

⊠⊠



Convex Hull of a MultiLinestring and a MultiPoint

```
SELECT ST_AsText(ST_ConvexHull(
    ST_Collect(
        ST_GeomFromText('MULTILINESTRING((100 190,10 8),(150 10, 20 30))'),
            ST_GeomFromText('MULTIPOINT(50 5, 150 30, 50 10, 10 10)')
            )) );
---st_astext--
POLYGON((50 5,10 8,10 10,100 190,150 30,150 10,50 5))
```

Using with ST_Collect to compute the convex hulls of geometry sets.

```
--Get estimate of infected area based on point observations
SELECT d.disease_type,
    ST_ConvexHull(ST_Collect(d.geom)) As geom
    FROM disease_obs As d
    GROUP BY d.disease_type;
```

□□

ST_Collect, ST_ConcaveHull, ST_MinimumBoundingCircle

7.14.7 ST_DelaunayTriangles

ST_DelaunayTriangles — Returns the Delaunay triangulation of the vertices of a geometry.

Synopsis

geometry **ST_DelaunayTriangles**(geometry g1, float tolerance = 0.0, int4 flags = 0);

□□

Computes the Delaunay triangulation of the vertices of the input geometry. The optional `tolerance` can be used to snap nearby input vertices together, which improves robustness in some situations. The result geometry is bounded by the convex hull of the input vertices. The result geometry representation is determined by the `flags` code:

- `0` - a GEOMETRYCOLLECTION of triangular POLYGONs (default)
- `1` - a MULTILINESTRING of the edges of the triangulation
- `2` - A TIN of the triangulation

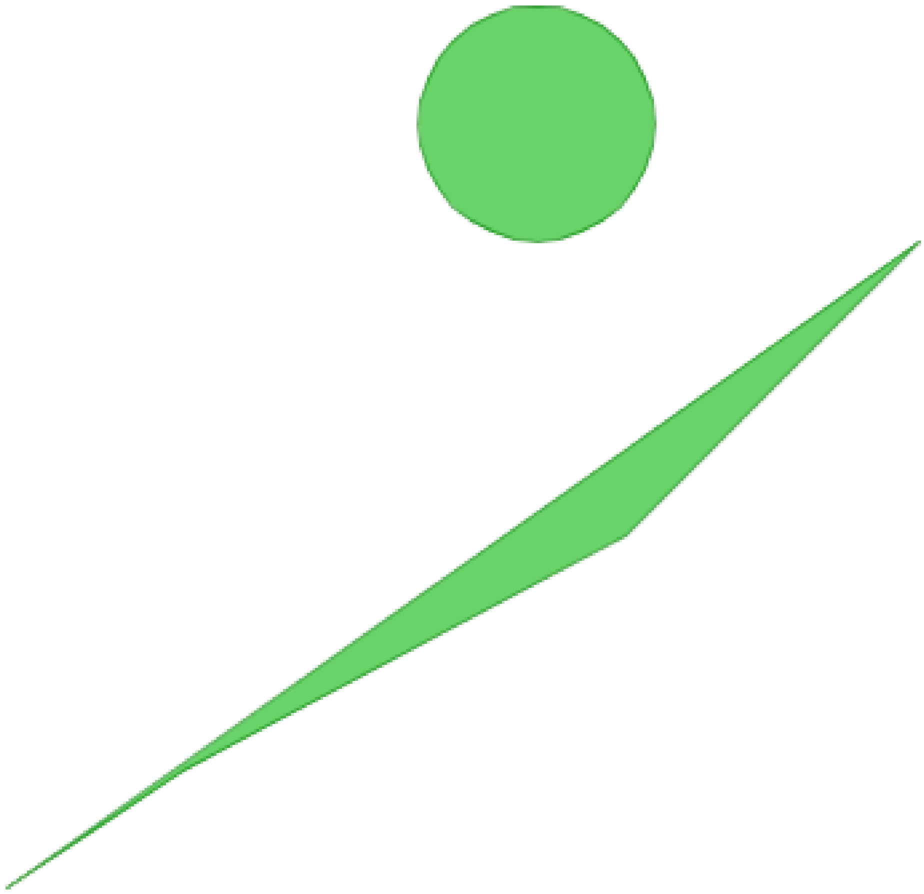
GEOS □□□□□

2.1.0 □□□□□□□□□□□□.

This function supports 3d and will not drop the z-index.

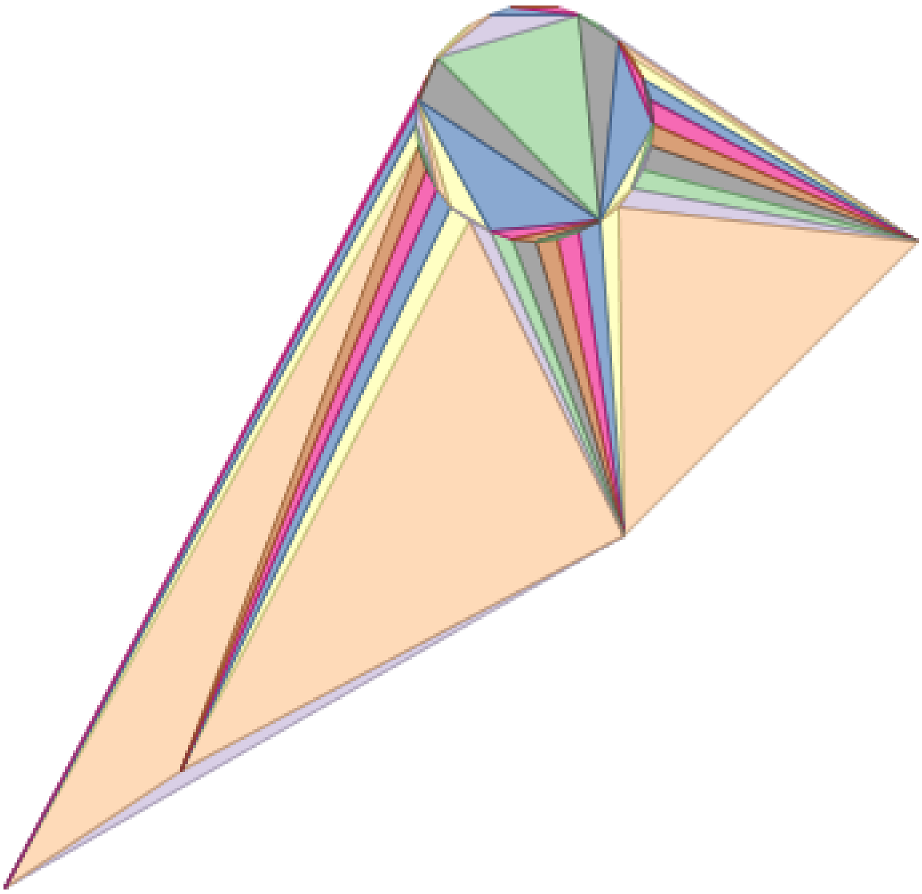
This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

□□



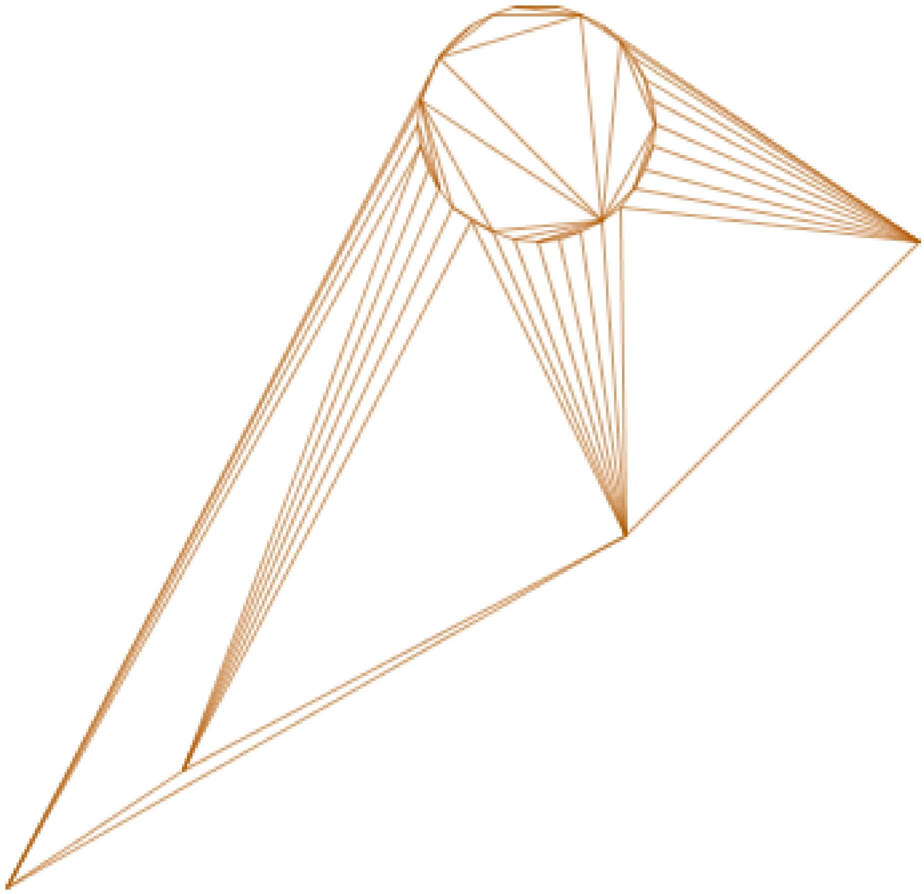
□□□□□

```
our original geometry
    ST_Union(ST_GeomFromText('POLYGON((175 150, 20 40,
            50 60, 125 100, 175 150))'),
        ST_Buffer(ST_GeomFromText('POINT(110 170)'), 20)
        )
```



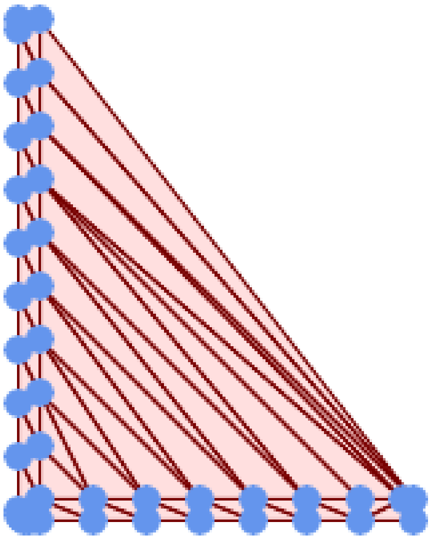
⊠⊠⊠⊠⊠ *ST_DelaunayTriangles:* ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
geometries overlaid multilinestring triangles

SELECT
    ST_DelaunayTriangles(
        ST_Union(ST_GeomFromText('POLYGON((175 150, 20 40,
            50 60, 125 100, 175 150))'),
        ST_Buffer(ST_GeomFromText('POINT(110 170)'), 20)
        ))
     As  dtriag;
```



-- □□□□□□□□□□□□□□

```
SELECT
    ST_DelaunayTriangles(
        ST_Union(ST_GeomFromText('POLYGON((175 150, 20 40,
            50 60, 125 100, 175 150))'),
        ST_Buffer(ST_GeomFromText('POINT(110 170)'), 20)
        ),0.001,1)
     As  dtriag;
```



-- ⊠⊠⊠⊠⊠⊠ 55 ⊠⊠⊠⊠⊠ 45 ⊠⊠⊠⊠⊠⊠⊠⊠

```
this produces a table of 42 points that form an L shape

SELECT (ST_DumpPoints(ST_GeomFromText(
'MULTIPOINT(14 14,34 14,54 14,74 14,94 14,114 14,134 14,
150 14,154 14,154 6,134 6,114 6,94 6,74 6,54 6,34 6,
14 6,10 6,8 6,7 7,6 8,6 10,6 30,6 50,6 70,6 90,6 110,6 130,
6 150,6 170,6 190,6 194,14 194,14 174,14 154,14 134,14 114,
14 94,14 74,14 54,14 34,14 14)'))).geom
    INTO TABLE l_shape;

output as individual polygon triangles

SELECT ST_AsText((ST_Dump(geom)).geom) As wkt
FROM ( SELECT ST_DelaunayTriangles(ST_Collect(geom)) As geom
FROM l_shape) As foo;


wkt

POLYGON((6 194,6 190,14 194,6 194))
POLYGON((14 194,6 190,14 174,14 194))
POLYGON((14 194,14 174,154 14,14 194))
POLYGON((154 14,14 174,14 154,154 14))
POLYGON((154 14,14 154,150 14,154 14))
POLYGON((154 14,150 14,154 6,154 14))
```

Example using vertices with Z values.

```
3D multipoint

SELECT ST_AsText(ST_DelaunayTriangles(ST_GeomFromText(
         'MULTIPOINT Z(14 14 10, 150 14 100,34 6 25, 20 10 150)'))) As wkt;


wkt
```

```
GEOMETRYCOLLECTION Z (POLYGON Z ((14 14 10,20 10 150,34 6 25,14 14 10))
 ,POLYGON Z ((14 14 10,34 6 25,150 14 100,14 14 10)))
```

⊠⊠

ST_VoronoiPolygons, ST_TriangulatePolygon, ST_ConstrainedDelaunayTriangles, ST_VoronoiLines, ST_Con

7.14.8 ST_FilterByM

ST_FilterByM — Removes vertices based on their M value

Synopsis

geometry **ST_FilterByM**(geometry geom, double precision min, double precision max = null, boolean returnM = false);

⊠⊠

Filters out vertex points based on their M-value. Returns a geometry with only vertex points that have a M-value larger or equal to the min value and smaller or equal to the max value. If max-value argument is left out only min value is considered. If fourth argument is left out the m-value will not be in the resulting geometry. If resulting geometry have too few vertex points left for its geometry type an empty geometry will be returned. In a geometry collection geometries without enough points will just be left out silently.

This function is mainly intended to be used in conjunction with ST_SetEffectiveArea. ST_EffectiveArea sets the effective area of a vertex in its m-value. With ST_FilterByM it then is possible to get a simplified version of the geometry without any calculations, just by filtering

> **Note**
> There is a difference in what ST_SimplifyVW returns when not enough points meet the criteria compared to ST_FilterByM. ST_SimplifyVW returns the geometry with enough points while ST_FilterByM returns an empty geometry

> **Note**
> Note that the returned geometry might be invalid

> **Note**
> This function returns all dimensions, including the Z and M values

Availability: 2.5.0

⊠⊠

A linestring is filtered

```
SELECT ST_AsText(ST_FilterByM(geom,30)) simplified
FROM (SELECT  ST_SetEffectiveArea('LINESTRING(5 2, 3 8, 6 20, 7 25, 10 10)'::geometry) geom ↩
    ) As foo;

result

         simplified
----------------------------
 LINESTRING(5 2,7 25,10 10)
```

⊠⊠

ST_SetEffectiveArea, ST_SimplifyVW

7.14.9 ST_GeneratePoints

ST_GeneratePoints — Generates a multipoint of random points contained in a Polygon or MultiPolygon.

Synopsis

geometry **ST_GeneratePoints**(geometry g, integer npoints, integer seed = 0);

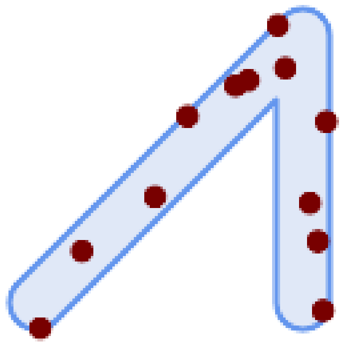
⊠⊠

ST_GeneratePoints generates a multipoint consisting of a given number of pseudo-random points which lie within the input area. The optional `seed` is used to regenerate a deterministic sequence of points, and must be greater than zero.

2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 3.0.0, added seed parameter

⊠⊠



Generated a multipoint consisting of 12 Points overlaid on top of original polygon using a random seed value 1996

```
SELECT ST_GeneratePoints(geom, 12, 1996)
FROM (
    SELECT ST_Buffer(
        ST_GeomFromText(
        'LINESTRING(50 50,150 150,150 50)'),
        10, 'endcap=round join=round') AS geom
) AS s;
```

Given a table of polygons s, return 12 individual points per polygon. Results will be different each time you run.

```
SELECT s.id, dp.path[1] AS pt_id, dp.geom
FROM s, ST_DumpPoints(ST_GeneratePoints(s.geom,12)) AS dp;
```

⊠⊠

ST_DumpPoints

7.14.10 ST_GeometricMedian

ST_GeometricMedian — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (median) ⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GeometricMedian** (geometry geom, float8 tolerance = NULL, int max_iter = 10000, boolean fail_if_not_converged = false);

⊠⊠

Computes the approximate geometric median of a MultiPoint geometry using the Weiszfeld algorithm. The geometric median is the point minimizing the sum of distances to the input points. It provides a centrality measure that is less sensitive to outlier points than the centroid (center of mass).

The algorithm iterates until the distance change between successive iterations is less than the supplied `tolerance` parameter. If this condition has not been met after `max_iterations` iterations, the function produces an error and exits, unless `fail_if_not_converged` is set to `false` (the default).

If a `tolerance` argument is not provided, the tolerance value is calculated based on the extent of the input geometry.

If present, the input point M values are interpreted as their relative weights.

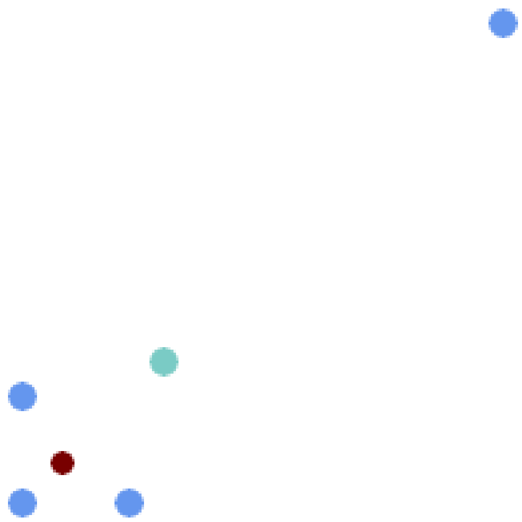
2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 2.5.0 Added support for M as weight of points.

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

⊠⊠



Comparison of the geometric median (red) and centroid (turquoise) of a MultiPoint.

```
WITH test AS (
SELECT 'MULTIPOINT((10 10), (10 40), (40 10), (190 190))'::geometry geom)
SELECT
  ST_AsText(ST_Centroid(geom)) centroid,
  ST_AsText(ST_GeometricMedian(geom)) median
FROM test;

      centroid      |                 median
--------------------+----------------------------------------
   POINT(62.5 62.5) | POINT(25.01778421249728 25.01778421249728)
(1 row)
```

⊠⊠

ST_Centroid

7.14.11 ST_LineMerge

ST_LineMerge — Return the lines formed by sewing together a MultiLineString.

Synopsis

geometry **ST_LineMerge**(geometry amultilinestring);
geometry **ST_LineMerge**(geometry amultilinestring, boolean directed);

⊠⊠

Returns a LineString or MultiLineString formed by joining together the line elements of a MultiLineString. Lines are joined at their endpoints at 2-way intersections. Lines are not joined across intersections of 3-way or greater degree.

If **directed** is TRUE, then ST_LineMerge will not change point order within LineStrings, so lines with opposite directions will not be merged

> **Note**
> Only use with MultiLineString/LineStrings. Other geometry types return an empty GeometryCollection

GEOS ⊠⊠⊠⊠⊠

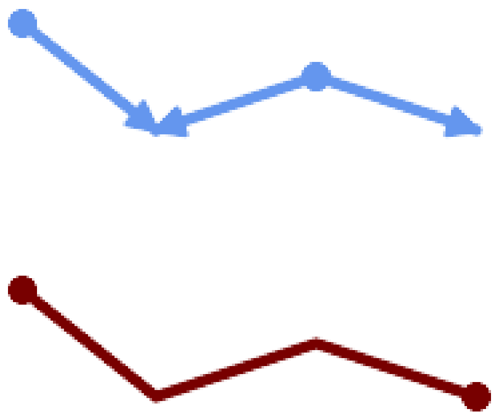
Enhanced: 3.3.0 accept a directed parameter.

Requires GEOS >= 3.11.0 to use the directed parameter.

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

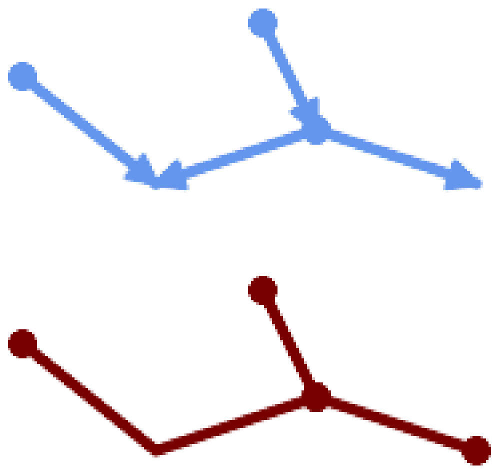
> **Warning**
> This function strips the M dimension.

⊠⊠



Merging lines with different orientation.

```
SELECT ST_AsText(ST_LineMerge(
'MULTILINESTRING((10 160, 60 120), (120 140, 60 120), (120 140, 180 120))'
                ));
--------------------------------------------
 LINESTRING(10 160,60 120,120 140,180 120)
```

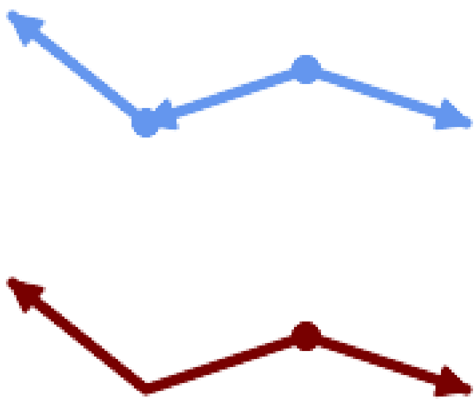


Lines are not merged across intersections with degree > 2.

```
SELECT ST_AsText(ST_LineMerge(
'MULTILINESTRING((10 160, 60 120), (120 140, 60 120), (120 140, 180 120), (100 180, 120 ↩
    140))'
                ));
--------------------------------------------
 MULTILINESTRING((10 160,60 120,120 140),(100 180,120 140),(120 140,180 120))
```

If merging is not possible due to non-touching lines, the original MultiLineString is returned.

```
SELECT ST_AsText(ST_LineMerge(
'MULTILINESTRING((-29 -27,-30 -29.7,-36 -31,-45 -33),(-45.2 -33.2,-46 -32))'
));
----------------
MULTILINESTRING((-45.2 -33.2,-46 -32),(-29 -27,-30 -29.7,-36 -31,-45 -33))
```



Lines with opposite directions are not merged if directed = TRUE.

```
SELECT ST_AsText(ST_LineMerge(
'MULTILINESTRING((60 30, 10 70), (120 50, 60 30), (120 50, 180 30))',
TRUE));
-------------------------------------------------------
 MULTILINESTRING((120 50,60 30,10 70),(120 50,180 30))
```

Example showing Z-dimension handling.

```
SELECT ST_AsText(ST_LineMerge(
      'MULTILINESTRING((-29 -27 11,-30 -29.7 10,-36 -31 5,-45 -33 6), (-29 -27 12,-30 -29.7 ↩
           5), (-45 -33 1,-46 -32 11))'
        ));
--------------------------------------------------------------------------------------------------- ↩

LINESTRING Z (-30 -29.7 5,-29 -27 11,-30 -29.7 10,-36 -31 5,-45 -33 1,-46 -32 11)
```

□□

ST_Segmentize, ST_LineSubstring

7.14.12 ST_MaximumInscribedCircle

ST_MaximumInscribedCircle — □□□□□□□□□□□□□□□.

Synopsis

(geometry, geometry, double precision) **ST_MaximumInscribedCircle**(geometry geom);

⊠⊠

Finds the largest circle that is contained within a (multi)polygon, or which does not overlap any lines and points. Returns a record with fields:

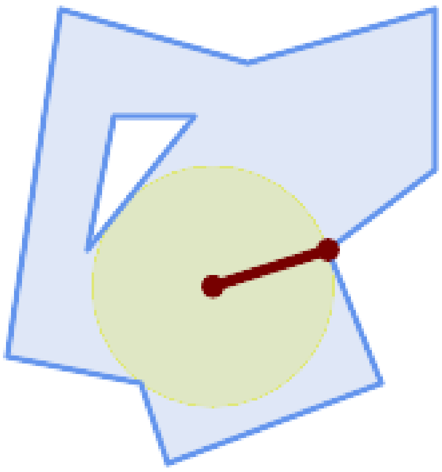
- `center` - center point of the circle
- `nearest` - a point on the geometry nearest to the center
- `radius` - radius of the circle

For polygonal inputs, the circle is inscribed within the boundary rings, using the internal rings as boundaries. For linear and point inputs, the circle is inscribed within the convex hull of the input, using the input lines and points as further boundaries.

Availability: 3.1.0.

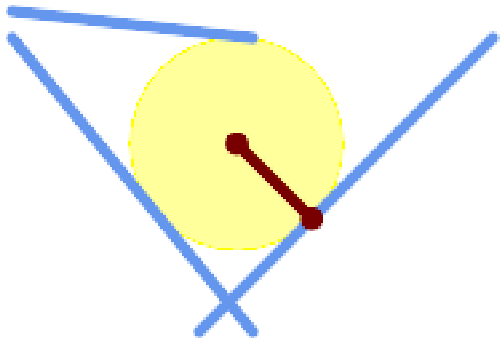
Requires GEOS >= 3.9.0.

⊠⊠



Maximum inscribed circle of a polygon. Center, nearest point, and radius are returned.

```
SELECT radius, ST_AsText(center) AS center, ST_AsText(nearest) AS nearest
    FROM ST_MaximumInscribedCircle(
        'POLYGON ((40 180, 110 160, 180 180, 180 120, 140 90, 160 40, 80 10, 70 40, 20 50,  ↩
           40 180),
        (60 140, 50 90, 90 140, 60 140))');

     radius      |           center           |    nearest
-----------------+----------------------------+---------------
 45.165845650018 | POINT(96.953125 76.328125) | POINT(140 90)
```



Maximum inscribed circle of a multi-linestring. Center, nearest point, and radius are returned.

☒☒

ST_MinimumBoundingRadius, ST_LargestEmptyCircle

7.14.13 ST_LargestEmptyCircle

ST_LargestEmptyCircle — Computes the largest circle not overlapping a geometry.

Synopsis

(geometry, geometry, double precision) **ST_LargestEmptyCircle**(geometry geom, double precision tolerance=0.0, geometry boundary=POINT EMPTY);

☒☒

Finds the largest circle which does not overlap a set of point and line obstacles. (Polygonal geometries may be included as obstacles, but only their boundary lines are used.) The center of the circle is constrained to lie inside a polygonal boundary, which by default is the convex hull of the input geometry. The circle center is the point in the interior of the boundary which has the farthest distance from the obstacles. The circle itself is provided by the center point and a nearest point lying on an obstacle determining the circle radius.

The circle center is determined to a given accuracy specified by a distance tolerance, using an iterative algorithm. If the accuracy distance is not specified a reasonable default is used.

Returns a record with fields:

- `center` - center point of the circle
- `nearest` - a point on the geometry nearest to the center
- `radius` - radius of the circle

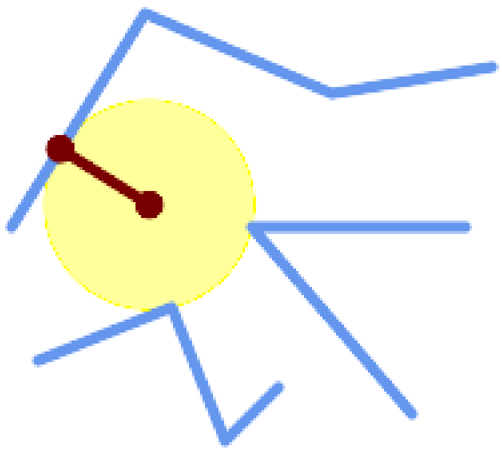
To find the largest empty circle in the interior of a polygon, see ST_MaximumInscribedCircle.

Availability: 3.4.0.

Requires GEOS >= 3.9.0.

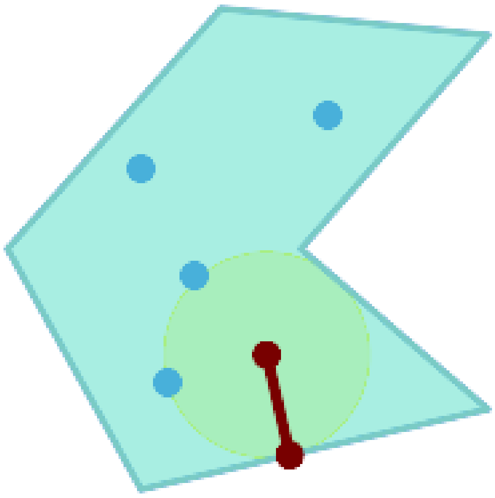
⊠⊠

```
SELECT radius,
      center,
      nearest
  FROM ST_LargestEmptyCircle(
        'MULTILINESTRING (
          (10 100, 60 180, 130 150, 190 160),
          (20 50, 70 70, 90 20, 110 40),
          (160 30, 100 100, 180 100))');
```



Largest Empty Circle within a set of lines.

```
SELECT radius,
       center,
       nearest
  FROM ST_LargestEmptyCircle(
         ST_Collect(
           'MULTIPOINT ((70 50), (60 130), (130 150), (80 90))'::geometry,
           'POLYGON ((90 190, 10 100, 60 10, 190 40, 120 100, 190 180, 90 190))'::geometry) ↩
               ,
           0,
         'POLYGON ((90 190, 10 100, 60 10, 190 40, 120 100, 190 180, 90 190))'::geometry
       );
```



Largest Empty Circle within a set of points, constrained to lie in a polygon. The constraint polygon boundary must be included as an obstacle, as well as specified as the constraint for the circle center.

⊠⊠

ST_MinimumBoundingRadius

7.14.14 ST_MinimumBoundingCircle

ST_MinimumBoundingCircle — Returns the smallest circle polygon that contains a geometry.

Synopsis

geometry **ST_MinimumBoundingCircle**(geometry geomA, integer num_segs_per_qt_circ=48);

⊠⊠

Returns the smallest circle polygon that contains a geometry.

> **Note**
> ⊠⊠⊠⊠⊠⊠ 48 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (minimum bounding circle) ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠, ST_MinimumBoundingRadius ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Use with ST_Collect to get the minimum bounding circle of a set of geometries.

To compute two points lying on the minimum circle (the ”maximum diameter”) use ST_LongestLine.

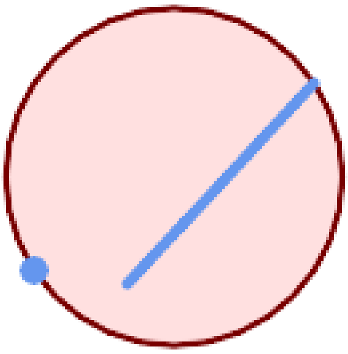
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Roeck) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

GEOS ⊠⊠⊠⊠⊠

1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□

```
SELECT d.disease_type,
    ST_MinimumBoundingCircle(ST_Collect(d.geom)) As geom
    FROM disease_obs As d
    GROUP BY d.disease_type;
```



□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□ *8* □□□□□□□.

```
SELECT ST_AsText(ST_MinimumBoundingCircle(
        ST_Collect(
            ST_GeomFromText('LINESTRING(55 75,125 150)'),
                ST_Point(20, 80)), 8
                )) As wktmbc;
wktmbc
-----------
POLYGON((135.59714732062 115,134.384753327498 102.690357210921,130.79416296937  ↩
    90.8537670908995,124.963360620072 79.9451031602111,117.116420743937  ↩
    70.3835792560632,107.554896839789 62.5366393799277,96.6462329091006  ↩
    56.70583703063,84.8096427890789 53.115246672502,72.5000000000001  ↩
    51.9028526793802,60.1903572109213 53.1152466725019,48.3537670908996  ↩
    56.7058370306299,37.4451031602112 62.5366393799276,27.8835792560632  ↩
    70.383579256063,20.0366393799278 79.9451031602109,14.20583703063  ↩
    90.8537670908993,10.615246672502 102.690357210921,9.40285267938019 115,10.6152466725019  ↩
    127.309642789079,14.2058370306299 139.1462329091,20.0366393799275  ↩
    150.054896839789,27.883579256063 159.616420743937,
37.4451031602108 167.463360620072,48.3537670908992 173.29416296937,60.190357210921  ↩
    176.884753327498,
72.4999999999998 178.09714732062,84.8096427890786 176.884753327498,96.6462329091003  ↩
    173.29416296937,107.554896839789 167.463360620072,
117.116420743937 159.616420743937,124.963360620072 150.054896839789,130.79416296937  ↩
    139.146232909101,134.384753327498 127.309642789079,135.59714732062 115))
```

□□

ST_Collect, ST_MinimumBoundingRadius, ST_LargestEmptyCircle, ST_LongestLine

7.14.15 ST_MinimumBoundingRadius

ST_MinimumBoundingRadius — Returns the center point and radius of the smallest circle that contains a geometry.

Synopsis

(geometry, double precision) **ST_MinimumBoundingRadius**(geometry geom);

⊠⊠

Computes the center point and radius of the smallest circle that contains a geometry. Returns a record with fields:

- `center` - center point of the circle
- `radius` - radius of the circle

Use with ST_Collect to get the minimum bounding circle of a set of geometries.

To compute two points lying on the minimum circle (the ”maximum diameter”) use ST_LongestLine.

2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_AsText(center), radius FROM ST_MinimumBoundingRadius('POLYGON((26426 65078,26531 65242,26075 65136,26096 65427,26426 65078))');

                st_astext                 |      radius
------------------------------------------+------------------
 POINT(26284.8418027133 65267.1145090825) | 247.436045591407
```

⊠⊠

ST_Collect, ST_MinimumBoundingCircle, ST_LongestLine

7.14.16 ST_OrientedEnvelope

ST_OrientedEnvelope — Returns a minimum-area rectangle containing a geometry.

Synopsis

geometry **ST_OrientedEnvelope**(geometry geom);

⊠⊠

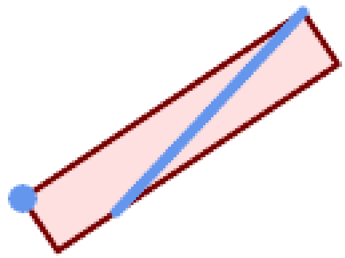
Returns the minimum-area rotated rectangle enclosing a geometry. Note that more than one such rectangle may exist. May return a Point or LineString in the case of degenerate inputs.

Availability: 2.5.0.

Requires GEOS >= 3.6.0.

⊠⊠

```
SELECT ST_AsText(ST_OrientedEnvelope('MULTIPOINT ((0 0), (-1 -1), (3 2))'));

                st_astext
                ------------------------------------------------
                POLYGON((3 2,2.88 2.16,-1.12 -0.84,-1 -1,3 2))
```



Oriented envelope of a point and linestring.

```
SELECT ST_AsText(ST_OrientedEnvelope(
        ST_Collect(
            ST_GeomFromText('LINESTRING(55 75,125 150)'),
                ST_Point(20, 80))
                )) As wktenv;
wktenv
-----------
POLYGON((19.9999999999997 79.9999999999999,33.0769230769229  ↩
    60.3846153846152,138.076923076924 130.384615384616,125.000000000001  ↩
    150.000000000001,19.9999999999997 79.9999999999999))
```

⊠⊠

ST_Envelope ST_MinimumBoundingCircle

7.14.17 ST_OffsetCurve

ST_OffsetCurve — Returns an offset line at a given distance and side from an input line.

Synopsis

geometry **ST_OffsetCurve**(geometry line, float signed_distance, text style_parameters=”);

⊠⊠

Return an offset line at a given distance and side from an input line. All points of the returned geometries are not further than the given distance from the input geometry. Useful for computing parallel lines about a center line.

For positive distance the offset is on the left side of the input line and retains the same direction. For a negative distance it is on the right side and in the opposite direction.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note that output may be a MULTILINESTRING or EMPTY for some jigsaw-shaped input geometries.

⊠⊠⊠ = ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- 'quad_segs=#' : ⊠⊠⊠ (quarter circle) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠ 8)
- 'join=round|mitre|bevel' : ⊠⊠⊠⊠⊠ (⊠⊠⊠⊠" ⊠⊠ (round)"). ' ⊠⊠⊠ (mitre)' ⊠⊠⊠⊠⊠' ⊠⊠⊠ (miter)' ⊠⊠⊠⊠⊠⊠⊠.
- 'mitre_limit=#.#' : ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠). 'mitre_limit' ⊠⊠⊠⊠⊠'miter_limit' ⊠⊠⊠⊠⊠⊠⊠⊠.

GEOS ⊠⊠⊠⊠⊠⊠

Behavior changed in GEOS 3.11 so offset curves now have the same direction as the input line, for both positive and negative offsets.

2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

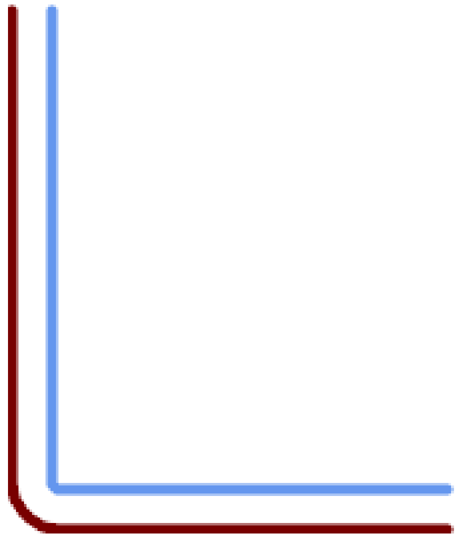
Enhanced: 2.5 - added support for GEOMETRYCOLLECTION and MULTILINESTRING

> **Note**
> This function ignores the Z dimension. It always gives a 2D result even when used on a 3D geometry.

⊠⊠

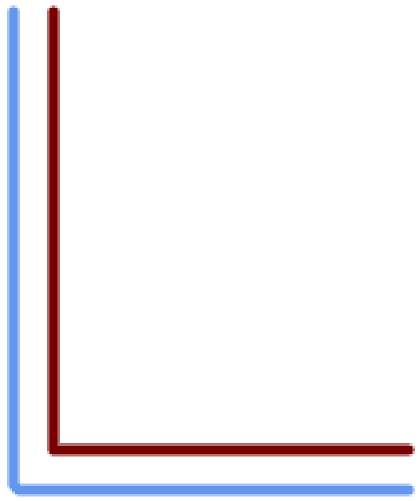
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_Union(
 ST_OffsetCurve(f.geom,  f.width/2, 'quad_segs=4 join=round'),
 ST_OffsetCurve(f.geom, -f.width/2, 'quad_segs=4 join=round')
) as track
FROM someroadstable;
```



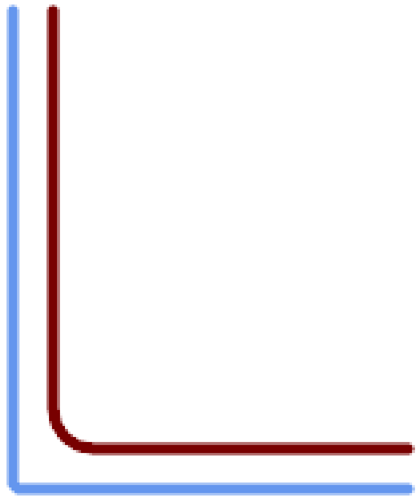
□□ 15, □□□□□□□'quad_segs=4 join=round' □□□□□□ 15 □□

```
SELECT ST_AsText(ST_OffsetCurve(
    ST_GeomFromText(
'LINESTRING(164 16,144 16,124 16,104
    16,84 16,64 16,
    44 16,24 16,20 16,18 16,17 17,
    16 18,16 20,16 40,16 60,16 80,16 100,
    16 120,16 140,16 160,16 180,16 195)')
    ,
    15, 'quad_segs=4 join=round'));

output

LINESTRING(164 1,18 1,12.2597485145237
    2.1418070123307,
    7.39339828220179 5.39339828220179,
    5.39339828220179 7.39339828220179,
    2.14180701233067 12.2597485145237,1
    18,1 195)
```



□□ -15, □□□□□□□'quad_segs=4 join=round' □□□□□□ -15 □□

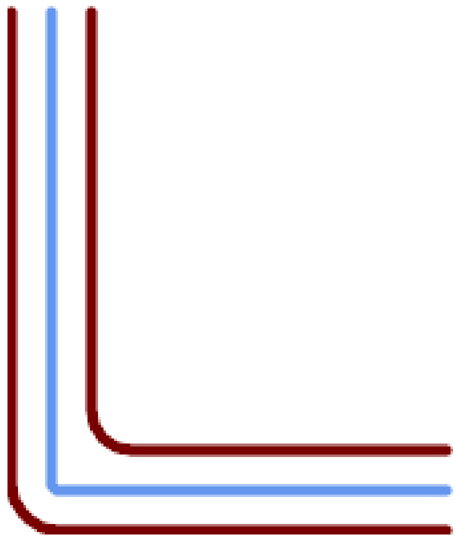
```
SELECT ST_AsText(ST_OffsetCurve(geom,
    -15, 'quad_segs=4 join=round')) As
    notsocurvy
    FROM ST_GeomFromText(
'LINESTRING(164 16,144 16,124 16,104
    16,84 16,64 16,
    44 16,24 16,20 16,18 16,17 17,
    16 18,16 20,16 40,16 60,16 80,16 100,
    16 120,16 140,16 160,16 180,16 195)')
    As geom;

notsocurvy

LINESTRING(31 195,31 31,164 31)
```



⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ -30 + 15 = -15 ⊠⊠⊠.

```
SELECT ST_AsText(ST_OffsetCurve(
    ST_OffsetCurve(geom,
    -30, 'quad_segs=4 join=round'), -15,
    'quad_segs=4 join=round')) As morecurvy
    FROM ST_GeomFromText(
'LINESTRING(164 16,144 16,124 16,104
    16,84 16,64 16,
    44 16,24 16,20 16,18 16,17 17,
    16 18,16 20,16 40,16 60,16 80,16 100,
    16 120,16 140,16 160,16 180,16 195)')
     As geom;
```

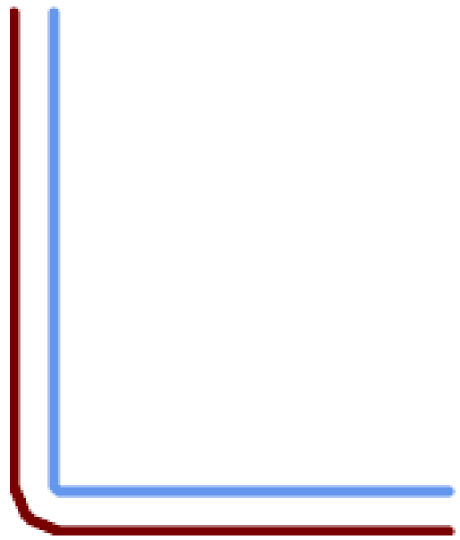
```
morecurvy

LINESTRING(164 31,46 31,40.2597485145236
    32.1418070123307,
35.3933982822018 35.3933982822018,
32.1418070123307 40.2597485145237,31
    46,31 195)
```



⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 15 ⊠⊠⊠⊠, ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠.

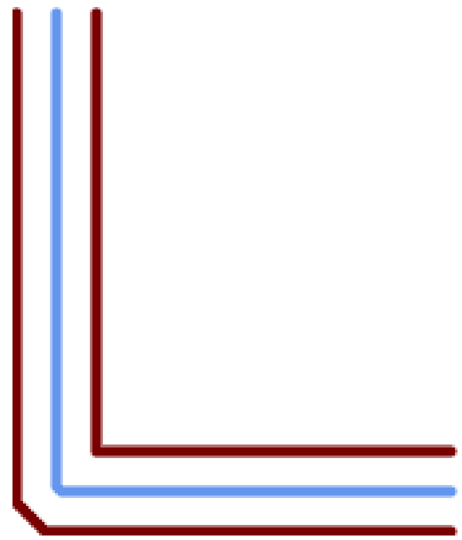
```
SELECT ST_AsText(ST_Collect(
    ST_OffsetCurve(geom, 15, 'quad_segs=4
     join=round'),
    ST_OffsetCurve(ST_OffsetCurve(geom,
    -30, 'quad_segs=4 join=round'), -15,
    'quad_segs=4 join=round')
    )
) As parallel_curves
    FROM ST_GeomFromText(
'LINESTRING(164 16,144 16,124 16,104
    16,84 16,64 16,
    44 16,24 16,20 16,18 16,17 17,
    16 18,16 20,16 40,16 60,16 80,16 100,
    16 120,16 140,16 160,16 180,16 195)')
     As geom;
```

```
parallel curves

MULTILINESTRING((164 1,18
    1,12.2597485145237 2.1418070123307,
7.39339828220179
    5.39339828220179,5.39339828220179 7.393398282201
2.14180701233067 12.2597485145237,1 18,1
    195),
(164 31,46 31,40.2597485145236
    32.1418070123307,35.3933982822018 35.39339828220
32.1418070123307 40.2597485145237,31
    46,31 195))
```



⊠⊠ 15, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠'quad_segs=4 join=round'

```
SELECT ST_AsText(ST_OffsetCurve( ↩
    ST_GeomFromText(
'LINESTRING(164 16,144 16,124 16,104  ↩
    16,84 16,64 16,
    44 16,24 16,20 16,18 16,17 17,
    16 18,16 20,16 40,16 60,16 80,16 100,
    16 120,16 140,16 160,16 180,16 195)') ↩
    ,
        15, 'quad_segs=4 join=bevel'));

output

LINESTRING(164 1,18 1,7.39339828220179  ↩
    5.39339828220179,
    5.39339828220179 7.39339828220179,1  ↩
    18,1 195)
```



⊠⊠⊠ 15, -15. join=mitre mitre_limit=2.1

```
SELECT ST_AsText(ST_Collect(
    ST_OffsetCurve(geom, 15, 'quad_segs=4 ↩
     join=mitre mitre_limit=2.2'),
    ST_OffsetCurve(geom, -15, 'quad_segs ↩
    =4 join=mitre mitre_limit=2.2')
    ) )
    FROM ST_GeomFromText(
'LINESTRING(164 16,144 16,124 16,104  ↩
    16,84 16,64 16,
    44 16,24 16,20 16,18 16,17 17,
    16 18,16 20,16 40,16 60,16 80,16 100,
    16 120,16 140,16 160,16 180,16 195)') ↩
     As geom;

output

MULTILINESTRING((164 1,11.7867965644036  ↩
    1,1 11.7867965644036,1 195),
    (31 195,31 31,164 31))
```

⊠⊠

ST_Buffer

7.14.18 ST_PointOnSurface

ST_PointOnSurface — Computes a point guaranteed to lie in a polygon, or on a geometry.

Synopsis

geometry **ST_PointOnSurface**(geometry g1);

☒☒

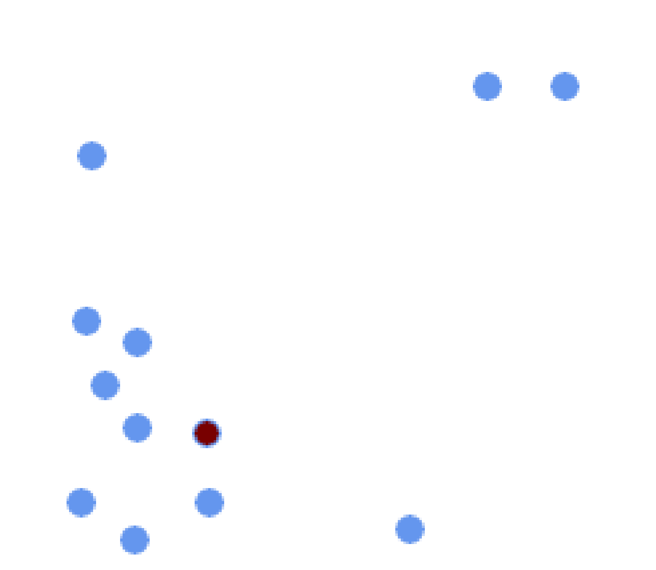
Returns a `POINT` which is guaranteed to lie in the interior of a surface (`POLYGON`, `MULTIPOLYGON`, and `CURVEPOLYGON`). In PostGIS this function also works on line and point geometries.

This method implements the OGC Simple Features Implementation Specification for SQL 1.1. s3.2.14.2 // s3.2.18.2

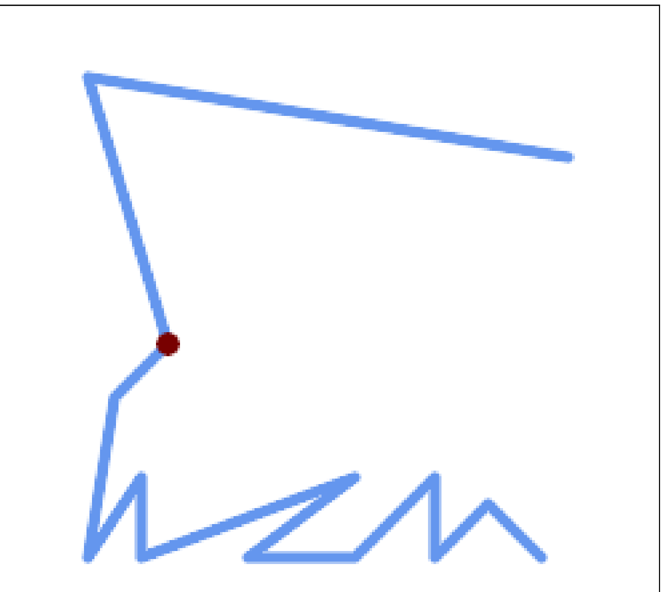
This method implements the SQL/MM specification. SQL-MM 3: 8.1.5, 9.5.6. The specifications define ST_PointOnSurface for surface geometries only. PostGIS extends the function to support all common geometry types. Other databases (Oracle, DB2, ArcSDE) seem to support this function only for surfaces. SQL Server 2008 supports all common geometry types.

This function supports 3d and will not drop the z-index.

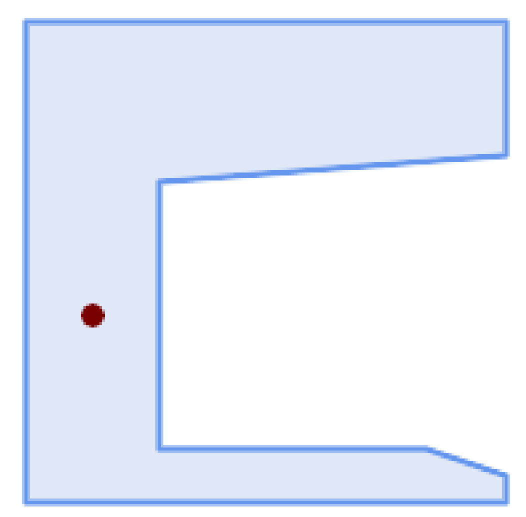
☒☒



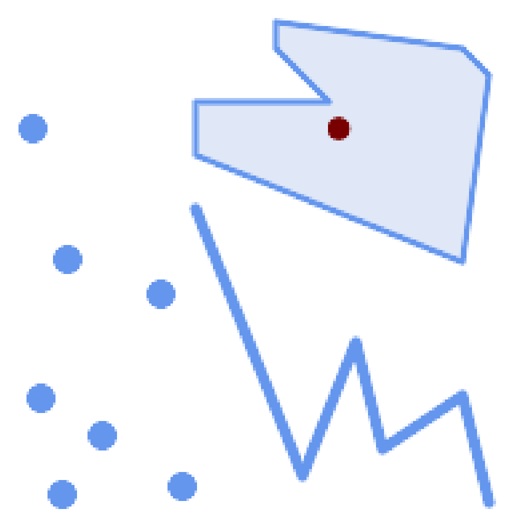
Point on surface of a `MULTIPOINT`



Point on surface of a `LINESTRING`



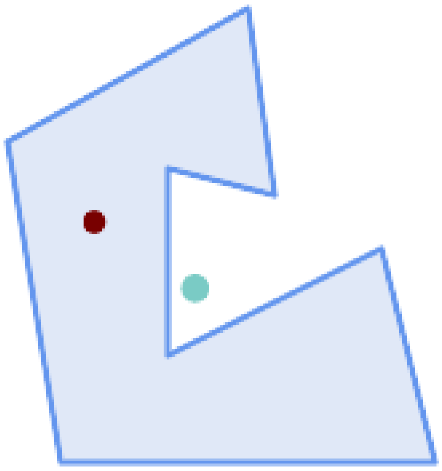
Point on surface of a POLYGON



Point on surface of a GEOMETRYCOLLECTION

```
SELECT ST_AsText(ST_PointOnSurface('POINT(0 5)'::geometry));
------------
 POINT(0 5)

SELECT ST_AsText(ST_PointOnSurface('LINESTRING(0 5, 0 10)'::geometry));
------------
 POINT(0 5)

SELECT ST_AsText(ST_PointOnSurface('POLYGON((0 0, 0 5, 5 5, 5 0, 0 0))'::geometry));
----------------
 POINT(2.5 2.5)

SELECT ST_AsEWKT(ST_PointOnSurface(ST_GeomFromEWKT('LINESTRING(0 5 1, 0 0 1, 0 10 2)')));
----------------
 POINT(0 0 1)
```

Example: The result of ST_PointOnSurface is guaranteed to lie within polygons, whereas the point computed by ST_Centroid may be outside.



Red: point on surface; Green: centroid

```
SELECT ST_AsText(ST_PointOnSurface(geom)) AS pt_on_surf,
       ST_AsText(ST_Centroid(geom)) AS centroid
    FROM (SELECT 'POLYGON ((130 120, 120 190, 30 140, 50 20, 190 20,
                      170 100, 90 60, 90 130, 130 120))'::geometry AS geom) AS t;

   pt_on_surf    |                  centroid
-----------------+---------------------------------------------
 POINT(62.5 110) | POINT(100.18264840182648 85.11415525114155)
```

☒☒

ST_Centroid, ST_MaximumInscribedCircle

7.14.19 ST_Polygonize

ST_Polygonize — Computes a collection of polygons formed from the linework of a set of geometries.

Synopsis

geometry **ST_Polygonize**(geometry set geomfield);
geometry **ST_Polygonize**(geometry[] geom_array);

☒☒

Creates a GeometryCollection containing the polygons formed by the linework of a set of geometries. If the input linework does not form any polygons, an empty GeometryCollection is returned.

This function creates polygons covering all delimited areas. If the result is intended to form a valid polygonal geometry, use ST_BuildArea to prevent holes being filled.

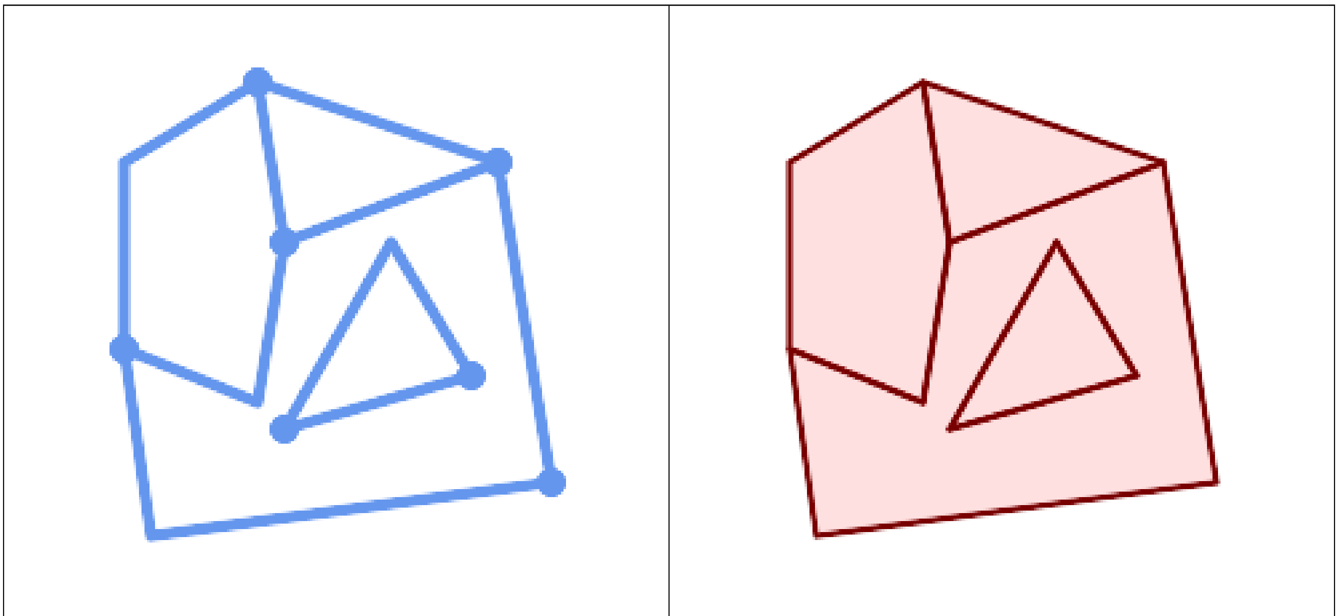
> **Note**
> The input linework must be correctly noded for this function to work properly. To ensure input is noded use ST_Node on the input geometry before polygonizing.

> **Note**
> GeometryCollections can be difficult to handle with external tools. Use ST_Dump to convert the polygonized result into separate polygons.

GEOS ⊠⊠⊠⊠⊠⊠

1.0.0RC1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠



Input lines *Polygonized result*

```
WITH data(geom) AS (VALUES
   ('LINESTRING (180 40, 30 20, 20 90)'::geometry)
  ,('LINESTRING (180 40, 160 160)'::geometry)
  ,('LINESTRING (80 60, 120 130, 150 80)'::geometry)
  ,('LINESTRING (80 60, 150 80)'::geometry)
  ,('LINESTRING (20 90, 70 70, 80 130)'::geometry)
  ,('LINESTRING (80 130, 160 160)'::geometry)
  ,('LINESTRING (20 90, 20 160, 70 190)'::geometry)
  ,('LINESTRING (70 190, 80 130)'::geometry)
  ,('LINESTRING (70 190, 160 160)'::geometry)
)
SELECT ST_AsText( ST_Polygonize( geom ))
    FROM data;

------------------------------------------------------------------------------------------
GEOMETRYCOLLECTION (POLYGON ((180 40, 30 20, 20 90, 70 70, 80 130, 160 160, 180 40), (150 ↩
    80, 120 130, 80 60, 150 80)),
                    POLYGON ((20 90, 20 160, 70 190, 80 130, 70 70, 20 90)),
                    POLYGON ((160 160, 80 130, 70 190, 160 160)),
                    POLYGON ((80 60, 120 130, 150 80, 80 60)))
```

Polygonizing a table of linestrings:

```
SELECT ST_AsEWKT(ST_Polygonize(geom_4269)) As geomtextrep
FROM (SELECT geom_4269 FROM ma.suffolk_edges) As foo;

-------------------------------------
 SRID=4269;GEOMETRYCOLLECTION(POLYGON((-71.040878 42.285678,-71.040943 42.2856,-71.04096 ↩
    42.285752,-71.040878 42.285678)),
 POLYGON((-71.17166 42.353675,-71.172026 42.354044,-71.17239 42.354358,-71.171794 ↩
    42.354971,-71.170511 42.354855,
 -71.17112 42.354238,-71.17166 42.353675)))

--Use ST_Dump to dump out the polygonize geoms into individual polygons
SELECT ST_AsEWKT((ST_Dump(t.polycoll)).geom) AS geomtextrep
FROM (SELECT ST_Polygonize(geom_4269) AS polycoll
    FROM (SELECT geom_4269 FROM ma.suffolk_edges)
        As foo) AS t;

------------------------
 SRID=4269;POLYGON((-71.040878 42.285678,-71.040943 42.2856,-71.04096 42.285752,
-71.040878 42.285678))
 SRID=4269;POLYGON((-71.17166 42.353675,-71.172026 42.354044,-71.17239 42.354358
,-71.171794 42.354971,-71.170511 42.354855,-71.17112 42.354238,-71.17166 42.353675))
```

□□

ST_BuildArea, ST_Dump, ST_Node

7.14.20 ST_ReducePrecision

ST_ReducePrecision — Returns a valid geometry with points rounded to a grid tolerance.

Synopsis

geometry **ST_ReducePrecision**(geometry g, float8 gridsize);

□□

Returns a valid geometry with all points rounded to the provided grid tolerance, and features below the tolerance removed.

Unlike ST_SnapToGrid the returned geometry will be valid, with no ring self-intersections or collapsed components.

Precision reduction can be used to:

- match coordinate precision to the data accuracy
- reduce the number of coordinates needed to represent a geometry
- ensure valid geometry output to formats which use lower precision (e.g. text formats such as WKT, GeoJSON or KML when the number of output decimal places is limited).
- export valid geometry to systems which use lower or limited precision (e.g. SDE, Oracle tolerance value)

Availability: 3.1.0.

Requires GEOS >= 3.9.0.

□□

```
SELECT ST_AsText(ST_ReducePrecision('POINT(1.412 19.323)', 0.1));
    st_astext
-----------------
 POINT(1.4 19.3)

SELECT ST_AsText(ST_ReducePrecision('POINT(1.412 19.323)', 1.0));
  st_astext
-------------
 POINT(1 19)

SELECT ST_AsText(ST_ReducePrecision('POINT(1.412 19.323)', 10));
  st_astext
-------------
 POINT(0 20)
```

Precision reduction can reduce number of vertices

```
SELECT ST_AsText(ST_ReducePrecision('LINESTRING (10 10, 19.6 30.1, 20 30, 20.3 30, 40 40)', 1));
  st_astext
-------------
 LINESTRING (10 10, 20 30, 40 40)
```

Precision reduction splits polygons if needed to ensure validity

```
SELECT ST_AsText(ST_ReducePrecision('POLYGON ((10 10, 60 60.1, 70 30, 40 40, 50 10, 10 10))', 10));
  st_astext
-------------
 MULTIPOLYGON (((60 60, 70 30, 40 40, 60 60)), ((40 40, 50 10, 10 10, 40 40)))
```

□□

ST_SnapToGrid, ST_Simplify, ST_SimplifyVW

7.14.21 ST_SharedPaths

ST_SharedPaths — □□□□□□□□□/□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

Synopsis

geometry **ST_SharedPaths**(geometry lineal1, geometry lineal2);

□□

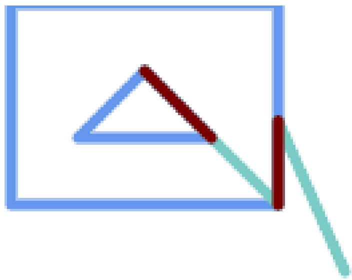
□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□.

GEOS □□□□□

2.0.0 □□□□□□□□□□□□□.

□□: □□□□□□□□

[illegible]



[illegible]

```
SELECT ST_AsText(
  ST_SharedPaths(
    ST_GeomFromText('MULTILINESTRING((26 125,26 200,126 200,126 125,26 125),
       (51 150,101 150,76 175,51 150))'),
    ST_GeomFromText('LINESTRING(151 100,126 156.25,126 125,90 161, 76 175)')
    )
  ) As wkt

                                wkt
-------------------------------------------------------------
GEOMETRYCOLLECTION(MULTILINESTRING((126 156.25,126 125),
 (101 150,90 161),(90 161,76 175)),MULTILINESTRING EMPTY)
```

```
same example but linestring orientation flipped

SELECT ST_AsText(
  ST_SharedPaths(
   ST_GeomFromText('LINESTRING(76 175,90 161,126 125,126 156.25,151 100)'),
   ST_GeomFromText('MULTILINESTRING((26 125,26 200,126 200,126 125,26 125),
       (51 150,101 150,76 175,51 150))')
    )
  ) As wkt

                                wkt
-------------------------------------------------------------
GEOMETRYCOLLECTION(MULTILINESTRING EMPTY,
MULTILINESTRING((76 175,90 161),(90 161,101 150),(126 125,126 156.25)))
```

⊠⊠

ST_Dump, ST_GeometryN, ST_NumGeometries

7.14.22 ST_Simplify

ST_Simplify — Returns a simplified representation of a geometry, using the Douglas-Peucker algorithm.

Synopsis

geometry **ST_Simplify**(geometry geom, float tolerance);
geometry **ST_Simplify**(geometry geom, float tolerance, boolean preserveCollapsed);

⊠⊠

Computes a simplified representation of a geometry using the Douglas-Peucker algorithm. The simplification `tolerance` is a distance value, in the units of the input SRS. Simplification removes vertices which are within the tolerance distance of the simplified linework. The result may not be valid even if the input is.

The function can be called with any kind of geometry (including GeometryCollections), but only line and polygon elements are simplified. Endpoints of linear geometry are preserved.

The `preserveCollapsed` flag retains small geometries that would otherwise be removed at the given tolerance. For example, if a 1m long line is simplified with a 10m tolerance, when `preserveCollapsed` is true the line will not disappear. This flag is useful for rendering purposes, to prevent very small features disappearing from a map.

Note
The returned geometry may lose its simplicity (see ST_IsSimple), topology may not be preserved, and polygonal results may be invalid (see ST_IsValid). Use ST_SimplifyPreserveTopology to preserve topology and ensure validity.

Note
This function does not preserve boundaries shared between polygons. Use ST_CoverageSimplify if this is required.

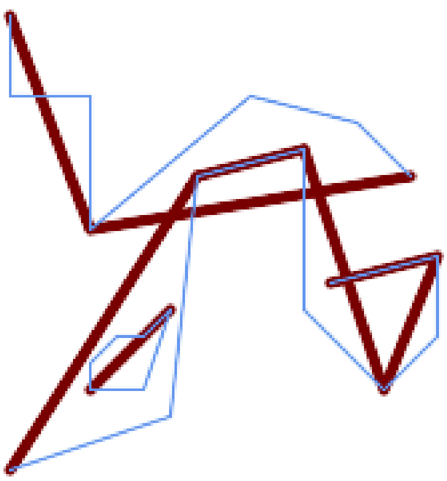
1.2.2 □□□□□□□□□□□□.

□□

□□□□□□□□□□□□□□□□□□□□□□□□□.

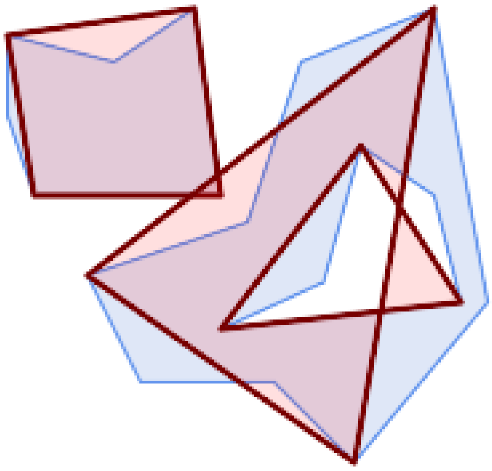
```
SELECT ST_Npoints(geom) AS np_before,
       ST_NPoints(ST_Simplify(geom, 0.1)) AS np01_notbadcircle,
       ST_NPoints(ST_Simplify(geom, 0.5)) AS np05_notquitecircle,
       ST_NPoints(ST_Simplify(geom, 1)) AS np1_octagon,
       ST_NPoints(ST_Simplify(geom, 10)) AS np10_triangle,
       (ST_Simplify(geom, 100) is null) AS  np100_geometrygoesaway
  FROM (SELECT ST_Buffer('POINT(1 3)', 10,12) As geom) AS t;

 np_before | np01_notbadcircle | np05_notquitecircle | np1_octagon | np10_triangle | ↩
    np100_geometrygoesaway
-----------+-------------------+---------------------+-------------+---------------+----------------

        49 |                33 |                  17 |           9 |             4 | t
```

Simplifying a set of lines. Lines may intersect after simplification.



```
SELECT ST_Simplify(
  'MULTILINESTRING ((20 180, 20 150, 50 150, 50 100, 110 150, 150 140, 170 120), (20 10, 80 ↩
       30, 90 120), (90 120, 130 130), (130 130, 130 70, 160 40, 180 60, 180 90, 140 80),  ↩
     (50 40, 70 40, 80 70, 70 60, 60 60, 50 50, 50 40))',
    40);
```

Simplifying a MultiPolygon. Polygonal results may be invalid.



```
SELECT ST_Simplify(
  'MULTIPOLYGON (((90 110, 80 180, 50 160, 10 170, 10 140, 20 110, 90 110)), ((40 80, 100 ↩
      100, 120 160, 170 180, 190 70, 140 10, 110 40, 60 40, 40 80), (180 70, 170 110, 142.5 ↩
      128.5, 128.5 77.5, 90 60, 180 70)))',
    40);
```

□□

ST_IsSimple, ST_SimplifyPreserveTopology, ST_SimplifyVW, ST_CoverageSimplify, Topology ST_Simplify

7.14.23 ST_SimplifyPreserveTopology

ST_SimplifyPreserveTopology — Returns a simplified and valid representation of a geometry, using the Douglas-Peucker algorithm.

Synopsis

geometry **ST_SimplifyPreserveTopology**(geometry geom, float tolerance);

□□

Computes a simplified representation of a geometry using a variant of the Douglas-Peucker algorithm which limits simplification to ensure the result has the same topology as the input. The simplification `tolerance` is a distance value, in the units of the input SRS. Simplification removes vertices which are within the tolerance distance of the simplified linework, as long as topology is preserved. The result will be valid and simple if the input is.

The function can be called with any kind of geometry (including GeometryCollections), but only line and polygon elements are simplified. For polygonal inputs, the result will have the same number of rings (shells and holes), and the rings will not cross. Ring endpoints may be simplified. For linear inputs, the result will have the same number of lines, and lines will not intersect if they did not do so in the original geometry. Endpoints of linear geometry are preserved.

> **Note**
> This function does not preserve boundaries shared between polygons. Use ST_CoverageSimplify if this is required.

GEOS ☒☒☒☒☒

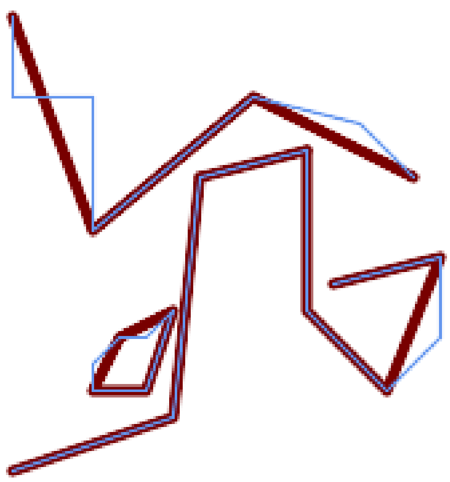
1.3.3 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

For the same example as ST_Simplify, ST_SimplifyPreserveTopology prevents oversimplification. The circle can at most become a square.

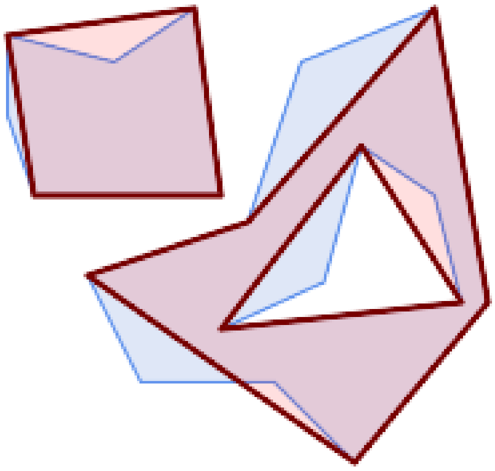
```
SELECT  ST_Npoints(geom) AS np_before,
        ST_NPoints(ST_SimplifyPreserveTopology(geom, 0.1)) AS np01_notbadcircle,
        ST_NPoints(ST_SimplifyPreserveTopology(geom, 0.5)) AS np05_notquitecircle,
        ST_NPoints(ST_SimplifyPreserveTopology(geom, 1))   AS np1_octagon,
        ST_NPoints(ST_SimplifyPreserveTopology(geom, 10))  AS np10_square,
        ST_NPoints(ST_SimplifyPreserveTopology(geom, 100)) AS np100_stillsquare
FROM (SELECT ST_Buffer('POINT(1 3)', 10,12) AS geom) AS t;

 np_before | np01_notbadcircle | np05_notquitecircle | np1_octagon | np10_square | ↩
    np100_stillsquare
-----------+-------------------+---------------------+-------------+-------------+------------------

        49 |                33 |                  17 |           9 |           5 | ↩
                            5
```

Simplifying a set of lines, preserving topology of non-intersecting lines.



```
SELECT ST_SimplifyPreserveTopology(
  'MULTILINESTRING ((20 180, 20 150, 50 150, 50 100, 110 150, 150 140, 170 120), (20 10, 80 ↩
      30, 90 120), (90 120, 130 130), (130 130, 130 70, 160 40, 180 60, 180 90, 140 80), ↩
     (50 40, 70 40, 80 70, 70 60, 60 60, 50 50, 50 40))',
    40);
```

Simplifying a MultiPolygon, preserving topology of shells and holes.



```
SELECT ST_SimplifyPreserveTopology(
  'MULTIPOLYGON (((90 110, 80 180, 50 160, 10 170, 10 140, 20 110, 90 110)), ((40 80, 100 ↩
      100, 120 160, 170 180, 190 70, 140 10, 110 40, 60 40, 40 80), (180 70, 170 110, 142.5 ↩
      128.5, 128.5 77.5, 90 60, 180 70)))',
    40);
```

□□

ST_Simplify, ST_SimplifyVW, ST_CoverageSimplify

7.14.24 ST_SimplifyPolygonHull

ST_SimplifyPolygonHull — Computes a simplifed topology-preserving outer or inner hull of a polygonal geometry.

Synopsis

geometry **ST_SimplifyPolygonHull**(geometry param_geom, float vertex_fraction, boolean is_outer = true);

□□

Computes a simplified topology-preserving outer or inner hull of a polygonal geometry. An outer hull completely covers the input geometry. An inner hull is completely covered by the input geometry. The result is a polygonal geometry formed by a subset of the input vertices. MultiPolygons and holes are handled and produce a result with the same structure as the input.

The reduction in vertex count is controlled by the `vertex_fraction` parameter, which is a number in the range 0 to 1. Lower values produce simpler results, with smaller vertex count and less concaveness. For both outer and inner hulls a vertex fraction of 1.0 produces the original geometry. For outer hulls a value of 0.0 produces the convex hull (for a single polygon); for inner hulls it produces a triangle.

The simplification process operates by progressively removing concave corners that contain the least amount of area, until the vertex count target is reached. It prevents edges from crossing, so the result is always a valid polygonal geometry.

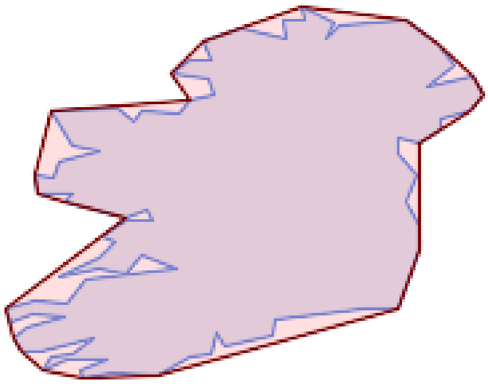
To get better results with geometries that contain relatively long line segments, it might be necessary to "segmentize" the input, as shown below.

GEOS ☒☒☒☒☒

Availability: 3.3.0.

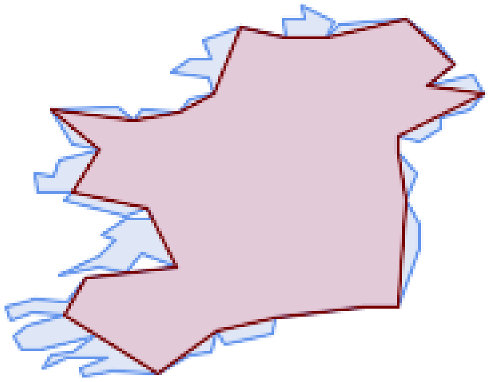
Requires GEOS >= 3.11.0.

☒☒



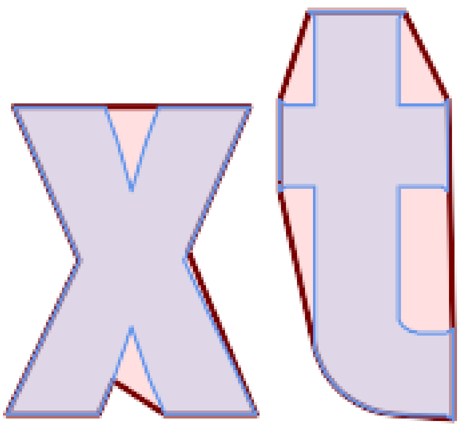
Outer hull of a Polygon

```
SELECT ST_SimplifyPolygonHull(
  'POLYGON ((131 158, 136 163, 161 165, 173 156, 179 148, 169 140, 186 144, 190 137, 185 ↩
      131, 174 128, 174 124, 166 119, 158 121, 158 115, 165 107, 161 97, 166 88, 166 79, 158 ↩
       57, 145 57, 112 53, 111 47, 93 43, 90 48, 88 40, 80 39, 68 32, 51 33, 40 31, 39 34,  ↩
      49 38, 34 38, 25 34, 28 39, 36 40, 44 46, 24 41, 17 41, 14 46, 19 50, 33 54, 21 55, 13 ↩
       52, 11 57, 22 60, 34 59, 41 68, 75 72, 62 77, 56 70, 46 72, 31 69, 46 76, 52 82, 47  ↩
      84, 56 90, 66 90, 64 94, 56 91, 33 97, 36 100, 23 100, 22 107, 29 106, 31 112, 46 116, ↩
       36 118, 28 131, 53 132, 59 127, 62 131, 76 130, 80 135, 89 137, 87 143, 73 145, 80  ↩
      150, 88 150, 85 157, 99 162, 116 158, 115 165, 123 165, 122 170, 134 164, 131 158))',
    0.3);
```



Inner hull of a Polygon

```
SELECT ST_SimplifyPolygonHull(
  'POLYGON ((131 158, 136 163, 161 165, 173 156, 179 148, 169 140, 186 144, 190 137, 185  ↩
      131, 174 128, 174 124, 166 119, 158 121, 158 115, 165 107, 161 97, 166 88, 166 79, 158 ↩
       57, 145 57, 112 53, 111 47, 93 43, 90 48, 88 40, 80 39, 68 32, 51 33, 40 31, 39 34,  ↩
      49 38, 34 38, 25 34, 28 39, 36 40, 44 46, 24 41, 17 41, 14 46, 19 50, 33 54, 21 55, 13 ↩
       52, 11 57, 22 60, 34 59, 41 68, 75 72, 62 77, 56 70, 46 72, 31 69, 46 76, 52 82, 47  ↩
      84, 56 90, 66 90, 64 94, 56 91, 33 97, 36 100, 23 100, 22 107, 29 106, 31 112, 46 116, ↩
       36 118, 28 131, 53 132, 59 127, 62 131, 76 130, 80 135, 89 137, 87 143, 73 145, 80  ↩
      150, 88 150, 85 157, 99 162, 116 158, 115 165, 123 165, 122 170, 134 164, 131 158))',
    0.3, false);
```



Outer hull simplification of a MultiPolygon, with segmentization

```
SELECT ST_SimplifyPolygonHull(
  ST_Segmentize(ST_Letters('xt'), 2.0),
    0.1);
```

⊠⊠

ST_ConvexHull, ST_SimplifyVW, ST_ConcaveHull, ST_Segmentize

7.14.25 ST_SimplifyVW

ST_SimplifyVW — Returns a simplified representation of a geometry, using the Visvalingam-Whyatt algorithm

Synopsis

geometry **ST_SimplifyVW**(geometry geom, float tolerance);

⊠⊠

Returns a simplified representation of a geometry using the Visvalingam-Whyatt algorithm. The simplification `tolerance` is an area value, in the units of the input SRS. Simplification removes vertices which form "corners" with area less than the tolerance. The result may not be valid even if the input is.

The function can be called with any kind of geometry (including GeometryCollections), but only line and polygon elements are simplified. Endpoints of linear geometry are preserved.

> **Note**
> The returned geometry may lose its simplicity (see ST_IsSimple), topology may not be preserved, and polygonal results may be invalid (see ST_IsValid). Use ST_SimplifyPreserveTopology to preserve topology and ensure validity. ST_CoverageSimplify also preserves topology and validity.

> **Note**
> This function does not preserve boundaries shared between polygons. Use ST_CoverageSimplify if this is required.

> **Note**
> ⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

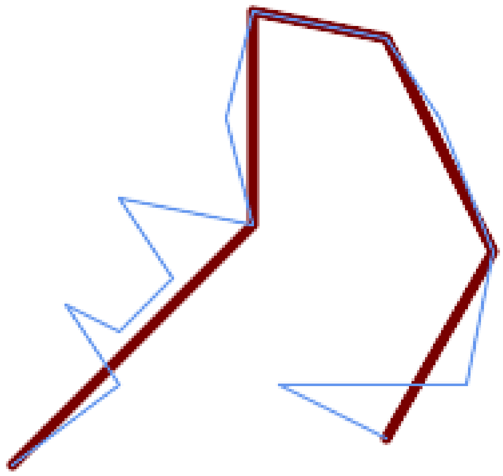
2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

A LineString is simplified with a minimum-area tolerance of 30.

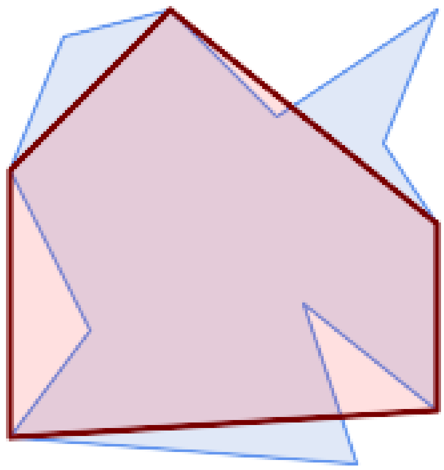
```
SELECT ST_AsText(ST_SimplifyVW(geom,30)) simplified
  FROM (SELECT 'LINESTRING(5 2, 3 8, 6 20, 7 25, 10 10)'::geometry AS geom) AS t;

 simplified
------------------------------
LINESTRING(5 2,7 25,10 10)
```

Simplifying a line.



```
SELECT ST_SimplifyVW(
  'LINESTRING (10 10, 50 40, 30 70, 50 60, 70 80, 50 110, 100 100, 90 140, 100 180, 150 ↩
      170, 170 140, 190 90, 180 40, 110 40, 150 20)',
    1600);
```

Simplifying a polygon.



```
SELECT ST_SimplifyVW(
  'MULTIPOLYGON (((90 110, 80 180, 50 160, 10 170, 10 140, 20 110, 90 110)), ((40 80, 100 ↩
      100, 120 160, 170 180, 190 70, 140 10, 110 40, 60 40, 40 80), (180 70, 170 110, 142.5 ↩
      128.5, 128.5 77.5, 90 60, 180 70)))',
    40);
```

□□

ST_SetEffectiveArea, ST_Simplify, ST_SimplifyPreserveTopology, ST_CoverageSimplify, Topology ST_Simpl

7.14.26 ST_SetEffectiveArea

ST_SetEffectiveArea — Sets the effective area for each vertex, using the Visvalingam-Whyatt algorithm.

Synopsis

geometry **ST_SetEffectiveArea**(geometry geom, float threshold = 0, integer set_area = 1);

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☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒ 0 ☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒, ☒☒☒☒☒☒ M ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒ [☒☒] ☒☒, [☒☒] ☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

> **Note**
> ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (ST_IsSimple ☒☒).

> **Note**
> ☒☒ (topology) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒ ST_SimplifyPreserveTopology ☒☒☒☒☒☒☒☒☒☒.

> **Note**
> ☒☒☒☒☒ M ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

> **Note**
> ☒☒☒☒ 3 ☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒.

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```
select ST_AsText(ST_SetEffectiveArea(geom)) all_pts, ST_AsText(ST_SetEffectiveArea(geom,30) ↩
     ) thrshld_30
FROM (SELECT  'LINESTRING(5 2, 3 8, 6 20, 7 25, 10 10)'::geometry geom) As foo;
-result
 all_pts | thrshld_30
-----------+-------------------+
LINESTRING M (5 2 3.40282346638529e+38,3 8 29,6 20 1.5,7 25 49.5,10 10 3.40282346638529e ↩
    +38) | LINESTRING M (5 2 3.40282346638529e+38,7 25 49.5,10 10 3.40282346638529e+38)
```

□□

ST_SimplifyVW

7.14.27 ST_TriangulatePolygon

ST_TriangulatePolygon — Computes the constrained Delaunay triangulation of polygons

Synopsis

geometry **ST_TriangulatePolygon**(geometry geom);

□□

Computes the constrained Delaunay triangulation of polygons. Holes and Multipolygons are supported.

The ”constrained Delaunay triangulation” of a polygon is a set of triangles formed from the vertices of the polygon, and covering it exactly, with the maximum total interior angle over all possible triangulations. It provides the ”best quality” triangulation of the polygon.

Availability: 3.3.0.

Requires GEOS >= 3.11.0.

□□

Triangulation of a square.

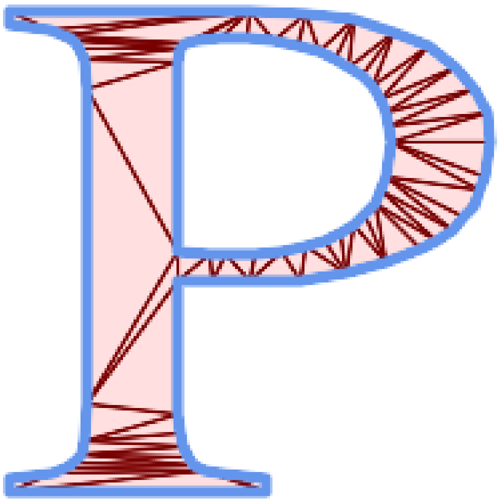
```
SELECT ST_AsText(
    ST_TriangulatePolygon('POLYGON((0 0, 0 1, 1 1, 1 0, 0 0))'));

                             st_astext
---------------------------------------------------------------------------
 GEOMETRYCOLLECTION(POLYGON((0 0,0 1,1 1,0 0)),POLYGON((1 1,1 0,0 0,1 1)))
```

□□

Triangulation of the letter P.

```
SELECT ST_AsText(ST_TriangulatePolygon(
    'POLYGON ((26 17, 31 19, 34 21, 37 24, 38 29, 39 43, 39 161, 38 172, 36 176, 34 179, 30 ↩
         181, 25 183, 10 185, 10 190, 100 190, 121 189, 139 187, 154 182, 167 177, 177 169,  ↩
        184 161, 189 152, 190 141, 188 128, 186 123, 184 117, 180 113, 176 108, 170 104, 164 ↩
         101, 151 96, 136 92, 119 89, 100 89, 86 89, 73 89, 73 39, 74 32, 75 27, 77 23, 79  ↩
        20, 83 18, 89 17, 106 15, 106 10, 10 10, 10 15, 26 17), (152 147, 151 152, 149 157,  ↩
        146 162, 142 166, 137 169, 132 172, 126 175, 118 177, 109 179, 99 180, 89 180, 80  ↩
        179, 76 178, 74 176, 73 171, 73 100, 85 99, 91 99, 102 99, 112 100, 121 102, 128  ↩
        104, 134 107, 139 110, 143 114, 147 118, 149 123, 151 128, 153 141, 152 147))'
    ));
```



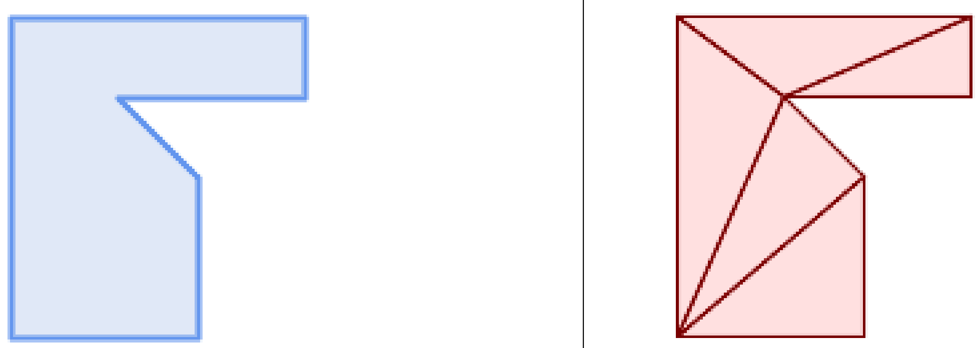
Polygon Triangulation

Same example as ST_Tesselate

```
SELECT ST_TriangulatePolygon(
                'POLYGON (( 10 190, 10 70, 80 70, 80 130, 50 160, 120 160, 120 190, 10 190 ↩
                    ))'::geometry
                );
```

ST_AsText ⊠⊠⊠:

```
GEOMETRYCOLLECTION(POLYGON((50 160,120 190,120 160,50 160))
    ,POLYGON((10 70,80 130,80 70,10 70))
    ,POLYGON((50 160,10 70,10 190,50 160))
    ,POLYGON((120 190,50 160,10 190,120 190))
    ,POLYGON((80 130,10 70,50 160,80 130)))
```



⊠⊠⊠⊠⊠

Triangulated Polygon

⊠⊠

ST_ConstrainedDelaunayTriangles, ST_DelaunayTriangles, ST_Tesselate

7.14.28 ST_VoronoiLines

ST_VoronoiLines — Returns the boundaries of the Voronoi diagram of the vertices of a geometry.

Synopsis

geometry **ST_VoronoiLines**(geometry geom , float8 tolerance = 0.0 , geometry extend_to = NULL);

⊠⊠

Computes a two-dimensional Voronoi diagram from the vertices of the supplied geometry and returns the boundaries between cells in the diagram as a MultiLineString. Returns null if input geometry is null. Returns an empty geometry collection if the input geometry contains only one vertex. Returns an empty geometry collection if the `extend_to` envelope has zero area.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- `tolerance`: The distance within which vertices will be considered equivalent. Robustness of the algorithm can be improved by supplying a nonzero tolerance distance. (default = 0.0)
- `extend_to`: If present, the diagram is extended to cover the envelope of the supplied geometry, unless smaller than the default envelope (default = NULL, default envelope is the bounding box of the input expanded by about 50%).

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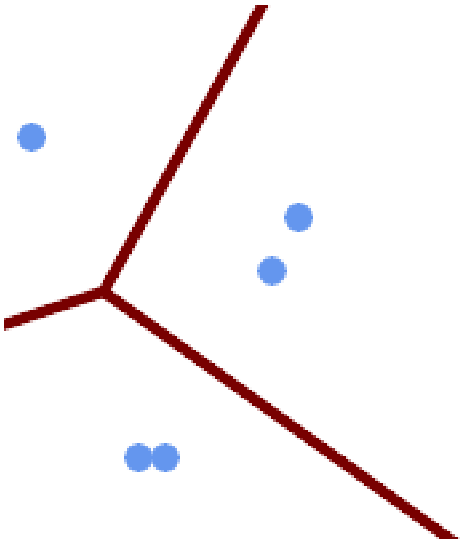


Voronoi diagram lines, with tolerance of 30 units

```
SELECT ST_VoronoiLines(
            'MULTIPOINT (50 30, 60 30, 100 100,10 150, 110 120)'::geometry,
            30) AS geom;
```

```
ST_AsText output
MULTILINESTRING((135.555555555556 270,36.8181818181818 92.2727272727273),(36.8181818181818 92.2727272727273,-110 43.3333333333333),(230 -45.7142857142858,36.8181818181818 92.2727272727273))
```

□□

ST_DelaunayTriangles, ST_VoronoiPolygons

7.14.29 ST_VoronoiPolygons

ST_VoronoiPolygons — Returns the cells of the Voronoi diagram of the vertices of a geometry.

Synopsis

geometry **ST_VoronoiPolygons**(geometry geom , float8 tolerance = 0.0 , geometry extend_to = NULL);

□□

Computes a two-dimensional Voronoi diagram from the vertices of the supplied geometry. The result is a GEOMETRYCOLLECTION of POLYGONs that covers an envelope larger than the extent of the input vertices. Returns null if input geometry is null. Returns an empty geometry collection if the input geometry contains only one vertex. Returns an empty geometry collection if the `extend_to` envelope has zero area.

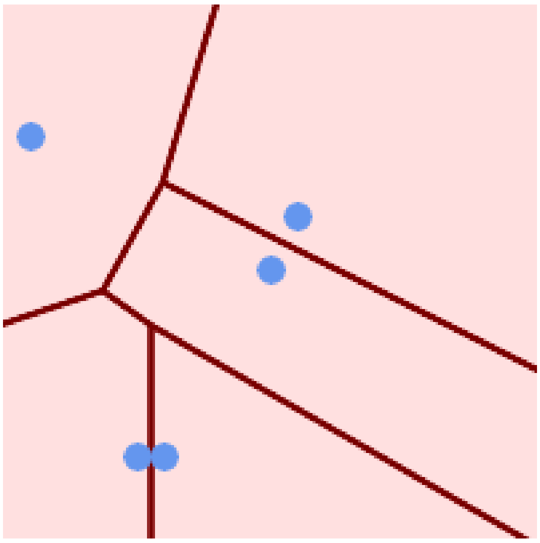
□□□□□□□□□□:

- `tolerance`: The distance within which vertices will be considered equivalent. Robustness of the algorithm can be improved by supplying a nonzero tolerance distance. (default = 0.0)
- `extend_to`: If present, the diagram is extended to cover the envelope of the supplied geometry, unless smaller than the default envelope (default = NULL, default envelope is the bounding box of the input expanded by about 50%).

GEOS □□□□□

2.3.0 □□□□□□□□□□□□.

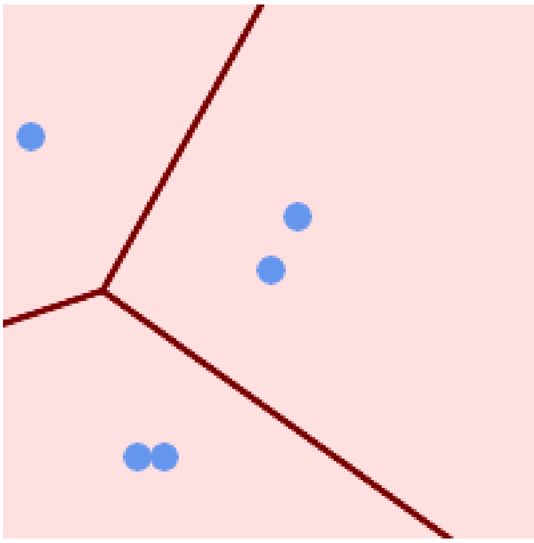
□□



Points overlaid on top of Voronoi diagram

```
SELECT ST_VoronoiPolygons(
                'MULTIPOINT (50 30, 60 30, 100 100,10 150, 110 120)'::geometry
            ) AS geom;
```

```
ST_AsText output
GEOMETRYCOLLECTION(POLYGON((-110 43.3333333333333,-110 270,100.5 270,59.3478260869565 132.826086956522,36.8181818181818 92.2727272727273,-110 43.3333333333333)),
POLYGON((55 -90,-110 -90,-110 43.3333333333333,36.8181818181818 92.2727272727273,55 79.2857142857143,55 -90)),
POLYGON((230 47.5,230 -20.7142857142857,55 79.2857142857143,36.8181818181818 92.2727272727273,59.3478260869565 132.826086956522,230 47.5)),POLYGON((230 -20.7142857142857,230 -90,55 -90,55 79.2857142857143,230 -20.7142857142857)),
POLYGON((100.5 270,230 270,230 47.5,59.3478260869565 132.826086956522,100.5 270)))
```



Voronoi diagram, with tolerance of 30 units

```
SELECT ST_VoronoiPolygons(
            'MULTIPOINT (50 30, 60 30, 100 100,10 150, 110 120)'::geometry,
            30) AS geom;
```

```
ST_AsText output
GEOMETRYCOLLECTION(POLYGON((-110 43.3333333333333,-110 270,100.5 270,59.3478260869565 132.826086956522,36.8181818181818 92.2727272727273,-110 43.3333333333333)),
POLYGON((230 47.5,230 -45.7142857142858,36.8181818181818 92.2727272727273,59.3478260869565 132.826086956522,230 47.5)),POLYGON((230 -45.7142857142858,230 -90,-110 -90,-110 43.3333333333333,36.8181818181818 92.2727272727273,230 -45.7142857142858)),
POLYGON((100.5 270,230 270,230 47.5,59.3478260869565 132.826086956522,100.5 270)))
```

⊠⊠

ST_DelaunayTriangles, ST_VoronoiLines

7.15 Coverages

7.15.1 ST_CoverageInvalidEdges

ST_CoverageInvalidEdges — Window function that finds locations where polygons fail to form a valid coverage.

Synopsis

geometry **ST_CoverageInvalidEdges**(geometry winset geom, float8 tolerance = 0);

⊠⊠

A window function which checks if the polygons in the window partition form a valid polygonal coverage. It returns linear indicators showing the location of invalid edges (if any) in each polygon.

A set of valid polygons is a valid coverage if the following conditions hold:

- **Non-overlapping** - polygons do not overlap (their interiors do not intersect)
- **Edge-Matched** - vertices along shared edges are identical

As a window function a value is returned for every input polygon. For polygons which violate one or more of the validity conditions the return value is a MULTILINESTRING containing the problematic edges. Coverage-valid polygons return the value NULL. Non-polygonal or empty geometries also produce NULL values.

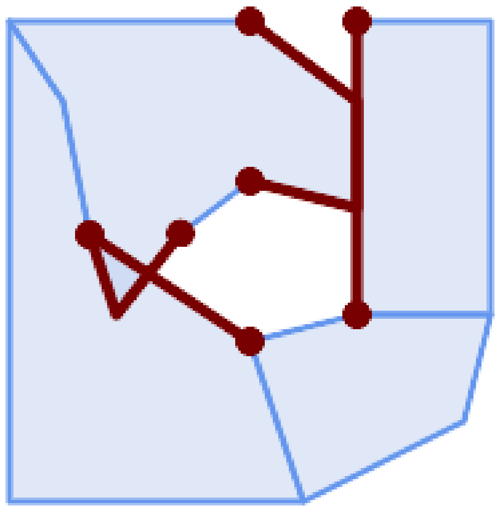
The conditions allow a valid coverage to contain holes (gaps between polygons), as long as the surrounding polygons are edge-matched. However, very narrow gaps are often undesirable. If the `tolerance` parameter is specified with a non-zero distance, edges forming narrower gaps will also be returned as invalid.

The polygons being checked for coverage validity must also be valid geometries. This can be checked with ST_IsValid.

Availability: 3.4.0

Requires GEOS >= 3.12.0

⊠⊠



Invalid edges caused by overlap and non-matching vertices

```
WITH coverage(id, geom) AS (VALUES
  (1, 'POLYGON ((10 190, 30 160, 40 110, 100 70, 120 10, 10 10, 10 190))'::geometry),
  (2, 'POLYGON ((100 190, 10 190, 30 160, 40 110, 50 80, 74 110.5, 100 130, 140 120, 140 160, 100 190))'::geometry),
  (3, 'POLYGON ((140 190, 190 190, 190 80, 140 80, 140 190))'::geometry),
  (4, 'POLYGON ((180 40, 120 10, 100 70, 140 80, 190 80, 180 40))'::geometry)
)
SELECT id, ST_AsText(ST_CoverageInvalidEdges(geom) OVER ())
  FROM coverage;

 id |               st_astext
----+---------------------------------------
  1 | LINESTRING (40 110, 100 70)
  2 | MULTILINESTRING ((100 130, 140 120, 140 160, 100 190), (40 110, 50 80, 74 110.5))
  3 | LINESTRING (140 80, 140 190)
  4 | null
```

```
-- Test entire table for coverage validity
SELECT true = ALL (
    SELECT ST_CoverageInvalidEdges(geom) OVER () IS NULL
    FROM coverage
    );
```

⊠⊠

ST_IsValid, ST_CoverageUnion, ST_CoverageSimplify

7.15.2 ST_CoverageSimplify

ST_CoverageSimplify — Window function that simplifies the edges of a polygonal coverage.

Synopsis

geometry **ST_CoverageSimplify**(geometry winset geom, float8 tolerance, boolean simplifyBoundary = true);

☒☒

A window function which simplifies the edges of polygons in a polygonal coverage. The simplification preserves the coverage topology. This means the simplified output polygons are consistent along shared edges, and still form a valid coverage.

The simplification uses a variant of the Visvalingam-Whyatt algorithm. The *tolerance* parameter has units of distance, and is roughly equal to the square root of triangular areas to be simplified.

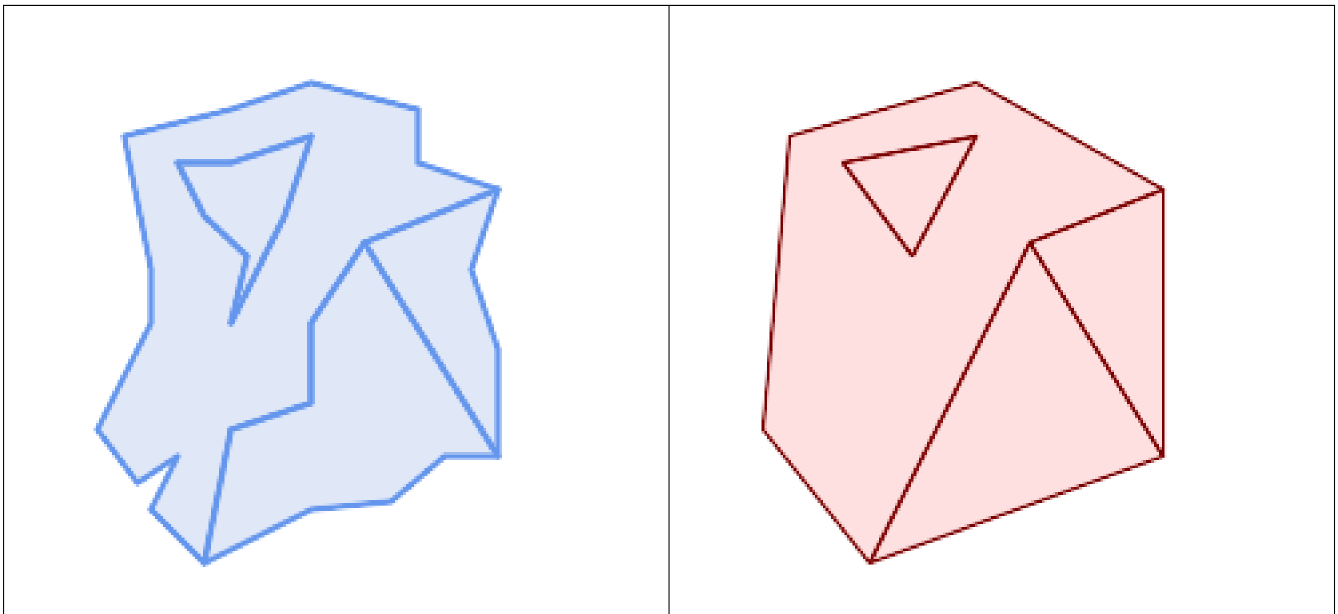
To simplify only the "internal" edges of the coverage (those that are shared by two polygons) set the *simplifyBoundary* parameter to false.

Note
If the input is not a valid coverage there may be unexpected artifacts in the output (such as boundary intersections, or separated boundaries which appeared to be shared). Use ST_CoverageInvalidEdges to determine if a coverage is valid.

Availability: 3.4.0

Requires GEOS >= 3.12.0

☒☒



Input coverage *Simplified coverage*

```
WITH coverage(id, geom) AS (VALUES
  (1, 'POLYGON ((160 150, 110 130, 90 100, 90 70, 60 60, 50 10, 30 30, 40 50, 25 40, 10 60, ↩
      30 100, 30 120, 20 170, 60 180, 90 190, 130 180, 130 160, 160 150), (40 160, 50 140, ↩
     66 125, 60 100, 80 140, 90 170, 60 160, 40 160))'::geometry),
```

```
  (2, 'POLYGON ((40 160, 60 160, 90 170, 80 140, 60 100, 66 125, 50 140, 40 160))'::geometry),
  (3, 'POLYGON ((110 130, 160 50, 140 50, 120 33, 90 30, 50 10, 60 60, 90 70, 90 100, 110 130))'::geometry),
  (4, 'POLYGON ((160 150, 150 120, 160 90, 160 50, 110 130, 160 150))'::geometry)
)
SELECT id, ST_AsText(ST_CoverageSimplify(geom, 30) OVER ())
  FROM coverage;

 id |               st_astext
----+--------------------------------------
  1 | POLYGON ((160 150, 110 130, 50 10, 10 60, 20 170, 90 190, 160 150), (40 160, 66 125, 90 170, 40 160))
  2 | POLYGON ((40 160, 66 125, 90 170, 40 160))
  3 | POLYGON ((110 130, 160 50, 50 10, 110 130))
  4 | POLYGON ((160 150, 160 50, 110 130, 160 150))
```

☒☒

ST_CoverageInvalidEdges

7.15.3 ST_CoverageUnion

ST_CoverageUnion — Computes the union of a set of polygons forming a coverage by removing shared edges.

Synopsis

geometry **ST_CoverageUnion**(geometry set geom);

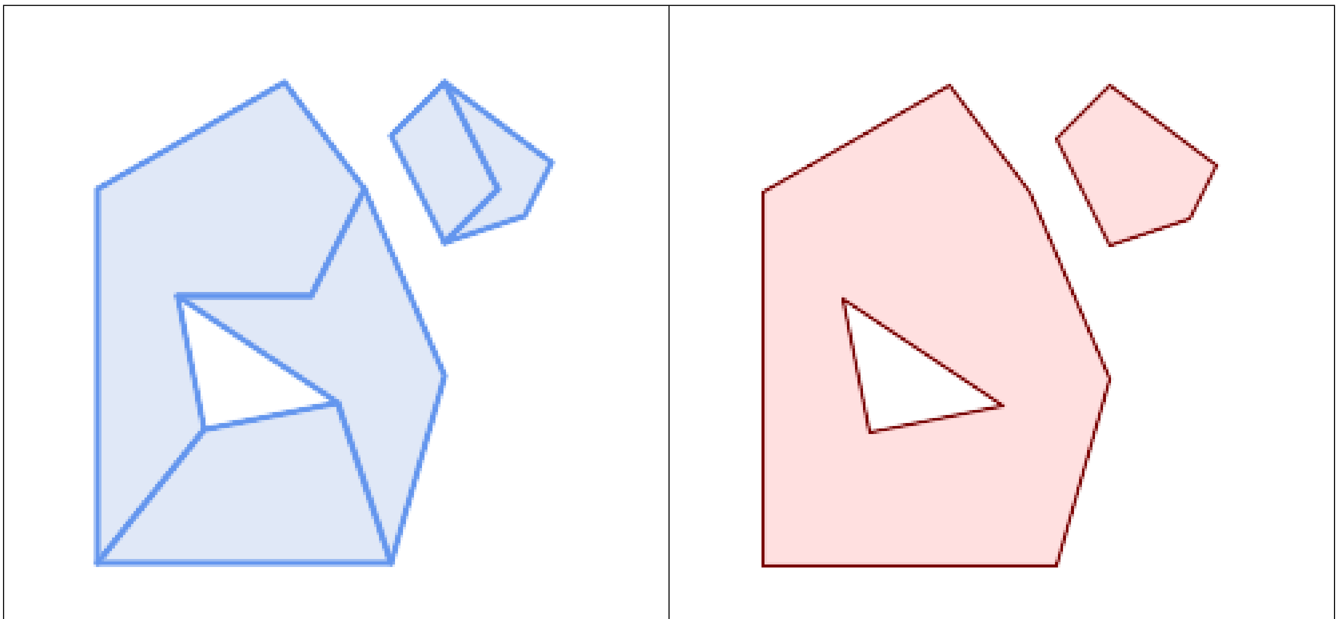
☒☒

An aggregate function which unions a set of polygons forming a polygonal coverage. The result is a polygonal geometry covering the same area as the coverage. This function produces the same result as ST_Union, but uses the coverage structure to compute the union much faster.

> **Note**
> If the input is not a valid coverage there may be unexpected artifacts in the output (such as unmerged or overlapping polygons). Use ST_CoverageInvalidEdges to determine if a coverage is valid.

Availability: 3.4.0 - requires GEOS >= 3.8.0

☒☒



Input coverage *Union result*

```
WITH coverage(id, geom) AS (VALUES
  (1, 'POLYGON ((10 10, 10 150, 80 190, 110 150, 90 110, 40 110, 50 60, 10 10))'::geometry),
  (2, 'POLYGON ((120 10, 10 10, 50 60, 100 70, 120 10))'::geometry),
  (3, 'POLYGON ((140 80, 120 10, 100 70, 40 110, 90 110, 110 150, 140 80))'::geometry),
  (4, 'POLYGON ((140 190, 120 170, 140 130, 160 150, 140 190))'::geometry),
  (5, 'POLYGON ((180 160, 170 140, 140 130, 160 150, 140 190, 180 160))'::geometry)
)
SELECT ST_AsText(ST_CoverageUnion(geom))
  FROM coverage;

--------------------------------------
MULTIPOLYGON (((10 150, 80 190, 110 150, 140 80, 120 10, 10 10, 10 150), (50 60, 100 70, 40 110, 50 60)), ((120 170, 140 190, 180 160, 170 140, 140 130, 120 170)))
```

⊠⊠

ST_CoverageInvalidEdges, ST_AsBinary

7.16 Affine Transformations

7.16.1 ST_Affine

ST_Affine — Apply a 3D affine transformation to a geometry.

Synopsis

geometry **ST_Affine**(geometry geomA, float a, float b, float c, float d, float e, float f, float g, float h, float i, float xoff, float yoff, float zoff);
geometry **ST_Affine**(geometry geomA, float a, float b, float d, float e, float xoff, float yoff);

□□

Applies a 3D affine transformation to the geometry to do things like translate, rotate, scale in one step.

Version 1: The call

```
ST_Affine(geom, a, b, c, d, e, f, g, h, i, xoff, yoff, zoff)
```

represents the transformation matrix

```
/ a  b  c  xoff \
| d  e  f  yoff |
| g  h  i  zoff |
\ 0  0  0     1 /
```

and the vertices are transformed as follows:

```
x' = a*x + b*y + c*z + xoff
y' = d*x + e*y + f*z + yoff
z' = g*x + h*y + i*z + zoff
```

All of the translate / scale functions below are expressed via such an affine transformation.

Version 2: Applies a 2d affine transformation to the geometry. The call

```
ST_Affine(geom, a, b, d, e, xoff, yoff)
```

represents the transformation matrix

```
/  a  b  0  xoff  \       /  a  b  xoff  \
|  d  e  0  yoff  | rsp.  |  d  e  yoff  |
|  0  0  1     0  |       \  0  0     1  /
\  0  0  0     1  /
```

and the vertices are transformed as follows:

```
x' = a*x + b*y + xoff
y' = d*x + e*y + yoff
z' = z
```

This method is a subcase of the 3D method above.

□□□□: 2.0.0 □□□□□□□□□□, □□□□□ TIN □□□□□□□□□□□□.

Availability: 1.1.2. Name changed from Affine to ST_Affine in 1.2.2

Note

1.3.4 □□□□□□□□□□□□□□□ (curve) □□□□□□□□□□□□□□□□□□□□□□□□. 1.3.4 □□□□□□□□□□□□□□□.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

☒☒

```
--Rotate a 3d line 180 degrees about the z axis.  Note this is long-hand for doing ↩
    ST_Rotate();
 SELECT ST_AsEWKT(ST_Affine(geom,  cos(pi()), -sin(pi()), 0,  sin(pi()), cos(pi()), 0,  0, ↩
     0, 1,  0, 0, 0)) As using_affine,
         ST_AsEWKT(ST_Rotate(geom, pi())) As using_rotate
        FROM (SELECT ST_GeomFromEWKT('LINESTRING(1 2 3, 1 4 3)') As geom) As foo;
        using_affine         |        using_rotate
-----------------------------+-----------------------------
 LINESTRING(-1 -2 3,-1 -4 3) | LINESTRING(-1 -2 3,-1 -4 3)
(1 row)

--Rotate a 3d line 180 degrees in both the x and z axis
SELECT ST_AsEWKT(ST_Affine(geom, cos(pi()), -sin(pi()), 0, sin(pi()), cos(pi()), -sin(pi()) ↩
    , 0, sin(pi()), cos(pi()), 0, 0, 0))
        FROM (SELECT ST_GeomFromEWKT('LINESTRING(1 2 3, 1 4 3)') As geom) As foo;
           st_asewkt
-------------------------------
 LINESTRING(-1 -2 -3,-1 -4 -3)
(1 row)
```

☒☒

ST_Rotate, ST_Scale, ST_Translate, ST_TransScale

7.16.2 ST_Rotate

ST_Rotate — Rotates a geometry about an origin point.

Synopsis

geometry **ST_Rotate**(geometry geomA, float rotRadians);
geometry **ST_Rotate**(geometry geomA, float rotRadians, float x0, float y0);
geometry **ST_Rotate**(geometry geomA, float rotRadians, geometry pointOrigin);

☒☒

Rotates geometry rotRadians counter-clockwise about the origin point. The rotation origin can be specified either as a POINT geometry, or as x and y coordinates. If the origin is not specified, the geometry is rotated about POINT(0 0).

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒.

Enhanced: 2.0.0 additional parameters for specifying the origin of rotation were added.

Availability: 1.1.2. Name changed from Rotate to ST_Rotate in 1.2.2

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
--Rotate 180 degrees
SELECT ST_AsEWKT(ST_Rotate('LINESTRING (50 160, 50 50, 100 50)', pi()));
               st_asewkt
---------------------------------------
 LINESTRING(-50 -160,-50 -50,-100 -50)
(1 row)

--Rotate 30 degrees counter-clockwise at x=50, y=160
SELECT ST_AsEWKT(ST_Rotate('LINESTRING (50 160, 50 50, 100 50)', pi()/6, 50, 160));
                                 st_asewkt
---------------------------------------------------------------------------
 LINESTRING(50 160,105 64.7372055837117,148.301270189222 89.7372055837117)
(1 row)

--Rotate 60 degrees clockwise from centroid
SELECT ST_AsEWKT(ST_Rotate(geom, -pi()/3, ST_Centroid(geom)))
FROM (SELECT 'LINESTRING (50 160, 50 50, 100 50)'::geometry AS geom) AS foo;
                           st_asewkt
--------------------------------------------------------------
 LINESTRING(116.4225 130.6721,21.1597 75.6721,46.1597 32.3708)
(1 row)
```

⊠⊠

ST_Affine, ST_RotateX, ST_RotateY, ST_RotateZ

7.16.3 ST_RotateX

ST_RotateX — Rotates a geometry about the X axis.

Synopsis

geometry **ST_RotateX**(geometry geomA, float rotRadians);

⊠⊠

Rotates a geometry geomA - rotRadians about the X axis.

> **Note**
> `ST_RotateX(geomA, rotRadians)` is short-hand for `ST_Affine(geomA, 1, 0, 0, 0, cos(rotRadians), -sin(rotRadians), 0, sin(rotRadians), cos(rotRadians), 0, 0, 0)`.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1.2. Name changed from RotateX to ST_RotateX in 1.2.2

This function supports Polyhedral surfaces.

This function supports 3d and will not drop the z-index.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
--Rotate a line 90 degrees along x-axis
SELECT ST_AsEWKT(ST_RotateX(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), pi()/2));
                 st_asewkt
---------------------------
 LINESTRING(1 -3 2,1 -1 1)
```

⊠⊠

ST_Affine, ST_RotateY, ST_RotateZ

7.16.4 ST_RotateY

ST_RotateY — Rotates a geometry about the Y axis.

Synopsis

geometry **ST_RotateY**(geometry geomA, float rotRadians);

⊠⊠

Rotates a geometry geomA - rotRadians about the y axis.

> **Note**
> ST_RotateY(geomA, rotRadians) is short-hand for ST_Affine(geomA, cos(rotRadians), 0, sin(rotRadians), 0, 1, 0, -sin(rotRadians), 0, cos(rotRadians), 0, 0, 0).

Availability: 1.1.2. Name changed from RotateY to ST_RotateY in 1.2.2

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports Polyhedral surfaces.

This function supports 3d and will not drop the z-index.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
--Rotate a line 90 degrees along y-axis
 SELECT ST_AsEWKT(ST_RotateY(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), pi()/2));
                 st_asewkt
---------------------------
 LINESTRING(3 2 -1,1 1 -1)
```

⊠⊠

ST_Affine, ST_RotateX, ST_RotateZ

7.16.5 ST_RotateZ

ST_RotateZ — Rotates a geometry about the Z axis.

Synopsis

geometry **ST_RotateZ**(geometry geomA, float rotRadians);

⊠⊠

Rotates a geometry geomA - rotRadians about the Z axis.

Note
This is a synonym for ST_Rotate

Note
`ST_RotateZ(geomA, rotRadians)` is short-hand for `SELECT ST_Affine(geomA, cos(rotRadians), -sin(rotRadians), 0, sin(rotRadians), cos(rotRadians), 0, 0, 0, 1, 0, 0, 0).`

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1.2. Name changed from RotateZ to ST_RotateZ in 1.2.2

Note
1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
--Rotate a line 90 degrees along z-axis
SELECT ST_AsEWKT(ST_RotateZ(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), pi()/2));
                 st_asewkt
---------------------------
 LINESTRING(-2 1 3,-1 1 1)

 --Rotate a curved circle around z-axis
SELECT ST_AsEWKT(ST_RotateZ(geom, pi()/2))
FROM (SELECT ST_LineToCurve(ST_Buffer(ST_GeomFromText('POINT(234 567)'), 3)) As geom) As ↩
    foo;
```

```
--------------------------------------------------------------------------------------------------------------------

CURVEPOLYGON(CIRCULARSTRING(-567 237,-564.87867965644 236.12132034356,-564 ←
    234,-569.12132034356 231.87867965644,-567 237))
```

⊠⊠

ST_Affine, ST_RotateX, ST_RotateY

7.16.6 ST_Scale

ST_Scale — Scales a geometry by given factors.

Synopsis

geometry **ST_Scale**(geometry geomA, float XFactor, float YFactor, float ZFactor);
geometry **ST_Scale**(geometry geomA, float XFactor, float YFactor);
geometry **ST_Scale**(geometry geom, geometry factor);
geometry **ST_Scale**(geometry geom, geometry factor, geometry origin);

⊠⊠

Scales the geometry to a new size by multiplying the ordinates with the corresponding factor parameters.

The version taking a geometry as the `factor` parameter allows passing a 2d, 3dm, 3dz or 4d point to set scaling factor for all supported dimensions. Missing dimensions in the `factor` point are equivalent to no scaling the corresponding dimension.

The three-geometry variant allows a "false origin" for the scaling to be passed in. This allows "scaling in place", for example using the centroid of the geometry as the false origin. Without a false origin, scaling takes place relative to the actual origin, so all coordinates are just multiplied by the scale factor.

> **Note**
> 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1.0.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 2.2.0 support for scaling all dimension (`factor` parameter) was introduced.

Enhanced: 2.5.0 support for scaling relative to a local origin (`origin` parameter) was introduced.

This function supports Polyhedral surfaces.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports M coordinates.

☒☒

```
--Version 1: scale X, Y, Z
SELECT ST_AsEWKT(ST_Scale(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), 0.5, 0.75, 0.8));
                          st_asewkt
--------------------------------------
 LINESTRING(0.5 1.5 2.4,0.5 0.75 0.8)

--Version 2: Scale X Y
 SELECT ST_AsEWKT(ST_Scale(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), 0.5, 0.75));
                        st_asewkt
----------------------------------
 LINESTRING(0.5 1.5 3,0.5 0.75 1)

--Version 3: Scale X Y Z M
 SELECT ST_AsEWKT(ST_Scale(ST_GeomFromEWKT('LINESTRING(1 2 3 4, 1 1 1 1)'),
   ST_MakePoint(0.5, 0.75, 2, -1)));
                               st_asewkt
----------------------------------------
 LINESTRING(0.5 1.5 6 -4,0.5 0.75 2 -1)

--Version 4: Scale X Y using false origin
SELECT ST_AsText(ST_Scale('LINESTRING(1 1, 2 2)', 'POINT(2 2)', 'POINT(1 1)'::geometry));
      st_astext
---------------------
 LINESTRING(1 1,3 3)
```

☒☒

ST_Affine, ST_TransScale

7.16.7 ST_Translate

ST_Translate — Translates a geometry by given offsets.

Synopsis

geometry **ST_Translate**(geometry g1, float deltax, float deltay);
geometry **ST_Translate**(geometry g1, float deltax, float deltay, float deltaz);

☒☒

Returns a new geometry whose coordinates are translated delta x,delta y,delta z units. Units are based on the units defined in spatial reference (SRID) for this geometry.

Note
1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.2.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

Move a point 1 degree longitude

```
SELECT ST_AsText(ST_Translate(ST_GeomFromText('POINT(-71.01 42.37)',4326),1,0)) As ↩
    wgs_transgeomtxt;

        wgs_transgeomtxt
        ---------------------
        POINT(-70.01 42.37)
```

Move a linestring 1 degree longitude and 1/2 degree latitude

```
SELECT ST_AsText(ST_Translate(ST_GeomFromText('LINESTRING(-71.01 42.37,-71.11 42.38)',4326) ↩
    ,1,0.5)) As wgs_transgeomtxt;
                   wgs_transgeomtxt
        ---------------------------------------
        LINESTRING(-70.01 42.87,-70.11 42.88)
```

Move a 3d point

```
SELECT ST_AsEWKT(ST_Translate(CAST('POINT(0 0 0)' As geometry), 5, 12,3));
        st_asewkt
        ---------
        POINT(5 12 3)
```

Move a curve and a point

```
SELECT ST_AsText(ST_Translate(ST_Collect('CURVEPOLYGON(CIRCULARSTRING(4 3,3.12 0.878,1 ↩
    0,-1.121 5.1213,6 7, 8 9,4 3))','POINT(1 3)'),1,2));


----------------------------------------------------------------------------------------------------

 GEOMETRYCOLLECTION(CURVEPOLYGON(CIRCULARSTRING(5 5,4.12 2.878,2 2,-0.121 7.1213,7 9,9 11,5 ↩
     5)),POINT(2 5))
```

⊠⊠

ST_Affine, ST_AsText, ST_GeomFromText

7.16.8 ST_TransScale

ST_TransScale — Translates and scales a geometry by given offsets and factors.

Synopsis

geometry **ST_TransScale**(geometry geomA, float deltaX, float deltaY, float XFactor, float YFactor);

⊠⊠

Translates the geometry using the deltaX and deltaY args, then scales it using the XFactor, YFactor args, working in 2D only.

> **Note**
> `ST_TransScale(geomA, deltaX, deltaY, XFactor, YFactor)` is short-hand for `ST_Affine(geomA, XFactor, 0, 0, 0, YFactor, 0, 0, 0, 1, deltaX*XFactor, deltaY*YFactor, 0)`.

> **Note**
> 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.3.4 ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1.0.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_AsEWKT(ST_TransScale(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), 0.5, 1, 1, 2));
                  st_asewkt
-----------------------------
 LINESTRING(1.5 6 3,1.5 4 1)


--Buffer a point to get an approximation of a circle, convert to curve and then translate ↩
   1,2 and scale it 3,4
  SELECT ST_AsText(ST_Transscale(ST_LineToCurve(ST_Buffer('POINT(234 567)', 3)),1,2,3,4));


------------------------------------------------------------------------------------------------------

 CURVEPOLYGON(CIRCULARSTRING(714 2276,711.363961030679 2267.51471862576,705 ↩
    2264,698.636038969321 2284.48528137424,714 2276))
```

⊠⊠

ST_Affine, ST_Translate

7.17 Clustering Functions

7.17.1 ST_ClusterDBSCAN

ST_ClusterDBSCAN — Window function that returns a cluster id for each input geometry using the DBSCAN algorithm.

Synopsis

integer **ST_ClusterDBSCAN**(geometry winset geom, float8 eps, integer minpoints);

⊠⊠

A window function that returns a cluster number for each input geometry, using the 2D Density-based spatial clustering of applications with noise (DBSCAN) algorithm. Unlike ST_ClusterKMeans, it does not require the number of clusters to be specified, but instead uses the desired distance (`eps`) and density (`minpoints`) parameters to determine each cluster.

An input geometry is added to a cluster if it is either:

- A ”core” geometry, that is within `eps` distance of at least `minpoints` input geometries (including itself); or
- A ”border” geometry, that is within `eps` distance of a core geometry.

Note that border geometries may be within `eps` distance of core geometries in more than one cluster. Either assignment would be correct, so the border geometry will be arbitrarily asssigned to one of the available clusters. In this situation it is possible for a correct cluster to be generated with fewer than `minpoints` geometries. To ensure deterministic assignment of border geometries (so that repeated calls to ST_ClusterDBSCAN will produce identical results) use an `ORDER BY` clause in the window definition. Ambiguous cluster assignments may differ from other DBSCAN implementations.

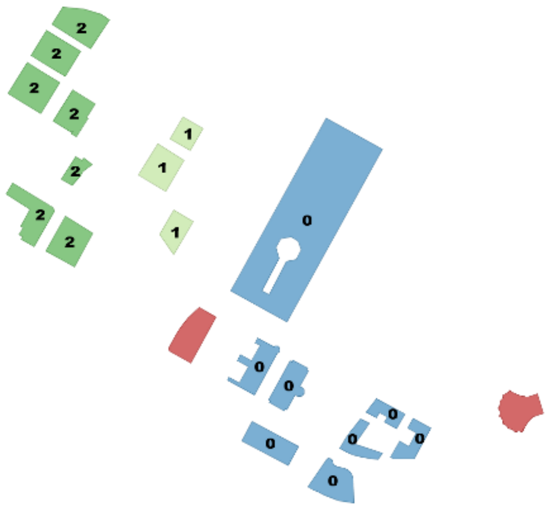
Note
Geometries that do not meet the criteria to join any cluster are assigned a cluster number of NULL.

2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

⊠⊠

Clustering polygon within 50 meters of each other, and requiring at least 2 polygons per cluster.



Clusters within 50 meters with at least 2 items per cluster. Singletons have NULL for cid

```
SELECT name, ST_ClusterDBSCAN(geom, eps => 50, minpoints =
> 2) over () AS cid
FROM boston_polys
WHERE name
> '' AND building
> ''
        AND ST_DWithin(geom,
        ST_Transform(
            ST_GeomFromText('POINT ↩
    (-71.04054 42.35141)', 4326), 26986),
      500);
```

```
               name                  |  ↩  --------
    bucket
Manulife Tower                       |  ↩
         0
Park Lane Seaport I                  |  ↩
         0
Park Lane Seaport II                 |  ↩
         0
Renaissance Boston Waterfront Hotel |  ↩
         0
Seaport Boston Hotel                 |  ↩
         0
Seaport Hotel & World Trade Center   |  ↩
         0
Waterside Place                      |  ↩
         0
World Trade Center East              |  ↩
         0
100 Northern Avenue                  |  ↩
         1
100 Pier 4                           |  ↩
         1
The Institute of Contemporary Art    |  ↩
         1
101 Seaport                          |  ↩
         2
District Hall                        |  ↩
         2
One Marina Park Drive                |  ↩
         2
Twenty Two Liberty                   |  ↩
         2
Vertex                               |  ↩
         2
Vertex                               |  ↩
         2
Watermark Seaport                    |  ↩
         2
Blue Hills Bank Pavilion             |    ↩
    NULL
World Trade Center West              |    ↩
    NULL
(20 rows)
```

A example showing combining parcels with the same cluster number into geometry collections.

```
SELECT cid, ST_Collect(geom) AS cluster_geom, array_agg(parcel_id) AS ids_in_cluster FROM (
    SELECT parcel_id, ST_ClusterDBSCAN(geom, eps => 0.5, minpoints => 5) over () AS cid,  ↩
        geom
    FROM parcels) sq
GROUP BY cid;
```

☒☒

ST_DWithin, ST_ClusterKMeans, ST_ClusterIntersecting, ST_ClusterIntersectingWin, ST_ClusterWithin, ST_ClusterWithinWin

7.17.2 ST_ClusterIntersecting

ST_ClusterIntersecting — Aggregate function that clusters input geometries into connected sets.

Synopsis

geometry[] **ST_ClusterIntersecting**(geometry set g);

☒☒

An aggregate function that returns an array of GeometryCollections partitioning the input geometries into connected clusters that are disjoint. Each geometry in a cluster intersects at least one other geometry in the cluster, and does not intersect any geometry in other clusters.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
WITH testdata AS
  (SELECT unnest(ARRAY['LINESTRING (0 0, 1 1)'::geometry,
           'LINESTRING (5 5, 4 4)'::geometry,
           'LINESTRING (6 6, 7 7)'::geometry,
           'LINESTRING (0 0, -1 -1)'::geometry,
           'POLYGON ((0 0, 4 0, 4 4, 0 4, 0 0))'::geometry]) AS geom)

SELECT ST_AsText(unnest(ST_ClusterIntersecting(geom))) FROM testdata;

--result

st_astext
---------
GEOMETRYCOLLECTION(LINESTRING(0 0,1 1),LINESTRING(5 5,4 4),LINESTRING(0 0,-1 -1),POLYGON((0 ←
     0,4 0,4 4,0 4,0 0)))
GEOMETRYCOLLECTION(LINESTRING(6 6,7 7))
```

☒☒

ST_ClusterIntersectingWin, ST_ClusterWithin, ST_ClusterWithinWin

7.17.3 ST_ClusterIntersectingWin

ST_ClusterIntersectingWin — Window function that returns a cluster id for each input geometry, clustering input geometries into connected sets.

Synopsis

integer **ST_ClusterIntersectingWin**(geometry winset geom);

☒☒

A window function that builds connected clusters of geometries that intersect. It is possible to traverse all geometries in a cluster without leaving the cluster. The return value is the cluster number that the geometry argument participates in, or null for null inputs.

Availability: 3.4.0

☒☒

```
WITH testdata AS (
  SELECT id, geom::geometry FROM (
  VALUES  (1, 'LINESTRING (0 0, 1 1)'),
          (2, 'LINESTRING (5 5, 4 4)'),
          (3, 'LINESTRING (6 6, 7 7)'),
          (4, 'LINESTRING (0 0, -1 -1)'),
          (5, 'POLYGON ((0 0, 4 0, 4 4, 0 4, 0 0))')) AS t(id, geom)
)
SELECT id,
  ST_AsText(geom),
  ST_ClusterIntersectingWin(geom) OVER () AS cluster
FROM testdata;

 id |           st_astext            | cluster
----+--------------------------------+---------
  1 | LINESTRING(0 0,1 1)            |       0
  2 | LINESTRING(5 5,4 4)            |       0
  3 | LINESTRING(6 6,7 7)            |       1
  4 | LINESTRING(0 0,-1 -1)          |       0
  5 | POLYGON((0 0,4 0,4 4,0 4,0 0)) |       0
```

☒☒

ST_ClusterIntersecting, ST_ClusterWithin, ST_ClusterWithinWin

7.17.4 ST_ClusterKMeans

ST_ClusterKMeans — Window function that returns a cluster id for each input geometry using the K-means algorithm.

Synopsis

integer **ST_ClusterKMeans**(geometry winset geom, integer number_of_clusters, float max_radius);

☒☒

Returns K-means cluster number for each input geometry. The distance used for clustering is the distance between the centroids for 2D geometries, and distance between bounding box centers for 3D geometries. For POINT inputs, M coordinate will be treated as weight of input and has to be larger than 0.

`max_radius`, if set, will cause ST_ClusterKMeans to generate more clusters than `k` ensuring that no cluster in output has radius larger than `max_radius`. This is useful in reachability analysis.

Enhanced: 3.2.0 Support for `max_radius`

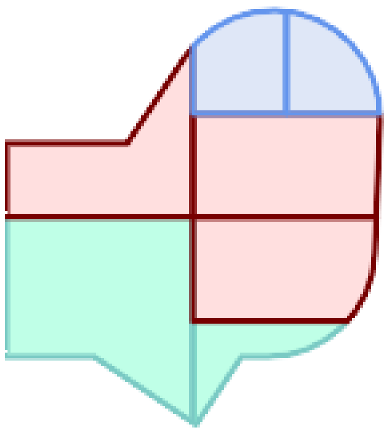
Enhanced: 3.1.0 Support for 3D geometries and weights

2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

Generate dummy set of parcels for examples:

```
CREATE TABLE parcels AS
SELECT lpad((row_number() over())::text,3,'0') As parcel_id, geom,
('{residential, commercial}'::text[])[1 + mod(row_number()OVER(),2)] As type
FROM
    ST_Subdivide(ST_Buffer('SRID=3857;LINESTRING(40 100, 98 100, 100 150, 60 90)'::geometry ↩
        ,
    40, 'endcap=square'),12) As geom;
```



Parcels color-coded by cluster number (cid)

```
SELECT ST_ClusterKMeans(geom, 3) OVER() AS cid, parcel_id, geom
    FROM parcels;
```

```
cid | parcel_id |   geom
-----+-----------+---------------
   0 | 001       | 0103000000...
   0 | 002       | 0103000000...
   1 | 003       | 0103000000...
   0 | 004       | 0103000000...
   1 | 005       | 0103000000...
   2 | 006       | 0103000000...
   2 | 007       | 0103000000...
```

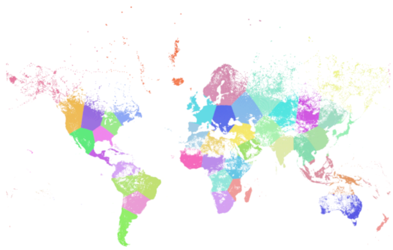
Partitioning parcel clusters by type:

```
SELECT ST_ClusterKMeans(geom, 3) over (PARTITION BY type) AS cid, parcel_id, type
    FROM parcels;
```

```
cid | parcel_id |    type
-----+-----------+-------------
   1 | 005       | commercial
   1 | 003       | commercial
   2 | 007       | commercial
   0 | 001       | commercial
   1 | 004       | residential
   0 | 002       | residential
   2 | 006       | residential
```

Example: Clustering a preaggregated planetary-scale data population dataset using 3D clusering and weighting. Identify at least 20 regions based on Kontur Population Data that do not span more than 3000 km from their center:

```
create table kontur_population_3000km_clusters as
select
    geom,
    ST_ClusterKMeans(
        ST_Force4D(
            ST_Transform(ST_Force3D(geom), 4978), -- cluster in 3D XYZ CRS
            mvalue => population -- set clustering to be weighed by population
        ),
        20,                      -- aim to generate at least 20 clusters
        max_radius => 3000000    -- but generate more to make each under 3000 km radius
    ) over () as cid
from
    kontur_population;
```



World population clustered to above specs produces 46 clusters. Clusters are centered at well-populated regions (New York, Moscow). Greenland is one cluster. There are island clusters that span across the antimeridian. Cluster edges follow Earth's curvature.

⊠⊠

ST_ClusterDBSCAN, ST_ClusterIntersectingWin, ST_ClusterWithinWin, ST_ClusterIntersecting, ST_Cluster
ST_Subdivide, ST_Force3D, ST_Force4D,

7.17.5 ST_ClusterWithin

ST_ClusterWithin — Aggregate function that clusters geometries by separation distance.

Synopsis

geometry[] **ST_ClusterWithin**(geometry set g, float8 distance);

⊠⊠

An aggregate function that returns an array of GeometryCollections, where each collection is a cluster containing some input geometries. Clustering partitions the input geometries into sets in which each geometry is within the specified *distance* of at least one other geometry in the same cluster. Distances are Cartesian distances in the units of the SRID.

ST_ClusterWithin is equivalent to running ST_ClusterDBSCAN with `minpoints => 0`.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

⊠⊠

```
WITH testdata AS
  (SELECT unnest(ARRAY['LINESTRING (0 0, 1 1)'::geometry,
                       'LINESTRING (5 5, 4 4)'::geometry,
                       'LINESTRING (6 6, 7 7)'::geometry,
                       'LINESTRING (0 0, -1 -1)'::geometry,
                       'POLYGON ((0 0, 4 0, 4 4, 0 4, 0 0))'::geometry]) AS geom)

SELECT ST_AsText(unnest(ST_ClusterWithin(geom, 1.4))) FROM testdata;

--result

st_astext
---------
GEOMETRYCOLLECTION(LINESTRING(0 0,1 1),LINESTRING(5 5,4 4),LINESTRING(0 0,-1 -1),POLYGON((0 ←
     0,4 0,4 4,0 4,0 0)))
GEOMETRYCOLLECTION(LINESTRING(6 6,7 7))
```

⊠⊠

ST_ClusterWithinWin, ST_ClusterDBSCAN, ST_ClusterIntersecting, ST_ClusterIntersectingWin

7.17.6 ST_ClusterWithinWin

ST_ClusterWithinWin — Window function that returns a cluster id for each input geometry, clustering using separation distance.

Synopsis

integer **ST_ClusterWithinWin**(geometry winset geom, float8 distance);

⊠⊠

A window function that returns a cluster number for each input geometry. Clustering partitions the geometries into sets in which each geometry is within the specified `distance` of at least one other geometry in the same cluster. Distances are Cartesian distances in the units of the SRID.

ST_ClusterWithinWin is equivalent to running ST_ClusterDBSCAN with `minpoints => 0`.

Availability: 3.4.0

This method supports Circular Strings and Curves.

⊠⊠

```
WITH testdata AS (
  SELECT id, geom::geometry FROM (
  VALUES  (1, 'LINESTRING (0 0, 1 1)'),
          (2, 'LINESTRING (5 5, 4 4)'),
          (3, 'LINESTRING (6 6, 7 7)'),
          (4, 'LINESTRING (0 0, -1 -1)'),
          (5, 'POLYGON ((0 0, 4 0, 4 4, 0 4, 0 0))')) AS t(id, geom)
)
SELECT id,
  ST_AsText(geom),
  ST_ClusterWithinWin(geom, 1.4) OVER () AS cluster
FROM testdata;


 id |           st_astext            | cluster
----+--------------------------------+---------
  1 | LINESTRING(0 0,1 1)            |       0
  2 | LINESTRING(5 5,4 4)            |       0
  3 | LINESTRING(6 6,7 7)            |       1
  4 | LINESTRING(0 0,-1 -1)          |       0
  5 | POLYGON((0 0,4 0,4 4,0 4,0 0)) |       0
```

⊠⊠

ST_ClusterWithin, ST_ClusterDBSCAN, ST_ClusterIntersecting, ST_ClusterIntersectingWin,

7.18 Bounding Box Functions

7.18.1 Box2D

Box2D — Returns a BOX2D representing the 2D extent of a geometry.

Synopsis

box2d **Box2D**(geometry geom);

⊠⊠

Returns a box2d representing the 2D extent of the geometry.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT Box2D(ST_GeomFromText('LINESTRING(1 2, 3 4, 5 6)'));

box2d
---------
BOX(1 2,5 6)
```

```
SELECT Box2D(ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 150505,220227 150406)'));

box2d
--------
BOX(220186.984375 150406,220288.25 150506.140625)
```

⊠⊠

Box3D, ST_GeomFromText

7.18.2 Box3D

Box3D — Returns a BOX3D representing the 3D extent of a geometry.

Synopsis

box3d **Box3D**(geometry geom);

⊠⊠

Returns a box3d representing the 3D extent of the geometry.
⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT Box3D(ST_GeomFromEWKT('LINESTRING(1 2 3, 3 4 5, 5 6 5)'));

Box3d
---------
BOX3D(1 2 3,5 6 5)
```

```
SELECT Box3D(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 1,220227 150406 ↩
    1)'));

Box3d
--------
BOX3D(220227 150406 1,220268 150415 1)
```

☒☒

Box2D, ST_GeomFromEWKT

7.18.3 ST_EstimatedExtent

ST_EstimatedExtent — Returns the estimated extent of a spatial table.

Synopsis

box2d **ST_EstimatedExtent**(text schema_name, text table_name, text geocolumn_name, boolean parent_only);
box2d **ST_EstimatedExtent**(text schema_name, text table_name, text geocolumn_name);
box2d **ST_EstimatedExtent**(text table_name, text geocolumn_name);

☒☒

Returns the estimated extent of a spatial table as a box2d. The current schema is used if not specified. The estimated extent is taken from the geometry column's statistics. This is usually much faster than computing the exact extent of the table using ST_Extent or ST_3DExtent.

The default behavior is to also use statistics collected from child tables (tables with INHERITS) if available. If `parent_only` is set to TRUE, only statistics for the given table are used and child tables are ignored.

For PostgreSQL >= 8.0.0 statistics are gathered by VACUUM ANALYZE and the result extent will be about 95% of the actual one. For PostgreSQL < 8.0.0 statistics are gathered by running `update_geometry_st` and the result extent is exact.

> **Note**
> In the absence of statistics (empty table or no ANALYZE called) this function returns NULL. Prior to version 1.5.4 an exception was thrown instead.

> **Note**
> Escaping names for tables and/or namespaces that include special characters and quotes may require special handling. A user notes: "For schemas and tables, use identifier escaping rules to produce a double-quoted string, and afterwards remove the first and last double-quote character. For geometry column pass as is."

1.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

Changed: 2.1.0. Up to 2.0.x this was called ST_Estimated_Extent.

This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_EstimatedExtent('ny', 'edges', 'geom');
--result--
BOX(-8877653 4912316,-8010225.5 5589284)

SELECT ST_EstimatedExtent('feature_poly', 'geom');
--result--
BOX(-124.659652709961 24.6830825805664,-67.7798080444336 49.0012092590332)
```

⊠⊠

ST_Extent, ST_3DExtent

7.18.4 ST_Expand

ST_Expand — Returns a bounding box expanded from another bounding box or a geometry.

Synopsis

geometry **ST_Expand**(geometry geom, float units_to_expand);
geometry **ST_Expand**(geometry geom, float dx, float dy, float dz=0, float dm=0);
box2d **ST_Expand**(box2d box, float units_to_expand);
box2d **ST_Expand**(box2d box, float dx, float dy);
box3d **ST_Expand**(box3d box, float units_to_expand);
box3d **ST_Expand**(box3d box, float dx, float dy, float dz=0);

⊠⊠

Returns a bounding box expanded from the bounding box of the input, either by specifying a single distance with which the box should be expanded on both axes, or by specifying an expansion distance for each axis. Uses double-precision. Can be used for distance queries, or to add a bounding box filter to a query to take advantage of a spatial index.

In addition to the version of ST_Expand accepting and returning a geometry, variants are provided that accept and return box2d and box3d data types.

Distances are in the units of the spatial reference system of the input.

ST_Expand is similar to ST_Buffer, except while buffering expands a geometry in all directions, ST_Expand expands the bounding box along each axis.

> **Note**
> Pre version 1.3, ST_Expand was used in conjunction with ST_Distance to do indexable distance queries. For example, `geom && ST_Expand('POINT(10 20)', 10) AND ST_Distance(geom, 'POINT(10 20)') < 10`. This has been replaced by the simpler and more efficient ST_DWithin function.

Availability: 1.5.0 behavior changed to output double precision instead of float4 coordinates.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 2.3.0 support was added to expand a box by different amounts in different dimensions.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

> **Note**
> Examples below use US National Atlas Equal Area (SRID=2163) which is a meter projection

```
--10 meter expanded box around bbox of a linestring
SELECT CAST(ST_Expand(ST_GeomFromText('LINESTRING(2312980 110676,2312923 110701,2312892 ↩
   110714)', 2163),10) As box2d);
                                         st_expand
------------------------------------
 BOX(2312882 110666,2312990 110724)

--10 meter expanded 3D box of a 3D box
SELECT ST_Expand(CAST('BOX3D(778783 2951741 1,794875 2970042.61545891 10)' As box3d),10)
                                                          st_expand
-----------------------------------------------------
 BOX3D(778773 2951731 -9,794885 2970052.61545891 20)

 --10 meter geometry astext rep of a expand box around a point geometry
 SELECT ST_AsEWKT(ST_Expand(ST_GeomFromEWKT('SRID=2163;POINT(2312980 110676)'),10));
                                                                                    st_asewkt ↩

------------------------------------------------------------------------------------------------- ↩

 SRID=2163;POLYGON((2312970 110666,2312970 110686,2312990 110686,2312990 110666,2312970 ↩
    110666))
```

☒☒

ST_Buffer, ST_DWithin, ST_SRID

7.18.5 ST_Extent

ST_Extent — Aggregate function that returns the bounding box of geometries.

Synopsis

box2d **ST_Extent**(geometry set geomfield);

☒☒

An aggregate function that returns a box2d bounding box that bounds a set of geometries.

The bounding box coordinates are in the spatial reference system of the input geometries.

ST_Extent is similar in concept to Oracle Spatial/Locator's SDO_AGGR_MBR.

> **Note**
> ST_Extent returns boxes with only X and Y ordinates even with 3D geometries. To return XYZ ordinates use ST_3DExtent.

Note
The returned box3d value does not include a SRID. Use ST_SetSRID to convert it into a geometry with SRID metadata. The SRID is the same as the input geometries.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

Note
Examples below use Massachusetts State Plane ft (SRID=2249)

```
SELECT ST_Extent(geom) as bextent FROM sometable;
                                        st_bextent
------------------------------------
BOX(739651.875 2908247.25,794875.8125 2970042.75)


--Return extent of each category of geometries
SELECT ST_Extent(geom) as bextent
FROM sometable
GROUP BY category ORDER BY category;

                                         bextent                       |         name
----------------------------------------------------+----------------
 BOX(778783.5625 2951741.25,794875.8125 2970042.75) | A
 BOX(751315.8125 2919164.75,765202.6875 2935417.25) | B
 BOX(739651.875 2917394.75,756688.375 2935866)      | C

 --Force back into a geometry
 -- and render the extended text representation of that geometry
SELECT ST_SetSRID(ST_Extent(geom),2249) as bextent FROM sometable;

                                bextent
--------------------------------------------------------------------------------
 SRID=2249;POLYGON((739651.875 2908247.25,739651.875 2970042.75,794875.8125 2970042.75,
 794875.8125 2908247.25,739651.875 2908247.25))
```

⊠⊠

ST_EstimatedExtent, ST_3DExtent, ST_SetSRID

7.18.6 ST_3DExtent

ST_3DExtent — Aggregate function that returns the 3D bounding box of geometries.

Synopsis

box3d **ST_3DExtent**(geometry set geomfield);

☒☒

An aggregate function that returns a box3d (includes Z ordinate) bounding box that bounds a set of geometries.

The bounding box coordinates are in the spatial reference system of the input geometries.

> **Note**
> The returned box3d value does not include a SRID. Use ST_SetSRID to convert it into a geometry with SRID metadata. The SRID is the same as the input geometries.

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒.

Changed: 2.0.0 In prior versions this used to be called ST_Extent3D

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
SELECT ST_3DExtent(foo.geom) As b3extent
FROM (SELECT ST_MakePoint(x,y,z) As geom
        FROM generate_series(1,3) As x
                CROSS JOIN generate_series(1,2) As y
                CROSS JOIN generate_series(0,2) As Z) As foo;
          b3extent
--------------------
 BOX3D(1 1 0,3 2 2)

--Get the extent of various elevated circular strings
SELECT ST_3DExtent(foo.geom) As b3extent
FROM (SELECT ST_Translate(ST_Force_3DZ(ST_LineToCurve(ST_Buffer(ST_Point(x,y),1))),0,0,z) As geom
        FROM generate_series(1,3) As x
                CROSS JOIN generate_series(1,2) As y
                CROSS JOIN generate_series(0,2) As Z) As foo;

        b3extent
--------------------
 BOX3D(1 0 0,4 2 2)
```

☒☒

ST_Extent, ST_Force3DZ, ST_SetSRID

7.18.7 ST_MakeBox2D

ST_MakeBox2D — Creates a BOX2D defined by two 2D point geometries.

Synopsis

box2d **ST_MakeBox2D**(geometry pointLowLeft, geometry pointUpRight);

⊠⊠

Creates a box2d defined by two Point geometries. This is useful for doing range queries.

⊠⊠

```
--Return all features that fall reside or partly reside in a US national atlas coordinate bounding box
--It is assumed here that the geometries are stored with SRID = 2163 (US National atlas equal area)
SELECT feature_id, feature_name, geom
FROM features
WHERE geom && ST_SetSRID(ST_MakeBox2D(ST_Point(-989502.1875, 528439.5625),
        ST_Point(-987121.375 ,529933.1875)),2163)
```

⊠⊠

ST_Point, ST_SetSRID, ST_SRID

7.18.8 ST_3DMakeBox

ST_3DMakeBox — Creates a BOX3D defined by two 3D point geometries.

Synopsis

box3d **ST_3DMakeBox**(geometry point3DLowLeftBottom, geometry point3DUpRightTop);

⊠⊠

Creates a box3d defined by two 3D Point geometries.

This function supports 3D and will not drop the z-index.

Changed: 2.0.0 In prior versions this used to be called ST_MakeBox3D

⊠⊠

```
SELECT ST_3DMakeBox(ST_MakePoint(-989502.1875, 528439.5625, 10),
        ST_MakePoint(-987121.375 ,529933.1875, 10)) As abb3d

--bb3d--
--------
BOX3D(-989502.1875 528439.5625 10,-987121.375 529933.1875 10)
```

□□

ST_MakePoint, ST_SetSRID, ST_SRID

7.18.9 ST_XMax

ST_XMax — Returns the X maxima of a 2D or 3D bounding box or a geometry.

Synopsis

float **ST_XMax**(box3d aGeomorBox2DorBox3D);

□□

Returns the X maxima of a 2D or 3D bounding box or a geometry.

> **Note**
> Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However, it will not accept a geometry or box2d text representation, since those do not auto-cast.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

□□

```
SELECT ST_XMax('BOX3D(1 2 3, 4 5 6)');
st_xmax
-------
4

SELECT ST_XMax(ST_GeomFromText('LINESTRING(1 3 4, 5 6 7)'));
st_xmax
-------
5

SELECT ST_XMax(CAST('BOX(-3 2, 3 4)' As box2d));
st_xmax
-------
3
--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to a BOX3D
SELECT ST_XMax('LINESTRING(1 3, 5 6)');

--ERROR:  BOX3D parser - doesn't start with BOX3D(

SELECT ST_XMax(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)'));
st_xmax
--------
220288.248780547
```

☒☒

ST_XMin, ST_YMax, ST_YMin, ST_ZMax, ST_ZMin

7.18.10 ST_XMin

ST_XMin — Returns the X minima of a 2D or 3D bounding box or a geometry.

Synopsis

float **ST_XMin**(box3d aGeomorBox2DorBox3D);

☒☒

Returns the X minima of a 2D or 3D bounding box or a geometry.

> **Note**
> Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However it will not accept a geometry or box2d text representation, since those do not auto-cast.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_XMin('BOX3D(1 2 3, 4 5 6)');
st_xmin
-------
1

SELECT ST_XMin(ST_GeomFromText('LINESTRING(1 3 4, 5 6 7)'));
st_xmin
-------
1

SELECT ST_XMin(CAST('BOX(-3 2, 3 4)' As box2d));
st_xmin
-------
-3
--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to ↩
    a BOX3D
SELECT ST_XMin('LINESTRING(1 3, 5 6)');

--ERROR:  BOX3D parser - doesn't start with BOX3D(

SELECT ST_XMin(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 ↩
    150406 3)'));
st_xmin
--------
220186.995121892
```

⊠⊠

ST_XMax, ST_YMax, ST_YMin, ST_ZMax, ST_ZMin

7.18.11 ST_YMax

ST_YMax — Returns the Y maxima of a 2D or 3D bounding box or a geometry.

Synopsis

float **ST_YMax**(box3d aGeomorBox2DorBox3D);

⊠⊠

Returns the Y maxima of a 2D or 3D bounding box or a geometry.

> **Note**
> Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However it will not accept a geometry or box2d text representation, since those do not auto-cast.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_YMax('BOX3D(1 2 3, 4 5 6)');
st_ymax
-------
5

SELECT ST_YMax(ST_GeomFromText('LINESTRING(1 3 4, 5 6 7)'));
st_ymax
-------
6

SELECT ST_YMax(CAST('BOX(-3 2, 3 4)' As box2d));
st_ymax
-------
4
--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to ↩
    a BOX3D
SELECT ST_YMax('LINESTRING(1 3, 5 6)');

--ERROR:  BOX3D parser - doesn't start with BOX3D(

SELECT ST_YMax(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 ↩
    150406 3)'));
st_ymax
--------
150506.126829327
```

□□

ST_XMin, ST_XMax, ST_YMin, ST_ZMax, ST_ZMin

7.18.12 ST_YMin

ST_YMin — Returns the Y minima of a 2D or 3D bounding box or a geometry.

Synopsis

float **ST_YMin**(box3d aGeomorBox2DorBox3D);

□□

Returns the Y minima of a 2D or 3D bounding box or a geometry.

> **Note**
> Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However it will not accept a geometry or box2d text representation, since those do not auto-cast.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

□□

```
SELECT ST_YMin('BOX3D(1 2 3, 4 5 6)');
st_ymin
-------
2

SELECT ST_YMin(ST_GeomFromText('LINESTRING(1 3 4, 5 6 7)'));
st_ymin
-------
3

SELECT ST_YMin(CAST('BOX(-3 2, 3 4)' As box2d));
st_ymin
-------
2
--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to ↩
    a BOX3D
SELECT ST_YMin('LINESTRING(1 3, 5 6)');

--ERROR:  BOX3D parser - doesn't start with BOX3D(

SELECT ST_YMin(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 ↩
    150406 3)'));
st_ymin
--------
150406
```

☒☒

ST_GeomFromEWKT, ST_XMin, ST_XMax, ST_YMax, ST_ZMax, ST_ZMin

7.18.13 ST_ZMax

ST_ZMax — Returns the Z maxima of a 2D or 3D bounding box or a geometry.

Synopsis

float **ST_ZMax**(box3d aGeomorBox2DorBox3D);

☒☒

Returns the Z maxima of a 2D or 3D bounding box or a geometry.

> **Note**
> Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However it will not accept a geometry or box2d text representation, since those do not auto-cast.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_ZMax('BOX3D(1 2 3, 4 5 6)');
st_zmax
-------
6

SELECT ST_ZMax(ST_GeomFromEWKT('LINESTRING(1 3 4, 5 6 7)'));
st_zmax
-------
7

SELECT ST_ZMax('BOX3D(-3 2 1, 3 4 1)' );
st_zmax
-------
1
--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to a BOX3D
SELECT ST_ZMax('LINESTRING(1 3 4, 5 6 7)');

--ERROR:  BOX3D parser - doesn't start with BOX3D(

SELECT ST_ZMax(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)'));
st_zmax
--------
3
```

⊠⊠

ST_GeomFromEWKT, ST_XMin, ST_XMax, ST_YMax, ST_YMin, ST_ZMax

7.18.14 ST_ZMin

ST_ZMin — Returns the Z minima of a 2D or 3D bounding box or a geometry.

Synopsis

float **ST_ZMin**(box3d aGeomorBox2DorBox3D);

⊠⊠

Returns the Z minima of a 2D or 3D bounding box or a geometry.

> **Note**
> Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However it will not accept a geometry or box2d text representation, since those do not auto-cast.

This function supports 3d and will not drop the z-index.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT ST_ZMin('BOX3D(1 2 3, 4 5 6)');
st_zmin
-------
3

SELECT ST_ZMin(ST_GeomFromEWKT('LINESTRING(1 3 4, 5 6 7)'));
st_zmin
-------
4

SELECT ST_ZMin('BOX3D(-3 2 1, 3 4 1)' );
st_zmin
-------
1
--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to a BOX3D
SELECT ST_ZMin('LINESTRING(1 3 4, 5 6 7)');

--ERROR:  BOX3D parser - doesn't start with BOX3D(

SELECT ST_ZMin(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)'));
st_zmin
--------
1
```

⊠⊠

ST_GeomFromEWKT, ST_GeomFromText, ST_XMin, ST_XMax, ST_YMax, ST_YMin, ST_ZMax

7.19 ⊠⊠⊠⊠⊠ (Linear Referencing)

7.19.1 ST_LineInterpolatePoint

ST_LineInterpolatePoint — Returns a point interpolated along a line at a fractional location.

Synopsis

geometry **ST_LineInterpolatePoint**(geometry a_linestring, float8 a_fraction);
geography **ST_LineInterpolatePoint**(geography a_linestring, float8 a_fraction, boolean use_spheroid = true);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 0 ⊠ 1 ⊠⊠⊠ Float8 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_LineLocatePoint ⊠⊠⊠⊠⊠⊠⊠.

Note
This function computes points in 2D and then interpolates values for Z and M, while ST_3DLineInterpolatePoint computes points in 3D and only interpolates the M value.

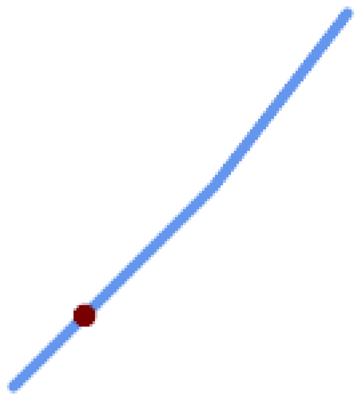
Note
1.1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ M ⊠ Z ⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0.0 ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

0.8.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.1.1 ⊠⊠⊠⊠ Z ⊠ M ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Line_Interpolate_Point ⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

☒☒



20% ☒☒ (0.20) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒

```
-- The point 20% along a line

SELECT ST_AsEWKT(  ST_LineInterpolatePoint(
        'LINESTRING(25 50, 100 125, 150 190)',
        0.2 ));
----------------
 POINT(51.5974135047432 76.5974135047432)
```

The mid-point of a 3D line:

```
SELECT ST_AsEWKT(  ST_LineInterpolatePoint('
        LINESTRING(1 2 3, 4 5 6, 6 7 8)',
        0.5 ));
--------------------
 POINT(3.5 4.5 5.5)
```

The closest point on a line to a point:

```
SELECT ST_AsText( ST_LineInterpolatePoint( line.geom,
                      ST_LineLocatePoint( line.geom, 'POINT(4 3)')))
FROM (SELECT ST_GeomFromText('LINESTRING(1 2, 4 5, 6 7)') As geom) AS line;
------------
 POINT(3 4)
```

☒☒

ST_LineInterpolatePoints, ST_LineInterpolatePoint, ST_LineMerge

7.19.2 ST_3DLineInterpolatePoint

ST_3DLineInterpolatePoint — Returns a point interpolated along a 3D line at a fractional location.

Synopsis

geometry **ST_3DLineInterpolatePoint**(geometry a_linestring, float8 a_fraction);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 0 ⊠ 1 ⊠⊠⊠ Float8 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ST_LineInterpolatePoint computes points in 2D and then interpolates the values for Z and M, while this function computes points in 3D and only interpolates the M value.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

Return point 20% along 3D line

```
SELECT ST_AsText(
    ST_3DLineInterpolatePoint('LINESTRING(25 50 70, 100 125 90, 150 190 200)',
        0.20));

   st_asetext
----------------
 POINT Z (59.0675892910822 84.0675892910822 79.0846904776219)
```

⊠⊠

ST_LineInterpolatePoint, ST_LineInterpolatePoint, ST_LineMerge

7.19.3 ST_LineInterpolatePoints

ST_LineInterpolatePoints — Returns points interpolated along a line at a fractional interval.

Synopsis

geometry **ST_LineInterpolatePoints**(geometry a_linestring, float8 a_fraction, boolean repeat);
geography **ST_LineInterpolatePoints**(geography a_linestring, float8 a_fraction, boolean use_spheroid = true, boolean repeat = true);

⊠⊠

Returns one or more points interpolated along a line at a fractional interval. The first argument must be a LINESTRING. The second argument is a float8 between 0 and 1 representing the spacing between the points as a fraction of line length. If the third argument is false, at most one point will be constructed (which is equivalent to ST_LineInterpolatePoint.)

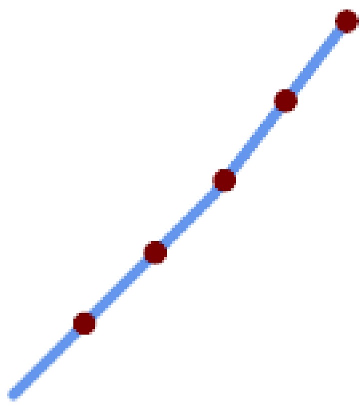
If the result has zero or one points, it is returned as a POINT. If it has two or more points, it is returned as a MULTIPOINT.

Availability: 2.5.0

This function supports 3d and will not drop the z-index.

This function supports M coordinates.

⊠⊠



A LineString with points interpolated every 20%

```
--Return points each 20% along a 2D line
SELECT ST_AsText(ST_LineInterpolatePoints('LINESTRING(25 50, 100 125, 150 190)', 0.20))
----------------
 MULTIPOINT((51.5974135047432 76.5974135047432),(78.1948270094864 103.194827009486) ↩
    ,(104.132163186446 130.37181214238),(127.066081593223 160.18590607119),(150 190))
```

⊠⊠

ST_LineInterpolatePoint, ST_LineLocatePoint

7.19.4 ST_LineLocatePoint

ST_LineLocatePoint — Returns the fractional location of the closest point on a line to a point.

Synopsis

float8 **ST_LineLocatePoint**(geometry a_linestring, geometry a_point);
float8 **ST_LineLocatePoint**(geography a_linestring, geography a_point, boolean use_spheroid = true);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠⊠ 1 ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (float) ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (ST_LineInterpolatePoint) ⊠⊠⊠⊠⊠⊠⊠ (ST_LineSubstring) ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Line_Locate_Point ⊠⊠⊠⊠.

□□

```
--Rough approximation of finding the street number of a point along the street
--Note the whole foo thing is just to generate dummy data that looks
--like house centroids and street
--We use ST_DWithin to exclude
--houses too far away from the street to be considered on the street
SELECT ST_AsText(house_loc) As as_text_house_loc,
        startstreet_num +
                CAST( (endstreet_num - startstreet_num)
                        * ST_LineLocatePoint(street_line, house_loc) As integer) As street_num
FROM
(SELECT ST_GeomFromText('LINESTRING(1 2, 3 4)') As street_line,
        ST_Point(x*1.01,y*1.03) As house_loc, 10 As startstreet_num,
                20 As endstreet_num
FROM generate_series(1,3) x CROSS JOIN generate_series(2,4) As y)
As foo
WHERE ST_DWithin(street_line, house_loc, 0.2);

 as_text_house_loc | street_num
-------------------+------------
 POINT(1.01 2.06)  |         10
 POINT(2.02 3.09)  |         15
 POINT(3.03 4.12)  |         20

 --find closest point on a line to a point or other geometry
 SELECT ST_AsText(ST_LineInterpolatePoint(foo.the_line, ST_LineLocatePoint(foo.the_line, ST_GeomFromText('POINT(4 3)'))))
FROM (SELECT ST_GeomFromText('LINESTRING(1 2, 4 5, 6 7)') As the_line) As foo;
   st_astext
----------------
 POINT(3 4)
```

□□

ST_DWithin, ST_Length2D, ST_LineInterpolatePoint, ST_LineSubstring

7.19.5 ST_LineSubstring

ST_LineSubstring — Returns the part of a line between two fractional locations.

Synopsis

geometry **ST_LineSubstring**(geometry a_linestring, float8 startfraction, float8 endfraction);
geography **ST_LineSubstring**(geography a_linestring, float8 startfraction, float8 endfraction);

□□

Computes the line which is the section of the input line starting and ending at the given fractional locations. The first argument must be a LINESTRING. The second and third arguments are values in the range [0, 1] representing the start and end locations as fractions of line length. The Z and M values are interpolated for added endpoints if present.

’ □□’ □’ □’ □□□□□□□□□□□□□□ ST_LineInterpolatePoint □□□□□□□□□.

> **Note**
> This only works with LINESTRINGs. To use on contiguous MULTILINESTRINGs first join them with ST_LineMerge.

> **Note**
> 1.1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ M ⊠ Z ⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

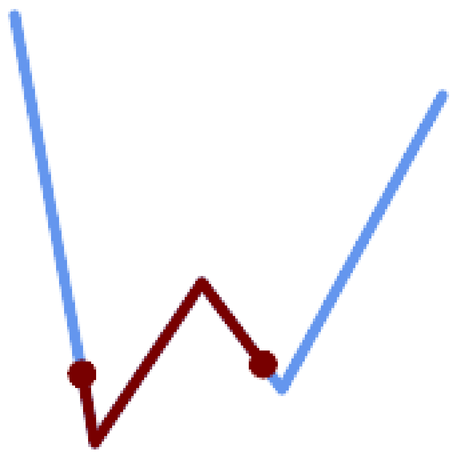
Enhanced: 3.4.0 - Support for geography was introduced.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Line_Substring ⊠⊠⊠⊠⊠.

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.1.1 ⊠⊠⊠⊠ Z ⊠ M ⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠



⊠⊠ 1/3 ⊠⊠ (0.333, 0.666) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsText(ST_LineSubstring( 'LINESTRING (20 180, 50 20, 90 80, 120 40, 180 150)', 0.333, 0.666));
------------------------------------------------------------------------------------------------

LINESTRING (45.17311810399485 45.74337011202746, 50 20, 90 80, 112.97593050157862 49.36542599789519)
```

If start and end locations are the same, the result is a POINT.

```
SELECT ST_AsText(ST_LineSubstring( 'LINESTRING(25 50, 100 125, 150 190)', 0.333, 0.333));
------------------------------------------
 POINT(69.2846934853974 94.2846934853974)
```

A query to cut a LineString into sections of length 100 or shorter. It uses `generate_series()` with a CROSS JOIN LATERAL to produce the equivalent of a FOR loop.

```
WITH data(id, geom) AS (VALUES
        ( 'A', 'LINESTRING( 0 0, 200 0)'::geometry ),
        ( 'B', 'LINESTRING( 0 100, 350 100)'::geometry ),
        ( 'C', 'LINESTRING( 0 200, 50 200)'::geometry )
    )
SELECT id, i,
       ST_AsText( ST_LineSubstring( geom, startfrac, LEAST( endfrac, 1 )) ) AS geom
FROM (
    SELECT id, geom, ST_Length(geom) len, 100 sublen FROM data
    ) AS d
CROSS JOIN LATERAL (
    SELECT i, (sublen * i) / len AS startfrac,
              (sublen * (i+1)) / len AS endfrac
    FROM generate_series(0, floor( len / sublen )::integer ) AS t(i)
    -- skip last i if line length is exact multiple of sublen
    WHERE (sublen * i) / len <
> 1.0
    ) AS d2;

 id | i |            geom
----+---+-----------------------------
 A  | 0 | LINESTRING(0 0,100 0)
 A  | 1 | LINESTRING(100 0,200 0)
 B  | 0 | LINESTRING(0 100,100 100)
 B  | 1 | LINESTRING(100 100,200 100)
 B  | 2 | LINESTRING(200 100,300 100)
 B  | 3 | LINESTRING(300 100,350 100)
 C  | 0 | LINESTRING(0 200,50 200)
```

Geography implementation measures along a spheroid, geometry along a line

```
SELECT ST_AsText(ST_LineSubstring( 'LINESTRING(-118.2436 34.0522, -71.0570 42.3611)':: ↩
    geography, 0.333, 0.666),6) AS geog_sub
 , ST_AsText(ST_LineSubstring('LINESTRING(-118.2436 34.0522, -71.0570 42.3611)'::geometry,  ↩
     0.333, 0.666),6) AS geom_sub;
---------------------------------------------------------------
geog_sub | LINESTRING(-104.167064 38.854691,-87.674646 41.849854)
geom_sub | LINESTRING(-102.530462 36.819064,-86.817324 39.585927)
```

□□

ST_Length, ST_LineExtend, ST_LineInterpolatePoint, ST_LineMerge

7.19.6 ST_LocateAlong

ST_LocateAlong — Returns the point(s) on a geometry that match a measure value.

Synopsis

geometry **ST_LocateAlong**(geometry geom_with_measure, float8 measure, float8 offset = 0);

⊠⊠

Returns the location(s) along a measured geometry that have the given measure values. The result is a Point or MultiPoint. Polygonal inputs are not supported.

If `offset` is provided, the result is offset to the left or right of the input line by the specified distance. A positive offset will be to the left, and a negative one to the right.

Note
Use this function only for linear geometries with an M component

The semantic is specified by the *ISO/IEC 13249-3 SQL/MM Spatial* standard.

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Locate_Along_Measure ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ ST_Locate_Along_Measure ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports M coordinates.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1.13

⊠⊠

```
SELECT ST_AsText(
  ST_LocateAlong(
    'MULTILINESTRINGM((1 2 3, 3 4 2, 9 4 3),(1 2 3, 5 4 5))'::geometry,
    3 ));

----------------------------------
 MULTIPOINT M ((1 2 3),(9 4 3),(1 2 3))
```

⊠⊠

ST_LocateBetween, ST_LocateBetweenElevations, ST_InterpolatePoint

7.19.7 ST_LocateBetween

ST_LocateBetween — Returns the portions of a geometry that match a measure range.

Synopsis

geometry **ST_LocateBetween**(geometry geom, float8 measure_start, float8 measure_end, float8 offset = 0);

□□

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□.

□□□□□□□□□□, □□. □□□□□□□□□, □□□□□□□□□□□□□□□□□□□.

Clipping a non-convex POLYGON may produce invalid geometry.

The semantic is specified by the *ISO/IEC 13249-3 SQL/MM Spatial* standard.

1.1.0 □□□□□□□□□□ ST_Locate_Between_Measures □□□□□□□□□.

□□□□: 2.0.0 □□□□□□□□ ST_Locate_Along_Measure □□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□.

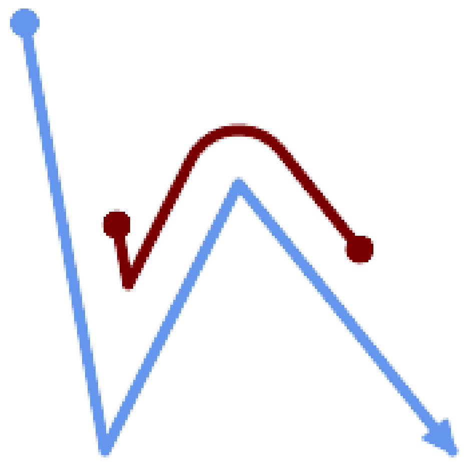
Enhanced: 3.0.0 - added support for POLYGON, TIN, TRIANGLE.

This function supports M coordinates.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1

□□

```
SELECT ST_AsText(
  ST_LocateBetween(
       'MULTILINESTRING M ((1 2 3, 3 4 2, 9 4 3),(1 2 3, 5 4 5))':: geometry,
       1.5, 3 ));
------------------------------------------------------------------------
 GEOMETRYCOLLECTION M (LINESTRING M (1 2 3,3 4 2,9 4 3),POINT M (1 2 3))
```



A LineString with the section between measures 2 and 8, offset to the left

```
SELECT ST_AsText( ST_LocateBetween(
  ST_AddMeasure('LINESTRING (20 180, 50 20, 100 120, 180 20)', 0, 10),
  2, 8,
  20
));
------------------------------------------------------------------------
```

```
MULTILINESTRING((54.49835019899045 104.53426957938231,58.70056060327303 ↩
    82.12248075654186,69.16695286779743 103.05526528559065,82.11145618000168 ↩
    128.94427190999915,84.24893681714357 132.32493442618113,87.01636951231555 ↩
    135.21267035596549,90.30307285299679 137.49198684843182,93.97759758337769 ↩
    139.07172433557758,97.89298381958797 139.8887023914453,101.89263860095893 ↩
    139.9102465862721,105.81659870902816 139.13549527600819,109.50792827749828 ↩
    137.5954340631298,112.81899532549731 135.351656550512,115.6173761888606 ↩
    132.49390095108848,145.31017306064817 95.37790486135405))
```

☒☒

ST_LocateAlong, ST_LocateAlong, ST_LocateBetween

7.19.8 ST_LocateBetweenElevations

ST_LocateBetweenElevations — Returns the portions of a geometry that lie in an elevation (Z) range.

Synopsis

geometry **ST_LocateBetweenElevations**(geometry geom, float8 elevation_start, float8 elevation_end);

☒☒

Returns a geometry (collection) with the portions of a geometry that lie in an elevation (Z) range.

Clipping a non-convex POLYGON may produce invalid geometry.

1.4.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

Enhanced: 3.0.0 - added support for POLYGON, TIN, TRIANGLE.

This function supports 3d and will not drop the z-index.

☒☒

```
SELECT ST_AsText(
  ST_LocateBetweenElevations(
    'LINESTRING(1 2 3, 4 5 6)'::geometry,
    2, 4 ));

             st_astext
-----------------------------------
 MULTILINESTRING Z ((1 2 3,2 3 4))

SELECT ST_AsText(
    ST_LocateBetweenElevations(
      'LINESTRING(1 2 6, 4 5 -1, 7 8 9)',
      6, 9)) As ewelev;

                                ewelev
-----------------------------------------------------------------------
 GEOMETRYCOLLECTION Z (POINT Z (1 2 6),LINESTRING Z (6.1 7.1 6,7 8 9))
```

⊠⊠

ST_Dump, ST_LocateAlong, ST_LocateBetween

7.19.9 ST_InterpolatePoint

ST_InterpolatePoint — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (M ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_InterpolatePoint**(geometry linear_geom_with_measure, geometry point);

⊠⊠

Returns an interpolated measure value of a linear measured geometry at the location closest to the given point.

> **Note**
> Use this function only for linear geometries with an M component

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

```
SELECT ST_InterpolatePoint('LINESTRING M (0 0 0, 10 0 20)', 'POINT(5 5)');
 ---------------------
         10
```

⊠⊠

ST_AddMeasure, ST_LocateAlong, ST_LocateBetween

7.19.10 ST_AddMeasure

ST_AddMeasure — Interpolates measures along a linear geometry.

Synopsis

geometry **ST_AddMeasure**(geometry geom_mline, float8 measure_start, float8 measure_end);

☒☒

☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

1.5.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

This function supports 3d and will not drop the z-index.

☒☒

```
SELECT ST_AsText(ST_AddMeasure(
ST_GeomFromEWKT('LINESTRING(1 0, 2 0, 4 0)'),1,4)) As ewelev;
           ewelev
--------------------------------
 LINESTRINGM(1 0 1,2 0 2,4 0 4)

SELECT ST_AsText(ST_AddMeasure(
ST_GeomFromEWKT('LINESTRING(1 0 4, 2 0 4, 4 0 4)'),10,40)) As ewelev;
                 ewelev
----------------------------------------
 LINESTRING(1 0 4 10,2 0 4 20,4 0 4 40)

SELECT ST_AsText(ST_AddMeasure(
ST_GeomFromEWKT('LINESTRINGM(1 0 4, 2 0 4, 4 0 4)'),10,40)) As ewelev;
                 ewelev
----------------------------------------
 LINESTRINGM(1 0 10,2 0 20,4 0 40)

SELECT ST_AsText(ST_AddMeasure(
ST_GeomFromEWKT('MULTILINESTRINGM((1 0 4, 2 0 4, 4 0 4),(1 0 4, 2 0 4, 4 0 4))'),10,70)) As ↩
     ewelev;
                             ewelev
-----------------------------------------------------------------
 MULTILINESTRINGM((1 0 10,2 0 20,4 0 40),(1 0 40,2 0 50,4 0 70))
```

7.20 Trajectory Functions

7.20.1 ST_IsValidTrajectory

ST_IsValidTrajectory — Tests if the geometry is a valid trajectory.

Synopsis

boolean **ST_IsValidTrajectory**(geometry line);

☒☒

Tests if a geometry encodes a valid trajectory. A valid trajectory is represented as a LINESTRING with measures (M values). The measure values must increase from each vertex to the next.

Valid trajectories are expected as input to spatio-temporal functions like ST_ClosestPointOfApproach

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

```
-- A valid trajectory
SELECT ST_IsValidTrajectory(ST_MakeLine(
  ST_MakePointM(0,0,1),
  ST_MakePointM(0,1,2))
);
 t

-- An invalid trajectory
SELECT ST_IsValidTrajectory(ST_MakeLine(ST_MakePointM(0,0,1), ST_MakePointM(0,1,0)));
NOTICE:  Measure of vertex 1 (0) not bigger than measure of vertex 0 (1)
 st_isvalidtrajectory
----------------------
 f
```

⊠⊠

ST_ClosestPointOfApproach

7.20.2 ST_ClosestPointOfApproach

ST_ClosestPointOfApproach — Returns a measure at the closest point of approach of two trajectories.

Synopsis

float8 **ST_ClosestPointOfApproach**(geometry track1, geometry track2);

⊠⊠

Returns the smallest measure at which points interpolated along the given trajectories are the least distance apart.

Inputs must be valid trajectories as checked by ST_IsValidTrajectory. Null is returned if the trajectories do not overlap in their M ranges.

To obtain the actual points at the computed measure use ST_LocateAlong .

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

```
-- Return the time in which two objects moving between 10:00 and 11:00
-- are closest to each other and their distance at that point
WITH inp AS ( SELECT
  ST_AddMeasure('LINESTRING Z (0 0 0, 10 0 5)'::geometry,
    extract(epoch from '2015-05-26 10:00'::timestamptz),
    extract(epoch from '2015-05-26 11:00'::timestamptz)
  ) a,
  ST_AddMeasure('LINESTRING Z (0 2 10, 12 1 2)'::geometry,
    extract(epoch from '2015-05-26 10:00'::timestamptz),
    extract(epoch from '2015-05-26 11:00'::timestamptz)
  ) b
), cpa AS (
  SELECT ST_ClosestPointOfApproach(a,b) m FROM inp
), points AS (
  SELECT ST_GeometryN(ST_LocateAlong(a,m),1) pa,
         ST_GeometryN(ST_LocateAlong(b,m),1) pb
  FROM inp, cpa
)
SELECT to_timestamp(m) t,
       ST_Distance(pa,pb) distance,
       ST_AsText(pa, 2) AS pa, ST_AsText(pb, 2) AS pb
FROM points, cpa;

               t               |      distance      |                  pa                  ↩
                   |                  pb
-------------------------------+--------------------+--------------------------------------+--------

 2015-05-26 10:45:31.034483-07 | 1.9603683315139542 | POINT ZM (7.59 0 3.79 1432662331.03)  ↩
     | POINT ZM (9.1 1.24 3.93 1432662331.03)
```

☒☒

ST_IsValidTrajectory, ST_DistanceCPA, ST_LocateAlong, ST_AddMeasure

7.20.3 ST_DistanceCPA

ST_DistanceCPA — Returns the distance between the closest point of approach of two trajectories.

Synopsis

float8 **ST_DistanceCPA**(geometry track1, geometry track2);

☒☒

Returns the distance (in 2D) between two trajectories at their closest point of approach.

Inputs must be valid trajectories as checked by ST_IsValidTrajectory. Null is returned if the trajectories do not overlap in their M ranges.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

This function supports 3d and will not drop the z-index.

☒☒

```
-- Return the minimum distance of two objects moving between 10:00 and 11:00
WITH inp AS ( SELECT
  ST_AddMeasure('LINESTRING Z (0 0 0, 10 0 5)'::geometry,
    extract(epoch from '2015-05-26 10:00'::timestamptz),
    extract(epoch from '2015-05-26 11:00'::timestamptz)
  ) a,
  ST_AddMeasure('LINESTRING Z (0 2 10, 12 1 2)'::geometry,
    extract(epoch from '2015-05-26 10:00'::timestamptz),
    extract(epoch from '2015-05-26 11:00'::timestamptz)
  ) b
)
SELECT ST_DistanceCPA(a,b) distance FROM inp;

     distance
------------------
 1.96036833151395
```

☒☒

ST_IsValidTrajectory, ST_ClosestPointOfApproach, ST_AddMeasure, |=|

7.20.4 ST_CPAWithin

ST_CPAWithin — Tests if the closest point of approach of two trajectories is within the specified distance.

Synopsis

boolean **ST_CPAWithin**(geometry track1, geometry track2, float8 dist);

☒☒

Tests whether two moving objects have ever been closer than the specified distance.

Inputs must be valid trajectories as checked by ST_IsValidTrajectory. False is returned if the trajectories do not overlap in their M ranges.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

This function supports 3d and will not drop the z-index.

☒☒

```
WITH inp AS ( SELECT
  ST_AddMeasure('LINESTRING Z (0 0 0, 10 0 5)'::geometry,
    extract(epoch from '2015-05-26 10:00'::timestamptz),
    extract(epoch from '2015-05-26 11:00'::timestamptz)
  ) a,
  ST_AddMeasure('LINESTRING Z (0 2 10, 12 1 2)'::geometry,
    extract(epoch from '2015-05-26 10:00'::timestamptz),
    extract(epoch from '2015-05-26 11:00'::timestamptz)
  ) b
```

```
)
SELECT ST_CPAWithin(a,b,2), ST_DistanceCPA(a,b) distance FROM inp;

 st_cpawithin |     distance
--------------+------------------
 t            | 1.96521473776207
```

□□

ST_IsValidTrajectory, ST_ClosestPointOfApproach, ST_DistanceCPA, |=|

7.21 Version Functions

7.21.1 PostGIS_Extensions_Upgrade

PostGIS_Extensions_Upgrade — Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.

Synopsis

text **PostGIS_Extensions_Upgrade**(text target_version=null);

□□

Packages and upgrades PostGIS extensions to given or latest version. Only extensions you have installed in the database will be packaged and upgraded if needed. Reports full PostGIS version and build configuration infos after. This is short-hand for doing multiple CREATE EXTENSION .. FROM unpackaged and ALTER EXTENSION .. UPDATE for each PostGIS extension. Currently only tries to upgrade extensions postgis, postgis_raster, postgis_sfcgal, postgis_topology, and postgis_tiger_geocoder.

Availability: 2.5.0

> **Note**
> Changed: 3.4.0 to add target_version argument.
> Changed: 3.3.0 support for upgrades from any PostGIS version. Does not work on all systems.
> Changed: 3.0.0 to repackage loose extensions and support postgis_raster.

□□

```
SELECT PostGIS_Extensions_Upgrade();
```

```
NOTICE:  Packaging extension postgis
NOTICE:  Packaging extension postgis_raster
NOTICE:  Packaging extension postgis_sfcgal
NOTICE:  Extension postgis_topology is not available or not packagable for some reason
NOTICE:  Extension postgis_tiger_geocoder is not available or not packagable for some ←
    reason

                    postgis_extensions_upgrade
-------------------------------------------------------------------
 Upgrade completed, run SELECT postgis_full_version(); for details
(1 row)
```

⊠⊠

Section 3.4, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version, PostGIS_Version

7.21.2 PostGIS_Full_Version

PostGIS_Full_Version — Reports full PostGIS version and build configuration infos.

Synopsis

text **PostGIS_Full_Version**();

⊠⊠

Reports full PostGIS version and build configuration infos. Also informs about synchronization between libraries and scripts suggesting upgrades as needed.

Enhanced: 3.4.0 now includes extra PROJ configurations NETWORK_ENABLED, URL_ENDPOINT and DATABASE_PATH of proj.db location

⊠⊠

```
SELECT PostGIS_Full_Version();
                                                            postgis_full_version
----------------------------------------------------------------------------------
POSTGIS="3.4.0dev 3.3.0rc2-993-g61bdf43a7" [EXTENSION] PGSQL="160" GEOS="3.12.0dev-CAPI ↩
    -1.18.0" SFCGAL="1.3.8" PROJ="7.2.1 NETWORK_ENABLED=OFF URL_ENDPOINT=https://cdn.proj. ↩
    org USER_WRITABLE_DIRECTORY=/tmp/proj DATABASE_PATH=/usr/share/proj/proj.db" GDAL="GDAL ↩
    3.2.2, released 2021/03/05" LIBXML="2.9.10" LIBJSON="0.15" LIBPROTOBUF="1.3.3" WAGYU ↩
    ="0.5.0 (Internal)" TOPOLOGY RASTER
(1 row)
```

⊠⊠

Section 3.4, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version, PostGIS_Wagyu_Version, PostGIS_Version

7.21.3 PostGIS_GEOS_Version

PostGIS_GEOS_Version — Returns the version number of the GEOS library.

Synopsis

text **PostGIS_GEOS_Version**();

⊠⊠

Returns the version number of the GEOS library, or NULL if GEOS support is not enabled.

⊠⊠

```
SELECT PostGIS_GEOS_Version();
 postgis_geos_version
----------------------
3.12.0dev-CAPI-1.18.0
(1 row)
```

⊠⊠

PostGIS_Full_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version, PostGIS_Version

7.21.4 PostGIS_GEOS_Compiled_Version

PostGIS_GEOS_Compiled_Version — Returns the version number of the GEOS library against which PostGIS was built.

Synopsis

text **PostGIS_GEOS_Compiled_Version**();

⊠⊠

Returns the version number of the GEOS library, or against which PostGIS was built.

Availability: 3.4.0

⊠⊠

```
SELECT PostGIS_GEOS_Compiled_Version();
 postgis_geos_compiled_version
-------------------------------
 3.12.0
(1 row)
```

⊠⊠

PostGIS_GEOS_Version, PostGIS_Full_Version

7.21.5 PostGIS_Liblwgeom_Version

PostGIS_Liblwgeom_Version — Returns the version number of the liblwgeom library. This should match the version of PostGIS.

Synopsis

text **PostGIS_Liblwgeom_Version**();

⊠⊠

Returns the version number of the liblwgeom library/

⊠⊠

```
SELECT PostGIS_Liblwgeom_Version();
postgis_liblwgeom_version
--------------------------
3.4.0dev 3.3.0rc2-993-g61bdf43a7
(1 row)
```

⊠⊠

PostGIS_Full_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version, PostGIS_Version

7.21.6 PostGIS_LibXML_Version

PostGIS_LibXML_Version — Returns the version number of the libxml2 library.

Synopsis

text **PostGIS_LibXML_Version**();

⊠⊠

Returns the version number of the LibXML2 library.

1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT PostGIS_LibXML_Version();
 postgis_libxml_version
----------------------
 2.9.10
(1 row)
```

⊠⊠

PostGIS_Full_Version, PostGIS_Lib_Version, PostGIS_PROJ_Version, PostGIS_GEOS_Version, PostGIS_Versio

7.21.7 PostGIS_LibJSON_Version

PostGIS_LibJSON_Version — Returns the version number of the libjson-c library.

Synopsis

text **PostGIS_LibJSON_Version**();

☒☒

Returns the version number of the LibJSON-C library.

☒☒

```
SELECT PostGIS_LibJSON_Version();
 postgis_libjson_version
-------------------------
 0.17
```

☒☒

PostGIS_Full_Version, PostGIS_Lib_Version, PostGIS_PROJ_Version, PostGIS_GEOS_Version, PostGIS_Versio

7.21.8 PostGIS_Lib_Build_Date

PostGIS_Lib_Build_Date — Returns build date of the PostGIS library.

Synopsis

text **PostGIS_Lib_Build_Date**();

☒☒

Returns build date of the PostGIS library.

☒☒

```
SELECT PostGIS_Lib_Build_Date();
 postgis_lib_build_date
------------------------
 2023-06-22 03:56:11
(1 row)
```

7.21.9 PostGIS_Lib_Version

PostGIS_Lib_Version — Returns the version number of the PostGIS library.

Synopsis

text **PostGIS_Lib_Version**();

⊠⊠

Returns the version number of the PostGIS library.

⊠⊠

```
SELECT PostGIS_Lib_Version();
 postgis_lib_version
---------------------
 3.4.0dev
(1 row)
```

⊠⊠

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version, PostGIS_Version

7.21.10 PostGIS_PROJ_Version

PostGIS_PROJ_Version — Returns the version number of the PROJ4 library.

Synopsis

text **PostGIS_PROJ_Version**();

⊠⊠

Returns the version number of the PROJ library and some configuration options of proj.

Enhanced: 3.4.0 now includes NETWORK_ENABLED, URL_ENDPOINT and DATABASE_PATH of proj.db location

⊠⊠

```
SELECT PostGIS_PROJ_Version();
  postgis_proj_version
-------------------------
7.2.1 NETWORK_ENABLED=OFF URL_ENDPOINT=https://cdn.proj.org USER_WRITABLE_DIRECTORY=/tmp/ ↩
    proj DATABASE_PATH=/usr/share/proj/proj.db
(1 row)
```

⊠⊠

PostGIS_PROJ_Compiled_Version, PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_Version

7.21.11 PostGIS_PROJ_Compiled_Version

PostGIS_PROJ_Compiled_Version — Returns the version number of the PROJ library against which PostGIS was built.

Synopsis

text **PostGIS_PROJ_Compiled_Version**();

☒☒

Returns the version number of the PROJ library, or against which PostGIS was built.

Availability: 3.5.0

☒☒

```
SELECT PostGIS_PROJ_Compiled_Version();
 postgis_proj_compiled_version
-------------------------------
 9.1.1
(1 row)
```

☒☒

PostGIS_PROJ_Version, PostGIS_Full_Version

7.21.12 PostGIS_Wagyu_Version

PostGIS_Wagyu_Version — Returns the version number of the internal Wagyu library.

Synopsis

text **PostGIS_Wagyu_Version**();

☒☒

Returns the version number of the internal Wagyu library, or `NULL` if Wagyu support is not enabled.

☒☒

```
SELECT PostGIS_Wagyu_Version();
 postgis_wagyu_version
-----------------------
 0.5.0 (Internal)
(1 row)
```

☒☒

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_PROJ_Version, PostGIS_Lib_Version, PostGIS_LibXM
PostGIS_Version

7.21.13 PostGIS_Scripts_Build_Date

PostGIS_Scripts_Build_Date — Returns build date of the PostGIS scripts.

Synopsis

text **PostGIS_Scripts_Build_Date**();

⊠⊠

Returns build date of the PostGIS scripts.

1.0.0RC1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT PostGIS_Scripts_Build_Date();
  postgis_scripts_build_date
-------------------------
 2023-06-22 03:56:11
(1 row)
```

⊠⊠

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_Version

7.21.14 PostGIS_Scripts_Installed

PostGIS_Scripts_Installed — Returns version of the PostGIS scripts installed in this database.

Synopsis

text **PostGIS_Scripts_Installed**();

⊠⊠

Returns version of the PostGIS scripts installed in this database.

> **Note**
> If the output of this function doesn't match the output of PostGIS_Scripts_Released you probably missed to properly upgrade an existing database. See the Upgrading section for more info.

Availability: 0.9.0

⊠⊠

```
SELECT PostGIS_Scripts_Installed();
  postgis_scripts_installed
-------------------------
 3.4.0dev 3.3.0rc2-993-g61bdf43a7
(1 row)
```

⊠⊠

PostGIS_Full_Version, PostGIS_Scripts_Released, PostGIS_Version

7.21.15 PostGIS_Scripts_Released

PostGIS_Scripts_Released — Returns the version number of the postgis.sql script released with the installed PostGIS lib.

Synopsis

text **PostGIS_Scripts_Released**();

⊠⊠

Returns the version number of the postgis.sql script released with the installed PostGIS lib.

> **Note**
> Starting with version 1.1.0 this function returns the same value of PostGIS_Lib_Version. Kept for backward compatibility.

Availability: 0.9.0

⊠⊠

```
SELECT PostGIS_Scripts_Released();
  postgis_scripts_released
-------------------------
 3.4.0dev 3.3.0rc2-993-g61bdf43a7
(1 row)
```

⊠⊠

PostGIS_Full_Version, PostGIS_Scripts_Installed, PostGIS_Lib_Version

7.21.16 PostGIS_Version

PostGIS_Version — Returns PostGIS version number and compile-time options.

Synopsis

text **PostGIS_Version**();

⊠⊠

Returns PostGIS version number and compile-time options.

⊠⊠

```
SELECT PostGIS_Version();
                        postgis_version
---------------------------------------
 3.4 USE_GEOS=1 USE_PROJ=1 USE_STATS=1
(1 row)
```

⊠⊠

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version

7.22 PostGIS GUC(Grand Unified Custom Variable)

7.22.1 postgis.backend

postgis.backend — GEOS ⊠ SFCGAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. geos ⊠⊠ sfcgal ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ geos ⊠⊠⊠.

⊠⊠

PostGIS ⊠ sfcgal ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GUC ⊠⊠⊠⊠⊠⊠⊠⊠. GEOS ⊠ SFCGAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ geos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ sfcgal ⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
set postgis.backend = sfcgal;
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
ALTER DATABASE mygisdb SET postgis.backend = sfcgal;
```

⊠⊠

Chapter 8

7.22.2 postgis.gdal_datapath

postgis.gdal_datapath — GDAL ⊠ GDAL_DATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠ ⊠⊠⊠⊠⊠⊠⊠ GDAL_DATA ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

GDAL ⊠ GDAL_DATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL GUC ⊠⊠⊠⊠⊠. `postgis.gdal_datapath` ⊠ ⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (hard-coded) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. GDAL ⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
PostgreSQL ⊠⊠⊠⊠⊠ postgresql.conf ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
GDAL ⊠ ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠ GDAL_DATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

`postgis.gdal_datapath` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SET postgis.gdal_datapath TO '/usr/local/share/gdal.hidden';
SET postgis.gdal_datapath TO default;
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
ALTER DATABASE gisdb
SET postgis.gdal_datapath = 'C:/Program Files/PostgreSQL/9.3/gdal-data';
```

⊠⊠

PostGIS_GDAL_Version, ST_Transform

7.22.3 postgis.gdal_enabled_drivers

postgis.gdal_enabled_drivers — PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL ⊠⊠⊠⊠ GDAL_SKIP ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL ⊠⊠⊠⊠ GDAL_SKIP ⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL ⊠⊠⊠⊠⊠ postgresql.conf ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `POSTGIS_GDAL_ENABLED_DRIVERS` ⊠⊠⊠ (pass) ⊠⊠ `postgis.gdal_enabled_drivers` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> `postgis.gdal_enabled_drivers` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
>
> - `DISABLE_ALL` ⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `DISABLE_ALL` ⊠⊠⊠⊠⊠, `postgis.gdal_enabled_drivers` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
> - `ENABLE_ALL` ⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
> - `VSICURL` ⊠ GDAL ⊠ `/vsicurl/` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
>
> `postgis.gdal_enabled_drivers` ⊠ DISABLE_ALL ⊠⊠⊠⊠⊠⊠⊠, DB ⊠⊠⊠⊠⊠, ST_FromGDALRaster(), ST_AsGDALRaster(), ST_AsTIFF(), ST_AsJPEG() ⊠⊠⊠ ST_AsPNG() ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ PostGIS ⊠⊠⊠, `postgis.gdal_enabled_drivers` ⊠ DISABLE_ALL ⊠⊠⊠⊠⊠⊠.

> **Note**
> GDAL_SKIP ⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠ Configuration Options ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

To set and reset `postgis.gdal_enabled_drivers` for current session

```
SET postgis.gdal_enabled_drivers = 'ENABLE_ALL';
SET postgis.gdal_enabled_drivers = default;
```

Set for all new connections to a specific database to specific drivers

```
ALTER DATABASE mygisdb SET postgis.gdal_enabled_drivers TO 'GTiff PNG JPEG';
```

Setting for whole database cluster to enable all drivers. Requires super user access. Also note that database, session, and user settings override this.

```
--writes to postgres.auto.conf
ALTER SYSTEM SET postgis.gdal_enabled_drivers TO 'ENABLE_ALL';
 --Reloads postgres conf
SELECT pg_reload_conf();
```

□□

ST_FromGDALRaster, ST_AsGDALRaster, ST_AsTIFF, ST_AsPNG, ST_AsJPEG, postgis.enable_outdb_rasters

7.22.4 postgis.enable_outdb_rasters

postgis.enable_outdb_rasters — DB □□□□□□□□□□□□□□□□□□□□□□□□□.

□□

DB □□□□□□□□□□□□□□□□□□□□□□□□□. PostgreSQL □□□□□ postgresql.conf □□□ □□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□.

PostgreSQL □□□□□□□□□□ 0 □□□□□□□□□□□ `POSTGIS_ENABLE_OUTDB_RASTERS` □□□ (pass) □□ `postgis.enable_outdb_rasters` □□□□□□□□□□□□□□.

> **Note**
> `postgis.enable_outdb_rasters` □□□□□□□□, GUC `postgis.enable_outdb_rasters` □ □□□□□□□□□□□□□□□□.

> **Note**
> □□ PostGIS □□□, `postgis.enable_outdb_rasters` □□□□□□□□□□.

2.2.0 □□□□□□□□□□□□.

□□

`postgis.enable_outdb_rasters` □□□□□□□□□□□□□□.

```
SET postgis.enable_outdb_rasters TO True;
SET postgis.enable_outdb_rasters = default;
SET postgis.enable_outdb_rasters = True;
SET postgis.enable_outdb_rasters = False;
```

Set for all new connections to a specific database

```
ALTER DATABASE gisdb SET postgis.enable_outdb_rasters = true;
```

Setting for whole database cluster. Requires super user access. Also note that database, session, and user settings override this.

```
--writes to postgres.auto.conf
ALTER SYSTEM SET postgis.enable_outdb_rasters = true;
 --Reloads postgres conf
SELECT pg_reload_conf();
```

□□

postgis.gdal_enabled_drivers postgis.gdal_vsi_options

7.22.5 postgis.gdal_vsi_options

postgis.gdal_vsi_options — DB □□□□□□□□□□□□□□□□□□□□□□□□□.

□□

A string configuration to set options used when working with an out-db raster. Configuration options control things like how much space GDAL allocates to local data cache, whether to read overviews, and what access keys to use for remote out-db data sources.

Availability: 3.2.0

□□

`postgis.enable_outdb_rasters` □□□□□□□□□□□□□□.

```
SET postgis.gdal_vsi_options = 'AWS_ACCESS_KEY_ID=xxxxxxxxxxxxxxx AWS_SECRET_ACCESS_KEY= ↩
    yyyyyyyyyyyyyyyyyyyyyyyyyy';
```

Set `postgis.gdal_vsi_options` just for the *current transaction* using the `LOCAL` keyword:

```
SET LOCAL postgis.gdal_vsi_options = 'AWS_ACCESS_KEY_ID=xxxxxxxxxxxxxxx  ↩
    AWS_SECRET_ACCESS_KEY=yyyyyyyyyyyyyyyyyyyyyyyyyy';
```

□□

postgis.enable_outdb_rasters postgis.gdal_enabled_drivers

7.23 Troubleshooting Functions

7.23.1 PostGIS_AddBBox

PostGIS_AddBBox — □□□□□□□□□□□□□.

Synopsis

geometry **PostGIS_AddBBox**(geometry geomA);

□□

□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□.

> **Note**
> □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□ □□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□ □□□□□□□□□.

This method supports Circular Strings and Curves.

□□

```
UPDATE sometable
 SET geom =  PostGIS_AddBBox(geom)
 WHERE PostGIS_HasBBox(geom) = false;
```

□□

PostGIS_DropBBox, PostGIS_HasBBox

7.23.2 PostGIS_DropBBox

PostGIS_DropBBox — □□□□□□□□□□□□□□□□□□□□□.

Synopsis

geometry **PostGIS_DropBBox**(geometry geomA);

□□

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, □□□□ ST_Intersects □□.

> **Note**
> □□. □□□□□□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□. 8.3 □□ 8.3.6 □□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□/□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, □□□□□/□□□□□□□□□□□□□□□.

This method supports Circular Strings and Curves.

□□

```
--This example drops bounding boxes where the cached box is not correct
                        --The force to ST_AsBinary before applying Box2D forces a ↵
                            recalculation of the box, and Box2D applied to the table ↵
                            geometry always
                        -- returns the cached bounding box.
                        UPDATE sometable
 SET geom =  PostGIS_DropBBox(geom)
 WHERE Not (Box2D(ST_AsBinary(geom)) = Box2D(geom));

       UPDATE sometable
 SET geom =  PostGIS_AddBBox(geom)
 WHERE Not PostGIS_HasBBOX(geom);
```

⊠⊠

PostGIS_AddBBox, PostGIS_HasBBox, Box2D

7.23.3 PostGIS_HasBBox

PostGIS_HasBBox — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **PostGIS_HasBBox**(geometry geomA);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS_AddBBox ⊠ PostGIS_DropBBox ⊠⊠⊠⊠⊠⊠⊠.

This method supports Circular Strings and Curves.

⊠⊠

```
SELECT geom
FROM sometable WHERE PostGIS_HasBBox(geom) = false;
```

⊠⊠

PostGIS_AddBBox, PostGIS_DropBBox

Chapter 8

SFCGAL Functions Reference

SFCGAL ⊠⊠⊠ 2D ⊠ 3D ⊠⊠⊠⊠⊠⊠⊠ CGAL ⊠⊠⊠⊠ C++ ⊠⊠ (wrapper) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

SFCGAL ⊠⊠⊠⊠ http://www.sfcgal.org ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ postgis_sfcgal ⊠⊠⊠⊠⊠⊠⊠.

8.1 SFCGAL Management Functions

8.1.1 postgis_sfcgal_version

postgis_sfcgal_version — ⊠⊠⊠⊠ SFCGAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **postgis_sfcgal_version**(void);

⊠⊠

⊠⊠⊠⊠ SFCGAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

⊠⊠

postgis_sfcgal_full_version

8.1.2 postgis_sfcgal_full_version

postgis_sfcgal_full_version — Returns the full version of SFCGAL in use including CGAL and Boost versions

Synopsis

text **postgis_sfcgal_version**(void);

⊠⊠

Returns the full version of SFCGAL in use including CGAL and Boost versions

Availability: 3.3.0

This method needs SFCGAL backend.

⊠⊠

postgis_sfcgal_version

8.2 SFCGAL Accessors and Setters

8.2.1 CG_ForceLHR

CG_ForceLHR — LHR(Left Hand Reverse; ⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **CG_ForceLHR**(geometry geom);

⊠⊠

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.2.2 CG_IsPlanar

CG_IsPlanar — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **CG_IsPlanar**(geometry geom);

☒☒

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.2.3 CG_IsSolid

CG_IsSolid — ☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

boolean **CG_IsSolid**(geometry geom1);

☒☒

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.2.4 CG_MakeSolid

CG_MakeSolid — ☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒ ☒☒☒☒☒☒☒☒☒☒☒☒ TIN ☒☒☒☒☒☒☒.

Synopsis

geometry **CG_MakeSolid**(geometry geom1);

☒☒

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.2.5 CG_Orientation

CG_Orientation — ⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **CG_Orientation**(geometry geom);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ -1 ⊠, ⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

8.2.6 CG_Area

CG_Area — Calculates the area of a geometry

Synopsis

double precision **CG_Area**(geometry geom);

⊠⊠

Calculates the area of a geometry.

Performed by the SFCGAL module

Note
NOTE: this function returns a double precision value representing the area.

Availability: 3.5.0

This method needs SFCGAL backend.

⊠⊠⊠⊠

```
SELECT CG_Area('Polygon ((0 0, 0 5, 5 5, 5 0, 0 0), (1 1, 2 1, 2 2, 1 2, 1 1), (3 3, 4 3, 4 ↩
    4, 3 4, 3 3))');
             cg_area
             --------
             25
             (1 row)
```

⊠⊠

ST_3DArea, ST_Area

8.2.7 CG_3DArea

CG_3DArea — 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float**CG_3DArea**(geometry geom1);

⊠⊠

Availability: 3.5.0

This method needs SFCGAL backend.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 8.1, 10.5

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

⊠⊠: ⊠⊠⊠⊠⊠ KWT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT CG_3DArea(geom) As cube_surface_area,
            CG_3DArea(CG_MakeSolid(geom)) As solid_surface_area
            FROM (SELECT 'POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
            ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
            ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
            ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
            ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
            ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )'::geometry) As f(geom);

            cube_surface_area | solid_surface_area
            -------------------+--------------------
            6 |                  0
```

⊠⊠

CG_Area, CG_MakeSolid, CG_IsSolid, CG_Area

8.2.8 CG_Volume

CG_Volume — 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠) 0 ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **CG_Volume**(geometry geom1);

☒☒

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 9.1 (same as CG_3DVolume)

☒☒

When closed surfaces are created with WKT, they are treated as areal rather than solid. To make them solid, you need to use CG_MakeSolid. Areal geometries have no volume. Here is an example to demonstrate.

```
SELECT CG_Volume(geom) As cube_surface_vol,
    CG_Volume(CG_MakeSolid(geom)) As solid_surface_vol
    FROM (SELECT 'POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
    ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
    ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
    ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
    ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
    ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )'::geometry) As f(geom);

    cube_surface_vol | solid_surface_vol
    ------------------+-------------------
    0 |                 1
```

☒☒

CG_3DArea, CG_MakeSolid, CG_IsSolid

8.2.9 ST_ForceLHR

ST_ForceLHR — LHR(Left Hand Reverse; ☒☒☒☒) ☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_ForceLHR**(geometry geom);

⊠⊠

> **Warning**
> ST_ForceLHR is deprecated as of 3.5.0. Use CG_ForceLHR instead.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.2.10 ST_IsPlanar

ST_IsPlanar — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_IsPlanar**(geometry geom);

⊠⊠

> **Warning**
> ST_IsPlanar is deprecated as of 3.5.0. Use CG_IsPlanar instead.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.2.11 ST_IsSolid

ST_IsSolid — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_IsSolid**(geometry geom1);

⊠⊠

> **Warning**
> ST_IsSolid is deprecated as of 3.5.0. Use CG_IsSolid instead.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.2.12 ST_MakeSolid

ST_MakeSolid — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_MakeSolid**(geometry geom1);

⊠⊠

> **Warning**
> ST_MakeSolid is deprecated as of 3.5.0. Use CG_MakeSolid instead.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.2.13 ST_Orientation

ST_Orientation — ⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_Orientation**(geometry geom);

⊠⊠

Warning
ST_Orientation is deprecated as of 3.5.0. Use CG_Orientation instead.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ -1 ⊠, ⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

8.2.14 ST_3DArea

ST_3DArea — 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float**ST_3DArea**(geometry geom1);

⊠⊠

Warning
ST_3DArea is deprecated as of 3.5.0. Use CG_3DArea instead.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 8.1, 10.5

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

⊠⊠: ⊠⊠⊠⊠⊠ KWT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_3DArea(geom) As cube_surface_area,
            ST_3DArea(ST_MakeSolid(geom)) As solid_surface_area
            FROM (SELECT 'POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
            ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
            ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
            ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
            ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
            ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )'::geometry) As f(geom);

            cube_surface_area | solid_surface_area
            -------------------+-------------------
            6 |                  0
```

⊠⊠

ST_Area, ST_MakeSolid, ST_IsSolid, ST_Area

8.2.15 ST_Volume

ST_Volume — 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float **ST_Volume**(geometry geom1);

⊠⊠

Warning
ST_Volume is deprecated as of 3.5.0. Use CG_Volume instead.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 9.1 (same as ST_3DVolume)

⊠⊠

WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_MakeSolid ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT ST_Volume(geom) As cube_surface_vol,
    ST_Volume(ST_MakeSolid(geom)) As solid_surface_vol
    FROM (SELECT 'POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
    ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
    ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
    ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
    ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
    ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )'::geometry) As f(geom);

    cube_surface_vol | solid_surface_vol
    ------------------+-------------------
    0 |                 1
```

⊠⊠

ST_3DArea, ST_MakeSolid, ST_IsSolid

8.3 SFCGAL Processing and Relationship Functions

8.3.1 CG_Intersection

CG_Intersection — Computes the intersection of two geometries

Synopsis

geometry **CG_Intersection**(geometry geomA , geometry geomB);

⊠⊠

Computes the intersection of two geometries.

Performed by the SFCGAL module

> **Note**
> NOTE: this function returns a geometry representing the intersection.

Availability: 3.5.0

This method needs SFCGAL backend.

⊠⊠⊠⊠

```
SELECT ST_AsText(CG_Intersection('LINESTRING(0 0, 5 5)', 'LINESTRING(5 0, 0 5)'));
                cg_intersection
                -----------------
                POINT(2.5 2.5)
                (1 row)
```

☒☒

ST_3DIntersection, ST_Intersection

8.3.2 CG_Intersects

CG_Intersects — Tests if two geometries intersect (they have at least one point in common)

Synopsis

boolean **CG_Intersects**(geometry geomA , geometry geomB);

☒☒

Returns `true` if two geometries intersect. Geometries intersect if they have any point in common.

Performed by the SFCGAL module

> **Note**
> NOTE: this is the "allowable" version that returns a boolean, not an integer.

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```
SELECT CG_Intersects('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )'::geometry);
    cg_intersects
    ---------------
    f
    (1 row)
    SELECT CG_Intersects('POINT(0 0)'::geometry, 'LINESTRING ( 0 0, 0 2 )'::geometry);
    cg_intersects
    ---------------
    t
    (1 row)
```

☒☒

CG_3DIntersects, ST_3DIntersects, ST_Intersects, ST_Disjoint

8.3.3 CG_3DIntersects

CG_3DIntersects — Tests if two 3D geometries intersect

Synopsis

boolean **CG_3DIntersects**(geometry geomA , geometry geomB);

⊠⊠

Tests if two 3D geometries intersect. 3D geometries intersect if they have any point in common in the three-dimensional space.

Performed by the SFCGAL module

> **Note**
> NOTE: this is the ”allowable” version that returns a boolean, not an integer.

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠⊠⊠

```
SELECT CG_3DIntersects('POINT(1.2 0.1 0)','POLYHEDRALSURFACE(((0 0 0,0.5 0.5 0,1 0 0,1 1 0,0 1 0,0 0 0)),((1 0 0,2 0 0,2 1 0,1 1 0,1 0 0),(1.2 0.2 0,1.2 0.8 0,1.8 0.8 0,1.8 0.2 0,1.2 0.2 0)))');
        cg_3dintersects
        ---------------
        t
        (1 row)
```

⊠⊠

CG_Intersects, ST_3DIntersects, ST_Intersects, ST_Disjoint

8.3.4 CG_Difference

CG_Difference — Computes the geometric difference between two geometries

Synopsis

geometry **CG_Difference**(geometry geomA , geometry geomB);

⊠⊠

Computes the geometric difference between two geometries. The resulting geometry is a set of points that are present in geomA but not in geomB.

Performed by the SFCGAL module

> **Note**
> NOTE: this function returns a geometry.

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠⊠⊠

```
SELECT ST_AsText(CG_Difference('POLYGON((0 0, 0 1, 1 1, 1 0, 0 0))'::geometry, 'LINESTRING ↵
    (0 0, 2 2)'::geometry));
    cg_difference
    ---------------
    POLYGON((0 0,1 0,1 1,0 1,0 0))
    (1 row)
```

⊠⊠

ST_3DDifference, ST_Difference

8.3.5 ST_3DDifference

ST_3DDifference — 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_3DDifference**(geometry geom1, geometry geom2);

⊠⊠

> **Warning**
> ST_3DDifference is deprecated as of 3.5.0. Use CG_3DDifference instead.

geom2 ⊠⊠⊠⊠⊠⊠⊠ geom1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.6 CG_3DDifference

CG_3DDifference — 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **CG_3DDifference**(geometry geom1, geometry geom2);

⊠⊠

geom2 ⊠⊠⊠⊠⊠⊠⊠ geom1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 3.5.0

This method needs SFCGAL backend.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1

This function supports 3d and will not drop the z-index.

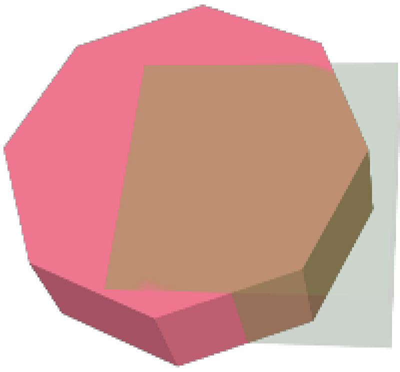
This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

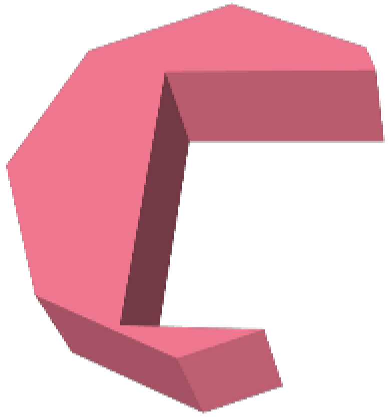
PostGIS ST_AsX3D ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X3Dom HTML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠ HTML ⊠⊠⊠⊠⊠⊠⊠.

```
SELECT CG_Extrude(ST_Buffer(
        ST_GeomFromText('POINT(100 90)'),
        CG_Extrude(ST_Buffer(ST_GeomFromText('POINT(80 80)'),
                                   50, '
        quad_segs=1'),0,0,30) AS geom2;
```



⊠⊠ *3* ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. *geom2* ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT CG_3DDifference(geom1,geom2)
                                   50, '
        quad_segs=2'),0,0,30) AS geom1,
                                   CG_Extrude(
        ST_Buffer(ST_GeomFromText('POINT(80 80)'),
                                   50, '
        quad_segs=1'),0,0,30) AS geom2 ) As t;
```



geom2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠

CG_Extrude, ST_AsX3D, CG_3DIntersection CG_3DUnion

8.3.7 CG_Distance

CG_Distance — Computes the minimum distance between two geometries

Synopsis

double precision **CG_Distance**(geometry geomA , geometry geomB);

⊠⊠

Computes the minimum distance between two geometries.

Performed by the SFCGAL module

Note
NOTE: this function returns a double precision value representing the distance.

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```
SELECT CG_Distance('LINESTRING(0.0 0.0,-1.0 -1.0)', 'LINESTRING(3.0 4.0,4.0 5.0)');
        cg_distance
        -------------
        2.0
        (1 row)
```

☒☒

CG_3DDistance, CG_Distance

8.3.8 CG_3DDistance

CG_3DDistance — Computes the minimum 3D distance between two geometries

Synopsis

double precision **CG_3DDistance**(geometry geomA , geometry geomB);

☒☒

Computes the minimum 3D distance between two geometries.

Performed by the SFCGAL module

> **Note**
> NOTE: this function returns a double precision value representing the 3D distance.

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```
SELECT CG_3DDistance('LINESTRING(-1.0 0.0 2.0,1.0 0.0 3.0)', 'TRIANGLE((-4.0 0.0 1.0,4.0 0.0 1.0,0.0 4.0 1.0,-4.0 0.0 1.0))');
        cg_3ddistance
        ----------------
        1
        (1 row)
```

⊠⊠

CG_Distance, ST_3DDistance

8.3.9 ST_3DConvexHull

ST_3DConvexHull — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_3DConvexHull**(geometry geom1);

⊠⊠

Warning
ST_3DConvexHull is deprecated as of 3.5.0. Use CG_3DConvexHull instead.

Availability: 3.3.0

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.10 CG_3DConvexHull

CG_3DConvexHull — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **CG_3DConvexHull**(geometry geom1);

⊠⊠

Availability: 3.5.0

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

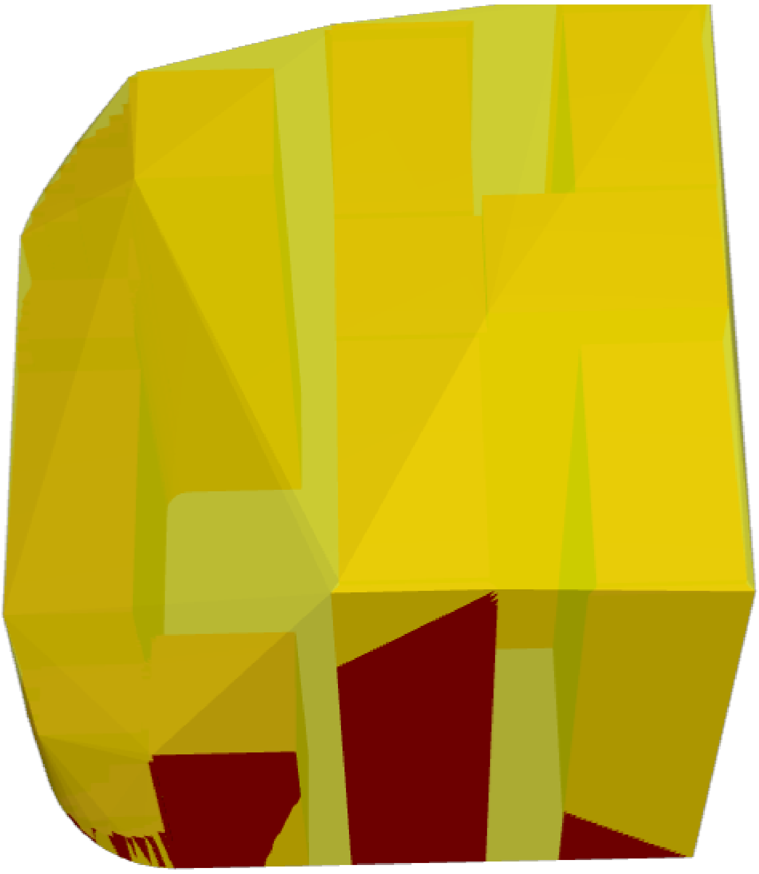
This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT ST_AsText(CG_3DConvexHull('LINESTRING Z(0 0 5, 1 5 3, 5 7 6, 9 5 3 , 5 7 5, 6 3 5) ↩
    '::geometry));
```

```
POLYHEDRALSURFACE Z (((1 5 3,9 5 3,0 0 5,1 5 3)),((1 5 3,0 0 5,5 7 6,1 5 3)),((5 7 6,5 7  ↩
    5,1 5 3,5 7 6)),((0 0 5,6 3 5,5 7 6,0 0 5)),((6 3 5,9 5 3,5 7 6,6 3 5)),((0 0 5,9 5 3,6  ↩
    3 5,0 0 5)),((9 5 3,5 7 5,5 7 6,9 5 3)),((1 5 3,5 7 5,9 5 3,1 5 3)))
```

```
WITH f AS (SELECT i, CG_Extrude(geom, 0,0, i ) AS geom
        FROM ST_Subdivide(ST_Letters('CH'),5) WITH ORDINALITY AS sd(geom,i)
        )
        SELECT CG_3DConvexHull(ST_Collect(f.geom) )
        FROM f;
```



Original geometry overlaid with 3D convex hull

⊠⊠

ST_Letters, ST_AsX3D

8.3.11 ST_3DIntersection

ST_3DIntersection — 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_3DIntersection**(geometry geom1, geometry geom2);

⊠⊠

Warning
ST_3DIntersection is deprecated as of 3.5.0. Use CG_3DIntersection instead.

geom1 ⊠ geom2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.12 CG_3DIntersection

CG_3DIntersection — 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **CG_3DIntersection**(geometry geom1, geometry geom2);

⊠⊠

geom1 ⊠ geom2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
Availability: 3.5.0

This method needs SFCGAL backend.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1

This function supports 3d and will not drop the z-index.

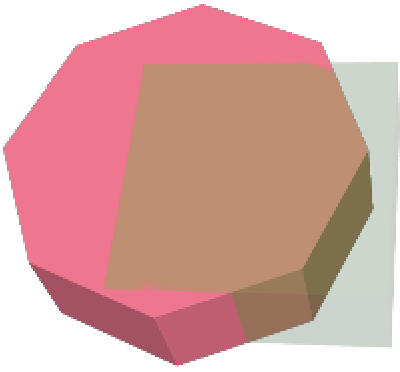
This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

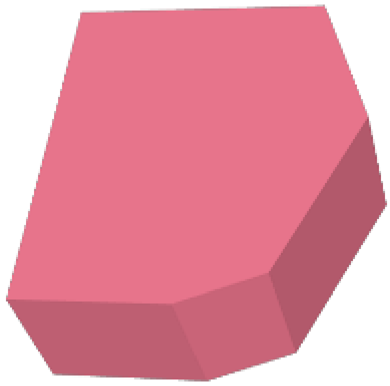
PostGIS ST_AsX3D ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X3Dom HTML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠ HTML ⊠⊠⊠⊠⊠⊠⊠.

```
SELECT CG_Extrude(ST_Buffer( ↩
        ST_GeomFromText('POINT(100 90)'),
                                    50, ' ↩
        quad_segs=2'),0,0,30) AS geom1,
        CG_Extrude(ST_Buffer(ST_GeomFromText('POINT(80 80)'),
                                    50, ' ↩
        quad_segs=1'),0,0,30) AS geom2;
```



⊠⊠ *3* ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. *geom2* ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT CG_3DIntersection(geom1,geom2)
                                    50, ' ↩
        quad_segs=2'),0,0,30) AS geom1,
        CG_Extrude(ST_Buffer(ST_GeomFromText('PO
                                    50, ' ↩
        quad_segs=1'),0,0,30) AS geom2 ) As t;
```



geom1 ⊠ *geom2* ⊠⊠⊠⊠⊠⊠

3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_AsText(CG_3DIntersection(linestring, polygon)) As wkt
    FROM  ST_GeomFromText('LINESTRING Z (2 2 6,1.5 1.5 7,1 1 8,0.5 0.5 8,0 0 10)') AS  ↩
        linestring
    CROSS JOIN ST_GeomFromText('POLYGON((0 0 8, 0 1 8, 1 1 8, 1 0 8, 0 0 8))') AS polygon;

    wkt
    --------------------------------
    LINESTRING Z (1 1 8,0.5 0.5 8)
```

⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠ Z

```
SELECT ST_AsText(CG_3DIntersection(
ST_GeomFromText('POLYHEDRALSURFACE Z( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )'),
'POLYGON Z ((0 0 0, 0 0 0.5, 0 0.5 0.5, 0 0.5 0, 0 0 0))'::geometry))
```

```
TIN Z (((0 0 0,0 0 0.5,0 0.5 0.5,0 0 0)),((0 0.5 0,0 0 0,0 0.5 0.5,0 0.5 0)))
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (ST_Dimension ⊠⊠⊠ 3 ⊠⊠⊠)

```
SELECT ST_AsText(CG_3DIntersection( CG_Extrude(ST_Buffer('POINT(10 20)'::geometry,10,1) ↩
    ,0,0,30),
            CG_Extrude(ST_Buffer('POINT(10 20)'::geometry,10,1),2,0,10) ));
```

```
POLYHEDRALSURFACE Z (((13.3333333333333 13.3333333333333 10,20 20 0,20 20  ↩
    10,13.3333333333333 13.3333333333333 10)),
        ((20 20 10,16.6666666666667 23.3333333333333 10,13.3333333333333 13.3333333333333  ↩
            10,20 20 10)),
```

```
        ((20 20 0,16.6666666666667 23.3333333333333 10,20 20 10,20 20 0)),
        ((13.3333333333333 13.3333333333333 10,10 10 0,20 20 0,13.3333333333333  ↩
           13.3333333333333 10)),
        ((16.6666666666667 23.3333333333333 10,12 28 10,13.3333333333333 13.3333333333333  ↩
           10,16.6666666666667 23.3333333333333 10)),
        ((20 20 0,9.99999999999995 30 0,16.6666666666667 23.3333333333333 10,20 20 0)),
        ((10 10 0,9.99999999999995 30 0,20 20 0,10 10 0)),((13.3333333333333  ↩
           13.3333333333333 10,12 12 10,10 10 0,13.3333333333333 13.3333333333333 10)),
        ((12 28 10,12 12 10,13.3333333333333 13.3333333333333 10,12 28 10)),
        ((16.6666666666667 23.3333333333333 10,9.99999999999995 30 0,12 28  ↩
           10,16.6666666666667 23.3333333333333 10)),
        ((10 10 0,0 20 0,9.99999999999995 30 0,10 10 0)),
        ((12 12 10,11 11 10,10 10 0,12 12 10)),((12 28 10,11 11 10,12 12 10,12 28 10)),
        ((9.99999999999995 30 0,11 29 10,12 28 10,9.99999999999995 30 0)),((0 20 0,2 20  ↩
           10,9.99999999999995 30 0,0 20 0)),
        ((10 10 0,2 20 10,0 20 0,10 10 0)),((11 11 10,2 20 10,10 10 0,11 11 10)),((12 28  ↩
           10,11 29 10,11 11 10,12 28 10)),
        ((9.99999999999995 30 0,2 20 10,11 29 10,9.99999999999995 30 0)),((11 11 10,11 29  ↩
           10,2 20 10,11 11 10)))
```

8.3.13 CG_Union

CG_Union — Computes the union of two geometries

Synopsis

geometry **CG_Union**(geometry geomA , geometry geomB);

⊠⊠

Computes the union of two geometries.

Performed by the SFCGAL module

> **Note**
> NOTE: this function returns a geometry representing the union.

Availability: 3.5.0

This method needs SFCGAL backend.

⊠⊠⊠⊠

```
SELECT CG_Union('POINT(.5 0)', 'LINESTRING(-1 0,1 0)');
                cg_union
                -----------
                LINESTRING(-1 0,0.5 0,1 0)
                (1 row)
```

⊠⊠

ST_3DUnion, ST_AsBinary

8.3.14 ST_3DUnion

ST_3DUnion — Perform 3D union.

Synopsis

geometry **ST_3DUnion**(geometry geom1, geometry geom2);
geometry **ST_3DUnion**(geometry set g1field);

⊠⊠

Warning
ST_3DUnion is deprecated as of 3.5.0. Use CG_3DUnion instead.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 3.3.0 aggregate variant was added

This method needs SFCGAL backend.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Aggregate variant: returns a geometry that is the 3D union of a rowset of geometries. The ST_3DUnion() function is an ”aggregate” function in the terminology of PostgreSQL. That means that it operates on rows of data, in the same way the SUM() and AVG() functions do and like most aggregates, it also ignores NULL geometries.

8.3.15 CG_3DUnion

CG_3DUnion — Perform 3D union using postgis_sfcgal.

Synopsis

geometry **CG_3DUnion**(geometry geom1, geometry geom2);
geometry **CG_3DUnion**(geometry set g1field);

☒☒

Availability: 3.5.0

This method needs SFCGAL backend.

This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

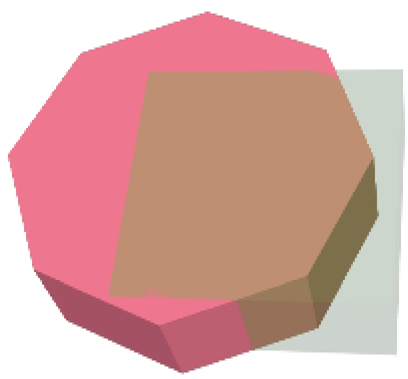
This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Aggregate variant: returns a geometry that is the 3D union of a rowset of geometries. The CG_3DUnion() function is an "aggregate" function in the terminology of PostgreSQL. That means that it operates on rows of data, in the same way the SUM() and AVG() functions do and like most aggregates, it also ignores NULL geometries.

☒☒

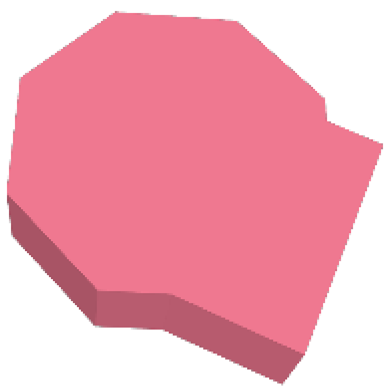
PostGIS ST_AsX3D ☒☒☒ 3 ☒☒☒☒☒☒☒☒☒☒ X3Dom HTML ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ ☒☒☒☒☒ HTML ☒☒☒☒☒☒☒.

```
SELECT CG_Extrude(ST_Buffer( ↩
                ST_GeomFromText('POINT(100 90)'),
                              50, ' ↩
                quad_segs=2'),0,0,30) AS geom1,
                CG_Extrude(ST_Buffer(ST_GeomFromText('POINT(80 80)'),
                              50, ' ↩
                quad_segs=1'),0,0,30) AS geom2;
```



☒☒ 3 ☒☒☒☒☒☒☒☒☒☒☒. *geom2* ☒☒☒☒☒ ☒☒☒☒☒☒☒.

```
SELECT CG_3DUnion(geom1,geom2)
                          50, ' ↩
                quad_segs=2'),0,0,30) AS geom1,
                CG_Extrude(ST_Buffer(ST_GeomFrom
                          50, ' ↩
                quad_segs=1'),0,0,30) AS geom2 )
```



geom1 ☒ *geom2* ☒☒☒

☒☒

CG_Extrude, ST_AsX3D, CG_3DIntersection CG_3DDifference

8.3.16 ST_AlphaShape

ST_AlphaShape — Computes an Alpha-shape enclosing a geometry

Synopsis

geometry **ST_AlphaShape**(geometry geom, float alpha, boolean allow_holes = false);

☒☒

> **Warning**
> ST_AlphaShape is deprecated as of 3.5.0. Use CG_AlphaShape instead.

Computes the Alpha-Shape of the points in a geometry. An alpha-shape is a (usually) concave polygonal geometry which contains all the vertices of the input, and whose vertices are a subset of the input vertices. An alpha-shape provides a closer fit to the shape of the input than the shape produced by the convex hull.

8.3.17 CG_AlphaShape

CG_AlphaShape — Computes an Alpha-shape enclosing a geometry

Synopsis

geometry **CG_AlphaShape**(geometry geom, float alpha, boolean allow_holes = false);

☒☒

Computes the Alpha-Shape of the points in a geometry. An alpha-shape is a (usually) concave polygonal geometry which contains all the vertices of the input, and whose vertices are a subset of the input vertices. An alpha-shape provides a closer fit to the shape of the input than the shape produced by the convex hull.

The "closeness of fit" is controlled by the `alpha` parameter, which can have values from 0 to infinity. Smaller alpha values produce more concave results. Alpha values greater than some data-dependent value produce the convex hull of the input.

> **Note**
> Following the CGAL implementation, the alpha value is the *square* of the radius of the disc used in the Alpha-Shape algorithm to "erode" the Delaunay Triangulation of the input points. See CGAL Alpha-Shapes for more information. This is different from the original definition of alpha-shapes, which defines alpha as the radius of the eroding disc.

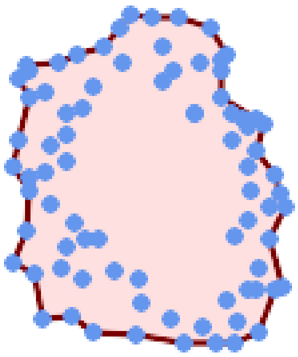
The computed shape does not contain holes unless the optional `allow_holes` argument is specified as true.

This function effectively computes a concave hull of a geometry in a similar way to ST_ConcaveHull, but uses CGAL and a different algorithm.

Availability: 3.5.0 - requires SFCGAL >= 1.4.1.

This method needs SFCGAL backend.

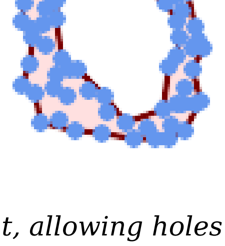
□□



Alpha-shape of a MultiPoint (same example As CG_OptimalAlphaShape)

```
SELECT ST_AsText(CG_AlphaShape('MULTIPOINT((63 84),(76 88),(68 73),(53 18),(91 50),(81 70),
            (88 29),(24 82),(32 51),(37 23),(27 54),(84 19),(75 87),(44 42),(77 67),(90 30) ↩
                ,(36 61),(32 65),
            (81 47),(88 58),(68 73),(49 95),(81 60),(87 50),
            (78 16),(79 21),(30 22),(78 43),(26 85),(48 34),(35 35),(36 40),(31 79),(83 29) ↩
                ,(27 84),(52 98),(72 95),(85 71),
            (75 84),(75 77),(81 29),(77 73),(41 42),(83 72),(23 36),(89 53),(27 57),(57 97) ↩
                ,(27 77),(39 88),(60 81),
            (80 72),(54 32),(55 26),(62 22),(70 20),(76 27),(84 35),(87 42),(82 54),(83 64) ↩
                ,(69 86),(60 90),(50 86),(43 80),(36 73),
            (36 68),(40 75),(24 67),(23 60),(26 44),(28 33),(40 32),(43 19),(65 16),(73 16) ↩
                ,(38 46),(31 59),(34 86),(45 90),(64 97))'::geometry,80.2));
```

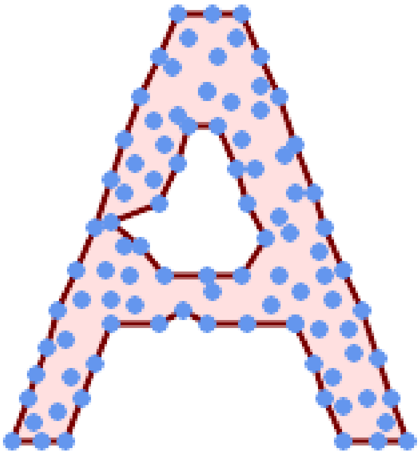
```
POLYGON((89 53,91 50,87 42,90 30,88 29,84 19,78 16,73 16,65 16,53 18,43 19,
        37 23,30 22,28 33,23 36,26 44,27 54,23 60,24 67,27 77,
        24 82,26 85,34 86,39 88,45 90,49 95,52 98,57 97,
        64 97,72 95,76 88,75 84,83 72,85 71,88 58,89 53))
```



Alpha-shape of a MultiPoint, allowing holes (same example as CG_OptimalAlphaShape)

```
SELECT ST_AsText(CG_AlphaShape('MULTIPOINT((63 84),(76 88),(68 73),(53 18),(91 50),(81 70) ↩
    ,(88 29),(24 82),(32 51),(37 23),(27 54),(84 19),(75 87),(44 42),(77 67),(90 30),(36 61) ↩
    ,(32 65),(81 47),(88 58),(68 73),(49 95),(81 60),(87 50),
    (78 16),(79 21),(30 22),(78 43),(26 85),(48 34),(35 35),(36 40),(31 79),(83 29),(27 84) ↩
        ,(52 98),(72 95),(85 71),
    (75 84),(75 77),(81 29),(77 73),(41 42),(83 72),(23 36),(89 53),(27 57),(57 97),(27 77) ↩
        ,(39 88),(60 81),
    (80 72),(54 32),(55 26),(62 22),(70 20),(76 27),(84 35),(87 42),(82 54),(83 64),(69 86) ↩
        ,(60 90),(50 86),(43 80),(36 73),
    (36 68),(40 75),(24 67),(23 60),(26 44),(28 33),(40 32),(43 19),(65 16),(73 16),(38 46) ↩
        ,(31 59),(34 86),(45 90),(64 97))'::geometry, 100.1,true))
```

```
POLYGON((89 53,91 50,87 42,90 30,84 19,78 16,73 16,65 16,53 18,43 19,30 22,28 33,23 36,
26 44,27 54,23 60,24 67,27 77,24 82,26 85,34 86,39 88,45 90,49 95,52 98,57 97,64 97,72 95,
76 88,75 84,83 72,85 71,88 58,89 53),(36 61,36 68,40 75,43 80,60 81,68 73,77 67,
81 60,82 54,81 47,78 43,76 27,62 22,54 32,44 42,38 46,36 61))
```



Alpha-shape of a MultiPoint, allowing holes (same example as ST_ConcaveHull)

```
SELECT ST_AsText(CG_AlphaShape(
                'MULTIPOINT ((132 64), (114 64), (99 64), (81 64), (63 64), (57 49), (52  ↩
                    36), (46 20), (37 20), (26 20), (32 36), (39 55), (43 69), (50 84), (57  ↩
                    100), (63 118), (68 133), (74 149), (81 164), (88 180), (101 180), (112  ↩
                    180), (119 164), (126 149), (132 131), (139 113), (143 100), (150 84),  ↩
                    (157 69), (163 51), (168 36), (174 20), (163 20), (150 20), (143 36),  ↩
                    (139 49), (132 64), (99 151), (92 138), (88 124), (81 109), (74 93), (70 ↩
                     82), (83 82), (99 82), (112 82), (126 82), (121 96), (114 109), (110  ↩
                    122), (103 138), (99 151), (34 27), (43 31), (48 44), (46 58), (52 73),  ↩
                    (63 73), (61 84), (72 71), (90 69), (101 76), (123 71), (141 62), (166  ↩
                    27), (150 33), (159 36), (146 44), (154 53), (152 62), (146 73), (134  ↩
                    76), (143 82), (141 91), (130 98), (126 104), (132 113), (128 127), (117 ↩
                     122), (112 133), (119 144), (108 147), (119 153), (110 171), (103 164), ↩
                     (92 171), (86 160), (88 142), (79 140), (72 124), (83 131), (79 118),  ↩
                    (68 113), (63 102), (68 93), (35 45))'::geometry,102.2, true));
```

```
POLYGON((26 20,32 36,35 45,39 55,43 69,50 84,57 100,63 118,68 133,74 149,81 164,88 180,
            101 180,112 180,119 164,126 149,132 131,139 113,143 100,150 84,157 69,163  ↩
                51,168 36,
            174 20,163 20,150 20,143 36,139 49,132 64,114 64,99 64,90 69,81 64,63 64,57  ↩
                49,52 36,46 20,37 20,26 20),
```

```
(74 93,81 109,88 124,92 138,103 138,110 122,114 109,121 96,112 82,99 82,83 ↩
    82,74 93))
```

□□

ST_ConcaveHull, CG_OptimalAlphaShape

8.3.18 CG_ApproxConvexPartition

CG_ApproxConvexPartition — Computes approximal convex partition of the polygon geometry

Synopsis

geometry **CG_ApproxConvexPartition**(geometry geom);

□□

Computes approximal convex partition of the polygon geometry (using a triangulation).

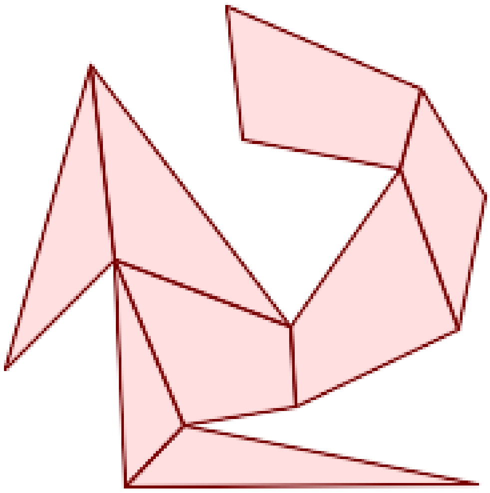
Note
A partition of a polygon P is a set of polygons such that the interiors of the polygons do not intersect and the union of the polygons is equal to the interior of the original polygon P. CG_ApproxConvexPartition and CG_GreeneApproxConvexPartition functions produce approximately optimal convex partitions. Both these functions produce convex decompositions by first decomposing the polygon into simpler polygons; CG_ApproxConvexPartition uses a triangulation and CG_GreeneApproxConvexPartition a monotone partition. These two functions both guarantee that they will produce no more than four times the optimal number of convex pieces but they differ in their runtime complexities. Though the triangulation-based approximation algorithm often results in fewer convex pieces, this is not always the case.

Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0

This method needs SFCGAL backend.

☒☒



Approximal Convex Partition (same example As CG_YMonotonePartition, CG_GreeneApproxConvexPartition and CG_OptimalConvexPartition)

```
SELECT ST_AsText(CG_ApproxConvexPartition('POLYGON((156 150,83 181,89 131,148 120,107 61,32 ↩
     159,0 45,41 86,45 1,177 2,67 24,109 31,170 60,180 110,156 150))'::geometry));
```

```
GEOMETRYCOLLECTION(POLYGON((156 150,83 181,89 131,148 120,156 150)),POLYGON((32 159,0 45,41 ↩
     86,32 159)),POLYGON((107 61,32 159,41 86,107 61)),POLYGON((45 1,177 2,67 24,45 1)), ↩
    POLYGON((41 86,45 1,67 24,41 86)),POLYGON((107 61,41 86,67 24,109 31,107 61)),POLYGON ↩
    ((148 120,107 61,109 31,170 60,148 120)),POLYGON((156 150,148 120,170 60,180 110,156  ↩
    150)))
```

☒☒

CG_YMonotonePartition, CG_GreeneApproxConvexPartition, CG_OptimalConvexPartition

8.3.19 ST_ApproximateMedialAxis

ST_ApproximateMedialAxis — ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_ApproximateMedialAxis**(geometry geom);

☒☒

Warning
ST_ApproximateMedialAxis is deprecated as of 3.5.0. Use CG_ApproximateMedialAxis instead.

Return an approximate medial axis for the areal input based on its straight skeleton. Uses an SFCGAL specific API when built against a capable version (1.2.0+). Otherwise the function is just a wrapper around CG_StraightSkeleton (slower case).

2.2.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.20 CG_ApproximateMedialAxis

CG_ApproximateMedialAxis — ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

Synopsis

geometry **CG_ApproximateMedialAxis**(geometry geom);

⌧⌧

Return an approximate medial axis for the areal input based on its straight skeleton. Uses an SFCGAL specific API when built against a capable version (1.2.0+). Otherwise the function is just a wrapper around CG_StraightSkeleton (slower case).

Availability: 3.5.0

This method needs SFCGAL backend.

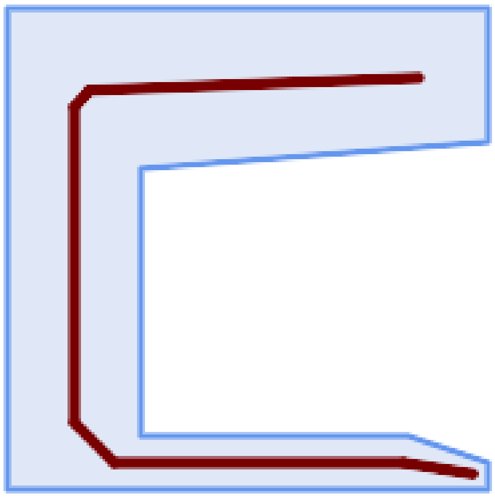
This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⌧⌧

```
SELECT CG_ApproximateMedialAxis(ST_GeomFromText('POLYGON (( 190 190, 10 190, 10 10, 190 10, ↩
     190 20, 160 30, 60 30, 60 130, 190 140, 190 190 ))'));
```



⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠

CG_StraightSkeleton

8.3.21 ST_ConstrainedDelaunayTriangles

ST_ConstrainedDelaunayTriangles — Return a constrained Delaunay triangulation around the given input geometry.

Synopsis

geometry **ST_ConstrainedDelaunayTriangles**(geometry g1);

⊠⊠

Warning
ST_ConstrainedDelaunayTriangles is deprecated as of 3.5.0. Use CG_ConstrainedDelaunayTriangles instead.

Return a Constrained Delaunay triangulation around the vertices of the input geometry. Output is a TIN.

This method needs SFCGAL backend.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

8.3.22 CG_ConstrainedDelaunayTriangles

CG_ConstrainedDelaunayTriangles — Return a constrained Delaunay triangulation around the given input geometry.

Synopsis

geometry **CG_ConstrainedDelaunayTriangles**(geometry g1);

⊠⊠

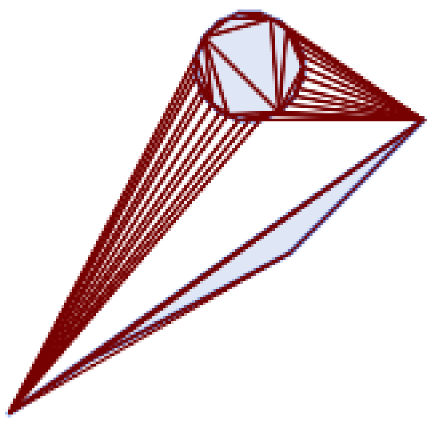
Return a Constrained Delaunay triangulation around the vertices of the input geometry. Output is a TIN.

This method needs SFCGAL backend.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

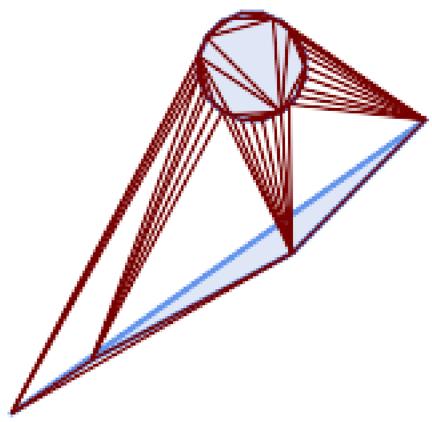
This function supports 3d and will not drop the z-index.

⊠⊠



CG_ConstrainedDelaunayTriangles of 2 polygons

```
select CG_ConstrainedDelaunayTriangles(
    ST_Union(
    'POLYGON((175 150, 20 40, 50 60, 125 100, 175 150))'::geometry,
    ST_Buffer('POINT(110 170)'::geometry, 20)
    )
    )
    ;
```



ST_DelaunayTriangles of 2 polygons. Triangle edges cross polygon boundaries.

```
select ST_DelaunayTriangles(
    ST_Union(
    'POLYGON((175 150, 20 40, 50 60, 125 100, 175 150))'::geometry,
    ST_Buffer('POINT(110 170)'::geometry, 20)
    )
    )
    ;
```

⊠⊠

ST_DelaunayTriangles, ST_TriangulatePolygon, CG_Tesselate, ST_ConcaveHull, ST_Dump

8.3.23 ST_Extrude

ST_Extrude — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Extrude**(geometry geom, float x, float y, float z);

⊠⊠

Warning
ST_Extrude is deprecated as of 3.5.0. Use CG_Extrude instead.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.24 CG_Extrude

CG_Extrude — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **CG_Extrude**(geometry geom, float x, float y, float z);

⊠⊠

Availability: 3.5.0

This method needs SFCGAL backend.

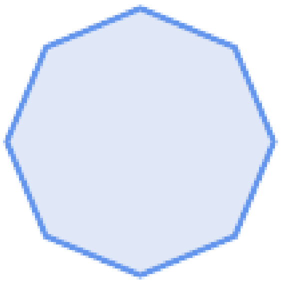
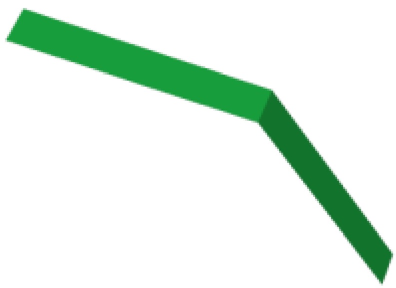
This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

□□

PostGIS ST_AsX3D □□□ 3 □□□□□□□□□□ X3Dom HTML □□□□□□□□□□□□□□ □□□□□ HTML □□□□□□□.

`SELECT ST_Buffer(ST_GeomFromText('POINT (100 90)'), 50, 'quad_segs=2'),0,0,30);`  □□□□□□□□□□□□□□□□□□□	`CG_Extrude(ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50, 'quad_segs=2'),0,0,30);`  *Z □□□□ 30 □□□□□□□□□□□□□□□□ Z(PolyhedralSurfaceZ) □□□□□□.*
`SELECT ST_GeomFromText('LINESTRING(50 50, 100 90, 95 150)')`  □□□□□□□	`SELECT CG_Extrude( ST_GeomFromText('LINESTRING(50 50, 100 90, 95 15`  *Z □□□□□□□□□□□□□□□□□□□ Z(PolyhedralSurfaceZ) □□□□□□.*

⊠⊠

ST_AsX3D, CG_ExtrudeStraightSkeleton

8.3.25 CG_ExtrudeStraightSkeleton

CG_ExtrudeStraightSkeleton — Straight Skeleton Extrusion

Synopsis

geometry **CG_ExtrudeStraightSkeleton**(geometry geom, float roof_height, float body_height = 0);

⊠⊠

Computes an extrusion with a maximal height of the polygon geometry.

Note
Perhaps the first (historically) use-case of straight skeletons: given a polygonal roof, the straight skeleton directly gives the layout of each tent. If each skeleton edge is lifted from the plane a height equal to its offset distance, the resulting roof is "correct" in that water will always fall down to the contour edges (the roof's border), regardless of where it falls on the roof. The function computes this extrusion aka "roof" on a polygon. If the argument body_height > 0, so the polygon is extruded like with CG_Extrude(polygon, 0, 0, body_height). The result is an union of these polyhedralsurfaces.

Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0

This method needs SFCGAL backend.

⊠⊠

```
SELECT ST_AsText(CG_ExtrudeStraightSkeleton('POLYGON (( 0 0, 5 0, 5 5, 4 5, 4 4, 0 4, 0 0 ) ↩
    , (1 1, 1 2,2 2, 2 1, 1 1))', 3.0, 2.0));
```

```
POLYHEDRALSURFACE Z (((0 0 0,0 4 0,4 4 0,4 5 0,5 5 0,5 0 0,0 0 0),(1 1 0,2 1 0,2 2 0,1 2  ↩
    0,1 1 0)),((0 0 0,0 0 2,0 4 2,0 4 0,0 0 0)),((0 4 0,0 4 2,4 4 2,4 4 0,0 4 0)),((4 4 0,4  ↩
    4 2,4 5 2,4 5 0,4 4 0)),((4 5 0,4 5 2,5 5 2,5 5 0,4 5 0)),((5 5 0,5 5 2,5 0 2,5 0 0,5 5  ↩
    0)),((5 0 0,5 0 2,0 0 2,0 0 0,5 0 0)),((1 1 0,1 1 2,2 1 2,2 1 0,1 1 0)),((2 1 0,2 1 2,2  ↩
    2 2,2 2 0,2 1 0)),((2 2 0,2 2 2,1 2 2,1 2 0,2 2 0)),((1 2 0,1 2 2,1 1 2,1 1 0,1 2 0)) ↩
    ,((4 5 2,5 5 2,4 4 2,4 5 2)),((2 1 2,5 0 2,0 0 2,2 1 2)),((5 5 2,5 0 2,4 4 2,5 5 2)),((2 ↩
     1 2,0 0 2,1 1 2,2 1 2)),((1 2 2,1 1 2,0 0 2,1 2 2)),((0 4 2,2 2 2,1 2 2,0 4 2)),((0 4  ↩
    2,1 2 2,0 0 2,0 4 2)),((4 4 2,5 0 2,2 2 2,4 4 2)),((4 4 2,2 2 2,0 4 2,4 4 2)),((2 2 2,5  ↩
    0 2,2 1 2,2 2 2)),((0.5 2.5 2.5,0 0 2,0.5 0.5 2.5,0.5 2.5 2.5)),((1 3 3,0 4 2,0.5 2.5  ↩
    2.5,1 3 3)),((0.5 2.5 2.5,0 4 2,0 0 2,0.5 2.5 2.5)),((2.5 0.5 2.5,5 0 2,3.5 1.5 3.5,2.5  ↩
    0.5 2.5)),((0 0 2,5 0 2,2.5 0.5 2.5,0 0 2)),((0.5 0.5 2.5,0 0 2,2.5 0.5 2.5,0.5 0.5 2.5) ↩
    ),((4.5 3.5 2.5,5 5 2,4.5 4.5 2.5,4.5 3.5 2.5)),((3.5 2.5 3.5,3.5 1.5 3.5,4.5 3.5  ↩
    2.5,3.5 2.5 3.5)),((4.5 3.5 2.5,5 0 2,5 5 2,4.5 3.5 2.5)),((3.5 1.5 3.5,5 0 2,4.5 3.5  ↩
    2.5,3.5 1.5 3.5)),((5 5 2,4 5 2,4.5 4.5 2.5,5 5 2)),((4.5 4.5 2.5,4 4 2,4.5 3.5 2.5,4.5  ↩
    4.5 2.5)),((4.5 4.5 2.5,4 5 2,4 4 2,4.5 4.5 2.5)),((3 3 3,0 4 2,1 3 3,3 3 3)),((3.5 2.5  ↩
    3.5,4.5 3.5 2.5,3 3 3,3.5 2.5 3.5)),((3 3 3,4 4 2,0 4 2,3 3 3)),((4.5 3.5 2.5,4 4 2,3 3  ↩
```

```
3,4.5 3.5 2.5)),((2 1 2,1 1 2,0.5 0.5 2.5,2 1 2)),((2.5 0.5 2.5,2 1 2,0.5 0.5 2.5,2.5 
0.5 2.5)),((1 1 2,1 2 2,0.5 2.5 2.5,1 1 2)),((0.5 0.5 2.5,1 1 2,0.5 2.5 2.5,0.5 0.5 2.5)
),((1 3 3,2 2 2,3 3 3,1 3 3)),((0.5 2.5 2.5,1 2 2,1 3 3,0.5 2.5 2.5)),((1 3 3,1 2 2,2 2 
2,1 3 3)),((2 2 2,2 1 2,2.5 0.5 2.5,2 2 2)),((3.5 2.5 3.5,3 3 3,3.5 1.5 3.5,3.5 2.5 3.5)
),((3.5 1.5 3.5,2 2 2,2.5 0.5 2.5,3.5 1.5 3.5)),((3 3 3,2 2 2,3.5 1.5 3.5,3 3 3)))
```

⊠⊠

ST_Extrude, CG_StraightSkeleton

8.3.26 CG_GreeneApproxConvexPartition

CG_GreeneApproxConvexPartition — Computes approximal convex partition of the polygon geometry

Synopsis

geometry **CG_GreeneApproxConvexPartition**(geometry geom);

⊠⊠

Computes approximal monotone convex partition of the polygon geometry.

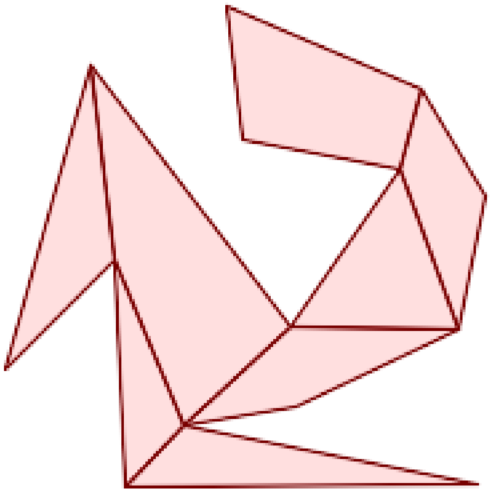
> **Note**
> A partition of a polygon P is a set of polygons such that the interiors of the polygons do not intersect and the union of the polygons is equal to the interior of the original polygon P. CG_ApproxConvexPartition and CG_GreeneApproxConvexPartition functions produce approximately optimal convex partitions. Both these functions produce convex decompositions by first decomposing the polygon into simpler polygons; CG_ApproxConvexPartition uses a triangulation and CG_GreeneApproxConvexPartition a monotone partition. These two functions both guarantee that they will produce no more than four times the optimal number of convex pieces but they differ in their runtime complexities. Though the triangulation-based approximation algorithm often results in fewer convex pieces, this is not always the case.

Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0

This method needs SFCGAL backend.

□□



Greene Approximal Convex Partition (same example As CG_YMonotonePartition, CG_ApproxConvexPartition and CG_OptimalConvexPartition)

```
SELECT ST_AsText(CG_GreeneApproxConvexPartition('POLYGON((156 150,83 181,89 131,148 120,107 ↩
     61,32 159,0 45,41 86,45 1,177 2,67 24,109 31,170 60,180 110,156 150))'::geometry));
```

```
GEOMETRYCOLLECTION(POLYGON((32 159,0 45,41 86,32 159)),POLYGON((45 1,177 2,67 24,45 1)), ↩
    POLYGON((67 24,109 31,170 60,107 61,67 24)),POLYGON((41 86,45 1,67 24,41 86)),POLYGON ↩
    ((107 61,32 159,41 86,67 24,107 61)),POLYGON((148 120,107 61,170 60,148 120)),POLYGON ↩
    ((148 120,170 60,180 110,156 150,148 120)),POLYGON((156 150,83 181,89 131,148 120,156  ↩
    150)))
```

□□

CG_YMonotonePartition, CG_ApproxConvexPartition, CG_OptimalConvexPartition

8.3.27 ST_MinkowskiSum

ST_MinkowskiSum — □□□□□□□□□□□□□.

Synopsis

geometry **ST_MinkowskiSum**(geometry geom1, geometry geom2);

□□

> **Warning**
> ST_MinkowskiSum is deprecated as of 3.5.0. Use CG_MinkowskiSum instead.

⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠ A ⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ A ⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ (motion planning) ⊠ CAD(computer-aided design) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ Wikipedia Minkowski addition ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠ (⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, Z ⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠ CGAL 2D Minkowskisum ⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

8.3.28 CG_MinkowskiSum

CG_MinkowskiSum — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **CG_MinkowskiSum**(geometry geom1, geometry geom2);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠ A ⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ A ⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ (motion planning) ⊠ CAD(computer-aided design) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ Wikipedia Minkowski addition ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠ (⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, Z ⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

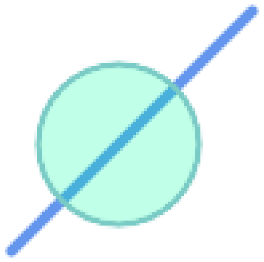
⊠⊠⊠⊠⊠ CGAL 2D Minkowskisum ⊠⊠⊠⊠⊠⊠⊠.

Availability: 3.5.0

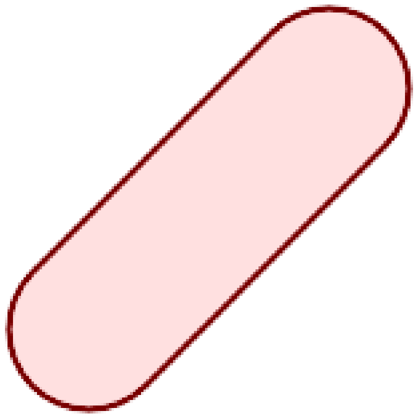
This method needs SFCGAL backend.

⊠⊠

⊠⊠



☒☒☒

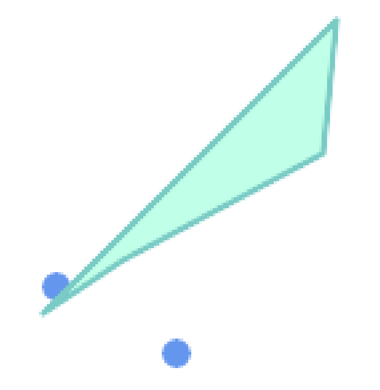


☒☒☒

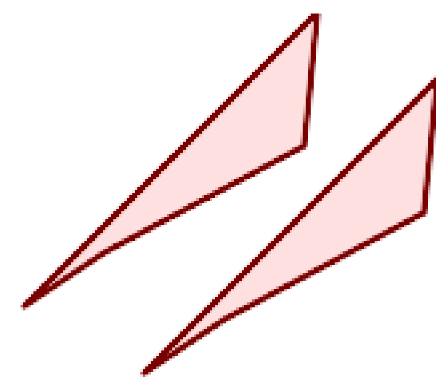
```
SELECT CG_MinkowskiSum(line, circle))
            FROM (SELECT
            ST_MakeLine(ST_Point(10, 10),ST_Point(100, 100)) As line,
            ST_Buffer(ST_GeomFromText('POINT(50 50)'), 30) As circle) As foo;

            -- wkt --
            MULTIPOLYGON(((30 59.9999999999999,30.5764415879031
                54.1472903395161,32.2836140246614 48.5194970290472,35.0559116309237
                43.3328930094119,38.7867965644036 38.7867965644035,43.332893009412
                35.0559116309236,48.5194970290474 32.2836140246614,54.1472903395162
                30.5764415879031,60.0000000000001 30,65.8527096604839
                30.5764415879031,71.4805029709527 32.2836140246614,76.6671069905881
                35.0559116309237,81.2132034355964 38.7867965644036,171.213203435596
                128.786796564404,174.944088369076 133.332893009412,177.716385975339
                138.519497029047,179.423558412097 144.147290339516,180 150,179.423558412097
                155.852709660484,177.716385975339 161.480502970953,174.944088369076
                166.667106990588,171.213203435596 171.213203435596,166.667106990588
                174.944088369076,
            161.480502970953 177.716385975339,155.852709660484 179.423558412097,150
                180,144.147290339516 179.423558412097,138.519497029047
                177.716385975339,133.332893009412 174.944088369076,128.786796564403
                171.213203435596,38.7867965644035 81.2132034355963,35.0559116309236
                76.667106990588,32.2836140246614 71.4805029709526,30.5764415879031
                65.8527096604838,30 59.9999999999999)))
```

☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒



⊠⊠⊠



⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT CG_MinkowskiSum(mp, poly)
        FROM (SELECT 'MULTIPOINT(25 50,70 25)'::geometry As mp,
        'POLYGON((130 150, 20 40, 50 60, 125 100, 130 150))'::geometry As poly
        ) As foo


        -- wkt --
        MULTIPOLYGON(
        ((70 115,100 135,175 175,225 225,70 115)),
        ((120 65,150 85,225 125,275 175,120 65))
        )
```

8.3.29 ST_OptimalAlphaShape

ST_OptimalAlphaShape — Computes an Alpha-shape enclosing a geometry using an ”optimal” alpha value.

Synopsis

geometry **ST_OptimalAlphaShape**(geometry geom, boolean allow_holes = false, integer nb_components = 1);

⊠⊠

> **Warning**
> ST_OptimalAlphaShape is deprecated as of 3.5.0. Use CG_OptimalAlphaShape instead.

Computes the ”optimal” alpha-shape of the points in a geometry. The alpha-shape is computed using a value of α chosen so that:

1. the number of polygon elements is equal to or smaller than `nb_components` (which defaults to 1)
2. all input points are contained in the shape

The result will not contain holes unless the optional `allow_holes` argument is specified as true.

Availability: 3.3.0 - requires SFCGAL >= 1.4.1.

This method needs SFCGAL backend.

8.3.30 CG_OptimalAlphaShape

CG_OptimalAlphaShape — Computes an Alpha-shape enclosing a geometry using an ”optimal” alpha value.

Synopsis

geometry **CG_OptimalAlphaShape**(geometry geom, boolean allow_holes = false, integer nb_components = 1);

□□

Computes the ”optimal” alpha-shape of the points in a geometry. The alpha-shape is computed using a value of α chosen so that:

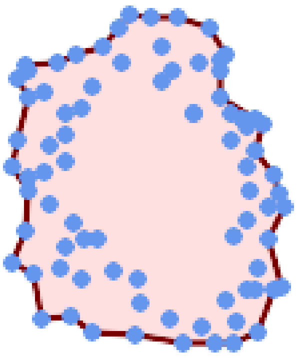
1. the number of polygon elements is equal to or smaller than `nb_components` (which defaults to 1)
2. all input points are contained in the shape

The result will not contain holes unless the optional `allow_holes` argument is specified as true.

Availability: 3.5.0 - requires SFCGAL >= 1.4.1.

This method needs SFCGAL backend.

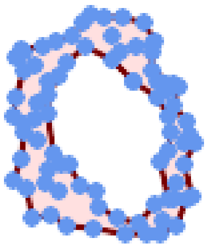
⊠⊠



Optimal alpha-shape of a MultiPoint (same example as CG_AlphaShape)

```
SELECT ST_AsText(CG_OptimalAlphaShape('MULTIPOINT((63 84),(76 88),(68 73),(53 18),(91 50),(81 70),
                (88 29),(24 82),(32 51),(37 23),(27 54),(84 19),(75 87),(44 42),(77 67),(90 30),(36 61),(32 65),
                (81 47),(88 58),(68 73),(49 95),(81 60),(87 50),
                (78 16),(79 21),(30 22),(78 43),(26 85),(48 34),(35 35),(36 40),(31 79),(83 29),(27 84),(52 98),(72 95),(85 71),
                (75 84),(75 77),(81 29),(77 73),(41 42),(83 72),(23 36),(89 53),(27 57),(57 97),(27 77),(39 88),(60 81),
                (80 72),(54 32),(55 26),(62 22),(70 20),(76 27),(84 35),(87 42),(82 54),(83 64),(69 86),(60 90),(50 86),(43 80),(36 73),
                (36 68),(40 75),(24 67),(23 60),(26 44),(28 33),(40 32),(43 19),(65 16),(73 16),(38 46),(31 59),(34 86),(45 90),(64 97))'::geometry));
```

```
POLYGON((89 53,91 50,87 42,90 30,88 29,84 19,78 16,73 16,65 16,53 18,43 19,37 23,30 22,28 33,23 36,
            26 44,27 54,23 60,24 67,27 77,24 82,26 85,34 86,39 88,45 90,49 95,52 98,57 97,64 97,72 95,76 88,75 84,75 77,83 72,85 71,83 64,88 58,89 53))
```



Optimal alpha-shape of a MultiPoint, allowing holes (same example as CG_AlphaShape)

```
SELECT ST_AsText(CG_OptimalAlphaShape('MULTIPOINT((63 84),(76 88),(68 73),(53 18),(91 50) ↩
    ,(81 70),(88 29),(24 82),(32 51),(37 23),(27 54),(84 19),(75 87),(44 42),(77 67),(90 30) ↩
    ,(36 61),(32 65),(81 47),(88 58),(68 73),(49 95),(81 60),(87 50),
        (78 16),(79 21),(30 22),(78 43),(26 85),(48 34),(35 35),(36 40),(31 79),(83 29),(27 ↩
            84),(52 98),(72 95),(85 71),
        (75 84),(75 77),(81 29),(77 73),(41 42),(83 72),(23 36),(89 53),(27 57),(57 97),(27 ↩
            77),(39 88),(60 81),
        (80 72),(54 32),(55 26),(62 22),(70 20),(76 27),(84 35),(87 42),(82 54),(83 64),(69 ↩
            86),(60 90),(50 86),(43 80),(36 73),
        (36 68),(40 75),(24 67),(23 60),(26 44),(28 33),(40 32),(43 19),(65 16),(73 16),(38 ↩
            46),(31 59),(34 86),(45 90),(64 97))'::geometry, allow_holes => true));
```

```
POLYGON((89 53,91 50,87 42,90 30,88 29,84 19,78 16,73 16,65 16,53 18,43 19,37 23,30 22,28 ↩
    33,23 36,26 44,27 54,23 60,24 67,27 77,24 82,26 85,34 86,39 88,45 90,49 95,52 98,57 ↩
    97,64 97,72 95,76 88,75 84,75 77,83 72,85 71,83 64,88 58,89 53),(36 61,36 68,40 75,43 ↩
    80,50 86,60 81,68 73,77 67,81 60,82 54,81 47,78 43,81 29,76 27,70 20,62 22,55 26,54 ↩
    32,48 34,44 42,38 46,36 61))
```

⊠⊠

ST_ConcaveHull, CG_AlphaShape

8.3.31 CG_OptimalConvexPartition

CG_OptimalConvexPartition — Computes an optimal convex partition of the polygon geometry

Synopsis

geometry **CG_OptimalConvexPartition**(geometry geom);

⊠⊠

Computes an optimal convex partition of the polygon geometry.

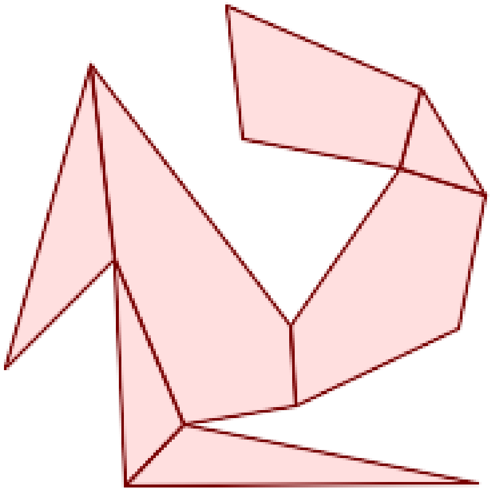
> **Note**
> A partition of a polygon P is a set of polygons such that the interiors of the polygons do not intersect and the union of the polygons is equal to the interior of the original polygon P. CG_OptimalConvexPartition produces a partition that is optimal in the number of pieces.

Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0

This method needs SFCGAL backend.

⊠⊠



Optimal Convex Partition (same example As CG_YMonotonePartition, CG_ApproxConvexPartition and CG_GreeneApproxConvexPartition)

```
SELECT ST_AsText(CG_OptimalConvexPartition('POLYGON((156 150,83 181,89 131,148 120,107 ↩
    61,32 159,0 45,41 86,45 1,177 2,67 24,109 31,170 60,180 110,156 150))'::geometry));
```

```
GEOMETRYCOLLECTION(POLYGON((156 150,83 181,89 131,148 120,156 150)),POLYGON((32 159,0 45,41 ↩
     86,32 159)),POLYGON((45 1,177 2,67 24,45 1)),POLYGON((41 86,45 1,67 24,41 86)),POLYGON ↩
    ((107 61,32 159,41 86,67 24,109 31,107 61)),POLYGON((148 120,107 61,109 31,170 60,180  ↩
    110,148 120)),POLYGON((156 150,148 120,180 110,156 150)))
```

⊠⊠

CG_YMonotonePartition, CG_ApproxConvexPartition, CG_GreeneApproxConvexPartition

8.3.32 CG_StraightSkeleton

CG_StraightSkeleton — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (straight skeleton) ⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **CG_StraightSkeleton**(geometry geom, boolean use_distance_as_m = false);

⊠⊠

Availability: 3.5.0

Requires SFCGAL >= 1.3.8 for option use_distance_as_m

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

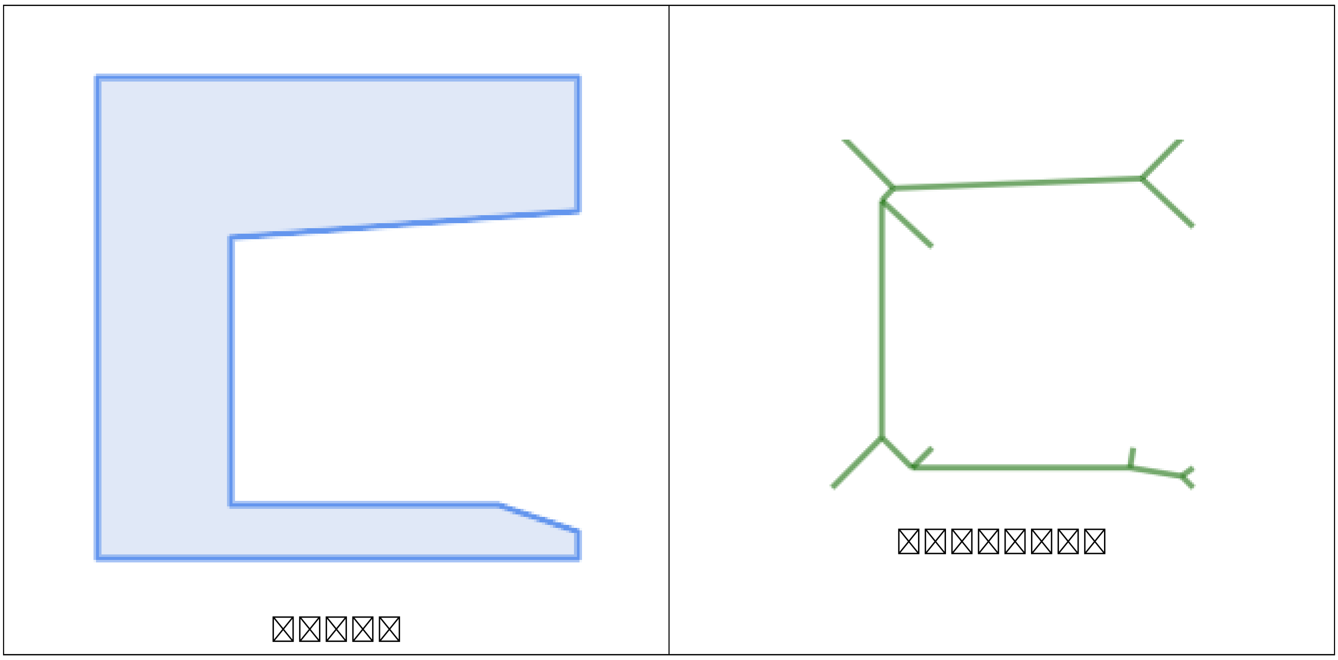
This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT CG_StraightSkeleton(ST_GeomFromText('POLYGON (( 190 190, 10 190, 10 10, 190 10, 190 ↩
    20, 160 30, 60 30, 60 130, 190 140, 190 190 ))'));
```

```
ST_AsText(CG_StraightSkeleton('POLYGON((0 0,1 0,1 1,0 1,0 0))', true);
```

```
MULTILINESTRING M ((0 0 0,0.5 0.5 0.5),(1 0 0,0.5 0.5 0.5),(1 1 0,0.5 0.5 0.5),(0 1 0,0.5 ↩
    0.5 0.5))
```



⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠

CG_ExtrudeStraightSkeleton

8.3.33 ST_StraightSkeleton

ST_StraightSkeleton — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (straight skeleton) ⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_StraightSkeleton**(geometry geom);

⊠⊠

> **Warning**
> ST_StraightSkeleton is deprecated as of 3.5.0. Use CG_StraightSkeleton instead.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

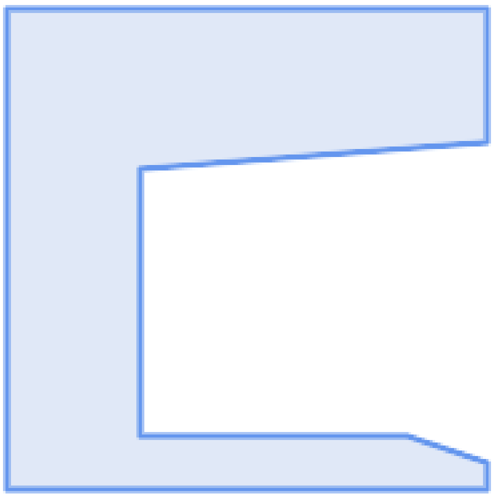
This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

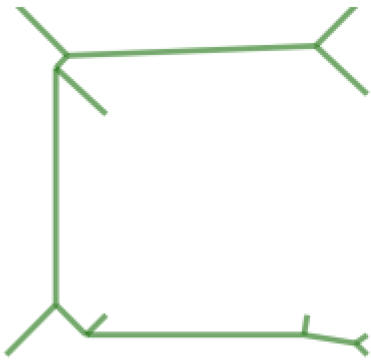
This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT ST_StraightSkeleton(ST_GeomFromText('POLYGON (( 190 190, 10 190, 10 10, 190 10, 190 20, 160 30, 60 30, 60 130, 190 140, 190 190 ))'));
```



⊠⊠⊠⊠⊠



⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠

CG_ExtrudeStraightSkeleton

8.3.34 ST_Tesselate

ST_Tesselate — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tessellation) ⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠ TIN ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Tesselate**(geometry geom);

⊠⊠

Warning
ST_Tesselate is deprecated as of 3.5.0. Use CG_Tesselate instead.

[⊠⊠] ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠) ⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

Note
ST_TriangulatePolygon does similar to this function except that it returns a geometry collection of polygons instead of a TIN and also only works with 2D geometries.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.35 CG_Tesselate

CG_Tesselate — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tessellation) ⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠ TIN ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

Synopsis

geometry **CG_Tesselate**(geometry geom);

⊠⊠

[⊠⊠] ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠) ⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

> **Note**
> ST_TriangulatePolygon does similar to this function except that it returns a geometry collection of polygons instead of a TIN and also only works with 2D geometries.

Availability: 3.5.0

This method needs SFCGAL backend.

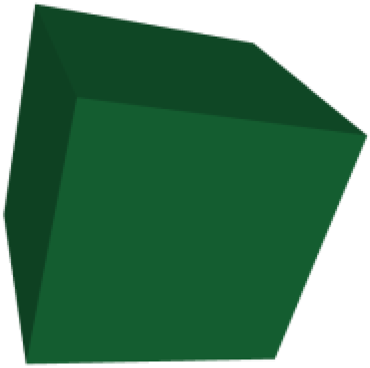
This function supports 3d and will not drop the z-index.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT ST_GeomFromText('POLYHEDRALSURFACE ↩
     Z( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
                                    ((0 0 ↩
     0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
                                    ((1 1 ↩
     0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
                                    ((0 1 ↩
     0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )');
```



☒☒☒☒☒☒

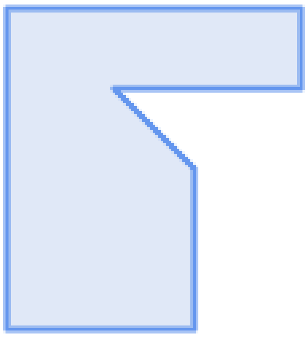
```
SELECT CG_Tesselate(ST_GeomFromText(' ↩
    POLYHEDRALSURFACE Z( ((0 0 0, 0 0 1, 0 1 1, 0 1
                                    ((0 0 0,  ↩
    0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1
                                    ((1 1 0,  ↩
    1 1 1, 1 0 1, 1 0 0, 1 1 0)),
                                    ((0 1 0,  ↩
    0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1
```

ST_AsText ☒☒☒:

```
TIN Z (((0 0 0,0 0 1,0 1 1,0 0 0)),((0 1  ↩
    0,0 0 0,0 1 1,0 1 0)),
                        ((0 0 0,0 1 0,1 1 ↩
     0,0 0 0)),
                        ((1 0 0,0 0 0,1 1 ↩
     0,1 0 0)),((0 0 1,1 0 0,1 0 1,0 0 1)),
                        ((0 0 1,0 0 0,1 0 ↩
     0,0 0 1)),
                        ((1 1 0,1 1 1,1 0 ↩
     1,1 1 0)),((1 0 0,1 1 0,1 0 1,1 0 0)),
                        ((0 1 0,0 1 1,1 1 ↩
     1,0 1 0)),((1 1 0,0 1 0,1 1 1,1 1 0)),
                        ((0 1 1,1 0 1,1 1 ↩
     1,0 1 1)),((0 1 1,0 0 1,1 0 1,0 1 1)))
```

☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒

```
SELECT 'POLYGON (( 10 190, 10 70, 80 70,
    80 130, 50 160, 120 160, 120 190, 10 190 ))'::geometry;
```

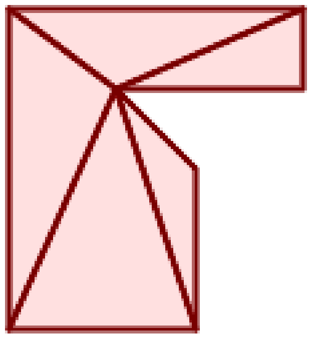


⊠⊠⊠⊠⊠

```
SELECT
                    CG_Tesselate('
    POLYGON (( 10 190, 10 70, 80 70, 80 130, 50 160,
    ;
```

ST_AsText ⊠⊠⊠:

```
TIN(((80 130,50 160,80 70,80 130)),((50
    160,10 190,10 70,50 160)),
                ((80 70,50 160,10 70,80
    70)),((120 160,120 190,50 160,120 160)),
                ((120 190,10 190,50
    160,120 190)))
```



⊠⊠⊠⊠⊠⊠⊠

⊠⊠

CG_ConstrainedDelaunayTriangles, ST_DelaunayTriangles, ST_TriangulatePolygon

8.3.36 CG_Triangulate

CG_Triangulate — Triangulates a polygonal geometry

Synopsis

geometry **CG_Triangulate**(geometry geom);

⊠⊠

Triangulates a polygonal geometry.

Performed by the SFCGAL module

Note
NOTE: this function returns a geometry representing the triangulated result.

Availability: 3.5.0

This method needs SFCGAL backend.

⊠⊠⊠⊠

```
SELECT CG_Triangulate('POLYGON((0.0 0.0,1.0 0.0,1.0 1.0,0.0 1.0,0.0 0.0),(0.2 0.2,0.2 
    0.8,0.8 0.8,0.8 0.2,0.2 0.2))');
                cg_triangulate
                ----------------
                TIN(((0.8 0.2,0.2 0.2,1 0,0.8 0.2)),((0.2 0.2,0 0,1 0,0.2 0.2)),((1 1,0.8 
                    0.8,0.8 0.2,1 1)),((0 1,0 0,0.2 0.2,0 1)),((0 1,0.2 0.8,1 1,0 1)),((0 
                    1,0.2 0.2,0.2 0.8,0 1)),((0.2 0.8,0.8 0.8,1 1,0.2 0.8)),((0.2 0.8,0.2 
                    0.2,0.8 0.2,0.2 0.8)),((1 1,0.8 0.2,1 0,1 1)),((0.8 0.8,0.2 0.8,0.8 
                    0.2,0.8 0.8)))

                (1 row)
```

⊠⊠

CG_ConstrainedDelaunayTriangles, ST_DelaunayTriangles, ST_TriangulatePolygon

8.3.37 CG_Visibility

CG_Visibility — Compute a visibility polygon from a point or a segment in a polygon geometry

Synopsis

geometry **CG_Visibility**(geometry polygon, geometry point);
geometry **CG_Visibility**(geometry polygon, geometry pointA, geometry pointB);

⊠⊠

Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0

This method needs SFCGAL backend.

This function supports 3d and will not drop the z-index.

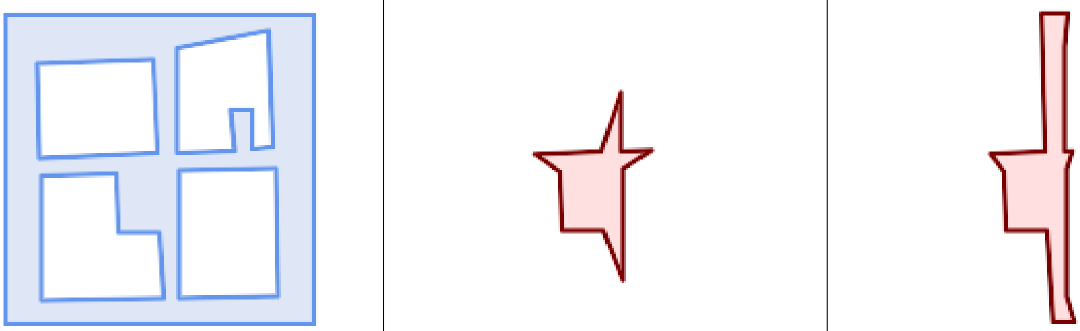
This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠⊠

```
SELECT CG_Visibility('POLYGON((23.5 23.5,23.5 173.5,173.5 173.5,173.5 23.5,23.5 23.5),(108 98,108 36,156 37,155 99,108 98),(107 157.5,107 106.5,135 107.5,133 127.5,143.5 127.5,143.5 108.5,153.5 109.5,151.5 166,107 157.5),(41 95.5,41 35,100.5 36,98.5 68,78.5 68,77.5 96.5,41 95.5),(39 150,40 104,97.5 106.5,95.5 152,39 150))'::geometry, 'POINT(91 87)'::geometry);
```

```
SELECT CG_Visibility('POLYGON((23.5 23.5,23.5 173.5,173.5 173.5,173.5 23.5,23.5 23.5),(108 98,108 36,156 37,155 99,108 98),(107 157.5,107 106.5,135 107.5,133 127.5,143.5 127.5,143.5 108.5,153.5 109.5,151.5 166,107 157.5),(41 95.5,41 35,100.5 36,98.5 68,78.5 68,77.5 96.5,41 95.5),(39 150,40 104,97.5 106.5,95.5 152,39 150))'::geometry,'POINT(78.5 68)'::geometry, 'POINT(98.5 68)'::geometry);
```



⊠⊠⊠⊠⊠ | *Visibility from the point* | *Visibility from the segment*

8.3.38 CG_YMonotonePartition

CG_YMonotonePartition — Computes y-monotone partition of the polygon geometry

Synopsis

geometry **CG_YMonotonePartition**(geometry geom);

⊠⊠

Computes y-monotone partition of the polygon geometry.

> **Note**
> A partition of a polygon P is a set of polygons such that the interiors of the polygons do not intersect and the union of the polygons is equal to the interior of the original polygon P. A y-monotone polygon is a polygon whose vertices v1,⋯,vn can be divided into two chains v1,⋯,vk and vk,⋯,vn,v1, such that any horizontal line intersects either chain at most once. This algorithm does not guarantee a bound on the number of polygons produced with respect to the optimal number.

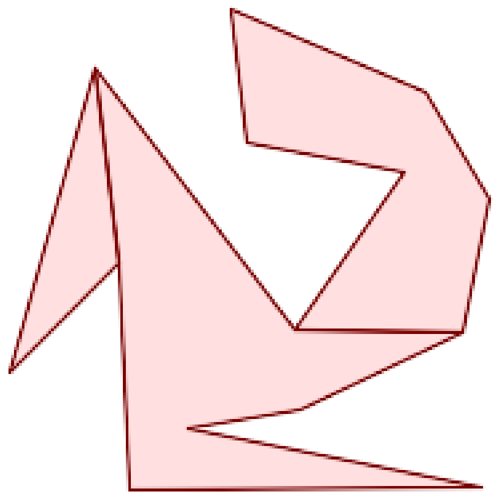
Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0

This method needs SFCGAL backend.

⊠⊠

⊠⊠⊠⊠⊠



Y-Monotone Partition (same example As CG_ApproxConvexPartition, CG_GreeneApproxConvexPartition and CG_OptimalConvexPartition)

```
SELECT ST_AsText(CG_YMonotonePartition('POLYGON((156 150,83 181,89 131,148 120,107 61,32 159,0 45,41 86,45 1,177 2,67 24,109 31,170 60,180 110,156 150))'::geometry));
```

```
GEOMETRYCOLLECTION(POLYGON((32 159,0 45,41 86,32 159)),POLYGON((107 61,32 159,41 86,45 1,177 2,67 24,109 31,170 60,107 61)),POLYGON((156 150,83 181,89 131,148 120,107 61,170 60,180 110,156 150)))
```

⊠⊠

CG_ApproxConvexPartition, CG_GreeneApproxConvexPartition, CG_OptimalConvexPartition

Chapter 9

⊠⊠ (topology)

PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (face), ⊠⊠⊠⊠ (edge), ⊠⊠ (node) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Sandro Santilli's presentation at PostGIS Day Paris 2011 conference gives a good synopsis of PostGIS Topology and where it is headed Topology with PostGIS 2.0 slide deck.

Vincent Picavet provides a good synopsis and overview of what is Topology, how is it used, and various FOSS4G tools that support it in PostGIS Topology PGConf EU 2012.

⊠⊠⊠⊠⊠⊠ GIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ US Census Topologically Integrated Geographic Encoding and Referencing System (TIGER) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠, Topology_Load_Tiger ⊠⊠⊠⊠⊠⊠⊠⊠.

PostGIS ⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 2.0.0 ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, SQL-MM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS Topology Wiki ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `topology` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

SQL/MM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Topology support is build by default starting with PostGIS 2.0, and can be disabled specifying --without-topology configure option at build time as described in Chapter 2

9.1 ⊠⊠⊠⊠

9.1.1 getfaceedges_returntype

getfaceedges_returntype — A composite type that consists of a sequence number and an edge number.

⊠⊠

A composite type that consists of a sequence number and an edge number. This is the return type for `ST_GetFaceEdges` and `GetNodeEdges` functions.

1. `sequence` ⊠⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.
2. `edge` ⊠⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

9.1.2 TopoGeometry

TopoGeometry — A composite type representing a topologically defined geometry.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TopoGeometry ⊠⊠⊠⊠ ⊠⊠⊠⊠ topology_id, layer_id, id, type ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1. `topology_id` ⊠⊠⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
2. `layer_id` ⊠⊠⊠⊠⊠⊠⊠⊠: TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ layer_id ⊠⊠⊠. topology_id ⊠ layer_id ⊠⊠⊠⊠⊠⊠ topology.layers ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (unique reference) ⊠⊠⊠⊠⊠⊠⊠.
3. `id` ⊠⊠⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
4. 1 ⊠⊠ 4 ⊠⊠⊠ `type` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1: [⊠⊠] ⊠⊠⊠, 2: [⊠⊠] ⊠⊠, 3: [⊠⊠] ⊠⊠⊠, 4: ⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠

⊠⊠⊠.

⊠⊠⊠⊠⊠⊠	⊠⊠
⊠⊠	⊠⊠⊠

⊠⊠

CreateTopoGeom

9.1.3 validatetopology_returntype

validatetopology_returntype — A composite type that consists of an error message and id1 and id2 to denote location of error. This is the return type for `ValidateTopology`.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ValidateTopology ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠ id1 ⊠ id2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1. `error` ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (varchar) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

   ⊠⊠⊠⊠⊠⊠⊠⊠ (descriptor) ⊠⊠⊠⊠⊠⊠⊠⊠⊠: coincident nodes(⊠⊠⊠⊠⊠⊠⊠), edge crosses node(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠), edge not simple(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠), edge end node geometry mismatch(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠), edge start node geometry mismatch(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠), face overlaps face(⊠⊠⊠⊠⊠⊠⊠), face within face(⊠⊠⊠⊠⊠⊠⊠)
2. `id1` ⊠⊠⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (edge)/⊠⊠ (face)/⊠⊠ (node) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
3. `id2` ⊠⊠⊠⊠⊠⊠⊠⊠: ⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ValidateTopology

9.2 ⊠⊠⊠⊠⊠

9.2.1 TopoElement

TopoElement — ⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ TopoGeometry ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (topological primitive) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠ (1: node, 2: edge, 3: face) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠, ⊠⊠ TopoGeometry ⊠ ⊠⊠⊠⊠⊠⊠⊠ topology.layer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT te[1] AS id, te[2] AS type FROM
( SELECT ARRAY[1,2]::topology.topoelement AS te ) f;
 id | type
----+------
  1 |    2
```

```
SELECT ARRAY[1,2]::topology.topoelement;
  te
-------
 {1,2}
```

```
--Example of what happens when you try to case a 3 element array to topoelement
-- NOTE: topoement has to be a 2 element array so fails dimension check
SELECT ARRAY[1,2,3]::topology.topoelement;
ERROR:  value for domain topology.topoelement violates check constraint "dimensions"
```

⊠⊠

GetTopoGeomElements, TopoElementArray, TopoGeometry, TopoGeom_addElement, TopoGeom_remEleme

9.2.2 TopoElementArray

TopoElementArray — An array of TopoElement objects.

□□

1 □□□□ TopoElement □□□□□□□, □□□□□ TopoElement □□□□□□□□□□□□□□□□□□.

□□

```
SELECT '{{1,2},{4,3}}'::topology.topoelementarray As tea;
  tea
-------
{{1,2},{4,3}}

-- more verbose equivalent --
SELECT ARRAY[ARRAY[1,2], ARRAY[4,3]]::topology.topoelementarray As tea;

  tea
-------
{{1,2},{4,3}}

--using the array agg function packaged with topology --
SELECT topology.TopoElementArray_Agg(ARRAY[e,t]) As tea
  FROM generate_series(1,4) As e CROSS JOIN generate_series(1,3) As t;
  tea
--------------------------------------------------------------------------
{{1,1},{1,2},{1,3},{2,1},{2,2},{2,3},{3,1},{3,2},{3,3},{4,1},{4,2},{4,3}}
```

```
SELECT '{{1,2,4},{3,4,5}}'::topology.topoelementarray As tea;
ERROR:  value for domain topology.topoelementarray violates check constraint ”dimensions”
```

□□

TopoElement, GetTopoGeomElementArray, TopoElementArray_Agg

9.3 □□□ TopoGeometry □□

9.3.1 AddTopoGeometryColumn

AddTopoGeometryColumn — □□□□□□ TopoGeometry □□□□□□, topology.layer □□□□□□□□ □□□□□, □ layer_id □□□□□□.

Synopsis

integer **AddTopoGeometryColumn**(varchar topology_name, varchar schema_name, varchar table_name, varchar column_name, varchar feature_type);
integer **AddTopoGeometryColumn**(varchar topology_name, varchar schema_name, varchar table_name, varchar column_name, varchar feature_type, integer child_layer);

□□

□ TopoGeometry □□□□□□□□□□□□□□□□□□□□□. TopoGeometry □□□□□□□□□□□□□ □□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□. AddTopoGeometryColumn() □□□□□□□□□□□□□□□□□□□□□□□□□:

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ topology.layer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

[child_layer] ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠ NULL ⊠⊠⊠⊠) ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (child_layer ⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠) ⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (AddTopoGeometryColumn ⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Valid `feature_types` are: POINT, MULTIPOINT, LINE, MULTILINE, POLYGON, MULTIPOLYGON, COLLECTION

Availability: 1.1

⊠⊠

```
-- Note for this example we created our new table in the ma_topo schema
-- though we could have created it in a different schema -- in which case topology_name and ↩
    schema_name would be different
CREATE SCHEMA ma;
CREATE TABLE ma.parcels(gid serial, parcel_id varchar(20) PRIMARY KEY, address text);
SELECT topology.AddTopoGeometryColumn('ma_topo', 'ma', 'parcels', 'topo', 'POLYGON');
```

```
CREATE SCHEMA ri;
CREATE TABLE ri.roads(gid serial PRIMARY KEY, road_name text);
SELECT topology.AddTopoGeometryColumn('ri_topo', 'ri', 'roads', 'topo', 'LINE');
```

⊠⊠

DropTopoGeometryColumn, toTopoGeom, CreateTopology, CreateTopoGeom

9.3.2 RenameTopoGeometryColumn

RenameTopoGeometryColumn — Renames a topogeometry column

Synopsis

topology.layer **RenameTopoGeometryColumn**(regclass layer_table, name feature_column, name new_nam

⊠⊠

This function changes the name of an existing TopoGeometry column ensuring metadata information about it is updated accordingly.

Availability: 3.4.0

⊠⊠

```
SELECT topology.RenameTopoGeometryColumn('public.parcels', 'topogeom', 'tgeom');
```

⊠⊠

AddTopoGeometryColumn, RenameTopology

9.3.3 DropTopology

DropTopology — ⊠⊠⊠⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **DropTopology**(varchar topology_schema_name);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1

⊠⊠

ma_topo ⊠⊠⊠⊠⊠⊠⊠⊠ topology.topology ⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT topology.DropTopology('ma_topo');
```

⊠⊠

DropTopoGeometryColumn

9.3.4 RenameTopology

RenameTopology — Renames a topology

Synopsis

varchar **RenameTopology**(varchar old_name, varchar new_name);

⊠⊠

Renames a topology schema, updating its metadata record in the `topology.topology` table.

Availability: 3.4.0

⊠⊠

Rename a topology from `topo_stage` to `topo_prod`.

```
SELECT topology.RenameTopology('topo_stage', 'topo_prod');
```

⊠⊠

CopyTopology, RenameTopoGeometryColumn

9.3.5 DropTopoGeometryColumn

DropTopoGeometryColumn — `schema_name` ⊠⊠⊠⊠⊠ `table_name` ⊠⊠⊠⊠⊠⊠⊠⊠ Topogeometry ⊠⊠⊠⊠⊠⊠ topology.layer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **DropTopoGeometryColumn**(varchar schema_name, varchar table_name, varchar column_name);

⊠⊠

`schema_name` ⊠⊠⊠⊠⊠ `table_name` ⊠⊠⊠⊠⊠⊠⊠⊠ Topogeometry ⊠⊠⊠⊠⊠⊠ topology.layer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠.

Availability: 1.1

⊠⊠

```
SELECT topology.DropTopoGeometryColumn('ma_topo', 'parcel_topo', 'topo');
```

⊠⊠

AddTopoGeometryColumn

9.3.6 Populate_Topology_Layer

Populate_Topology_Layer — Adds missing entries to topology.layer table by reading metadata from topo tables.

Synopsis

setof record **Populate_Topology_Layer**();

⊠⊠

Adds missing entries to the `topology.layer` table by inspecting topology constraints on tables. This function is useful for fixing up entries in topology catalog after restores of schemas with topo data.

It returns the list of entries created. Returned columns are `schema_name`, `table_name`, `feature_column`.

2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT CreateTopology('strk_topo');
CREATE SCHEMA strk;
CREATE TABLE strk.parcels(gid serial, parcel_id varchar(20) PRIMARY KEY, address text);
SELECT topology.AddTopoGeometryColumn('strk_topo', 'strk', 'parcels', 'topo', 'POLYGON');
-- this will return no records because this feature is already registered
SELECT *
  FROM topology.Populate_Topology_Layer();

-- let's rebuild
TRUNCATE TABLE topology.layer;

SELECT *
  FROM topology.Populate_Topology_Layer();

SELECT topology_id,layer_id, schema_name As sn, table_name As tn, feature_column As fc
FROM topology.layer;
```

```
schema_name | table_name | feature_column
-------------+------------+----------------
 strk        | parcels    | topo
(1 row)

 topology_id | layer_id |  sn  |    tn    |  fc
-------------+----------+------+---------+------
           2 |        2 | strk | parcels | topo
(1 row)
```

⊠⊠

AddTopoGeometryColumn

9.3.7 TopologySummary

TopologySummary — Takes a topology name and provides summary totals of types of objects in topology.

Synopsis

text **TopologySummary**(varchar topology_schema_name);

☒☒

Takes a topology name and provides summary totals of types of objects in topology.

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
SELECT topology.topologysummary('city_data');
                    topologysummary
--------------------------------------------------------
 Topology city_data (329), SRID 4326, precision: 0
 22 nodes, 24 edges, 10 faces, 29 topogeoms in 5 layers
 Layer 1, type Polygonal (3), 9 topogeoms
  Deploy: features.land_parcels.feature
 Layer 2, type Puntal (1), 8 topogeoms
  Deploy: features.traffic_signs.feature
 Layer 3, type Lineal (2), 8 topogeoms
  Deploy: features.city_streets.feature
 Layer 4, type Polygonal (3), 3 topogeoms
  Hierarchy level 1, child layer 1
  Deploy: features.big_parcels.feature
 Layer 5, type Puntal (1), 1 topogeoms
  Hierarchy level 1, child layer 2
  Deploy: features.big_signs.feature
```

☒☒

Topology_Load_Tiger

9.3.8 ValidateTopology

ValidateTopology — Returns a set of validatetopology_returntype objects detailing issues with topology.

Synopsis

setof validatetopology_returntype **ValidateTopology**(varchar toponame, geometry bbox);

☒☒

Returns a set of validatetopology_returntype objects detailing issues with topology, optionally limiting the check to the area specified by the `bbox` parameter.

List of possible errors, what they mean and what the returned ids represent are displayed below:

☒☒	**id1**	**id2**	**Meaning**
coincident nodes	Identifier of first node.	Identifier of second node.	Two nodes have the same geometry.
edge crosses node(☒☒☒☒☒☒☒☒☒☒☒☒)	Identifier of the edge.	Identifier of the node.	An edge has a node in its interior. See ST_Relate.

⊠⊠	id1	id2	Meaning
invalid edge(⊠⊠⊠⊠⊠⊠⊠⊠⊠)	Identifier of the edge.		An edge geometry is invalid. See ST_IsValid.
edge not simple(⊠⊠⊠⊠⊠⊠⊠⊠⊠)	Identifier of the edge.		An edge geometry has self-intersections. See ST_IsSimple.
edge crosses edge(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠)	Identifier of first edge.	Identifier of second edge.	Two edges have an interior intersection. See ST_Relate.
edge start node geometry mismatch(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠)	Identifier of the edge.	Identifier of the indicated start node.	The geometry of the node indicated as the starting node for an edge does not match the first point of the edge geometry. See ST_StartPoint.
edge end node geometry mismatch(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠)	Identifier of the edge.	Identifier of the indicated end node.	The geometry of the node indicated as the ending node for an edge does not match the last point of the edge geometry. See ST_EndPoint.
face without edges(⊠⊠⊠⊠⊠⊠⊠⊠)	Identifier of the orphaned face.		No edge reports an existing face on either of its sides (left_face, right_face).
face has no rings(⊠⊠⊠⊠⊠⊠⊠)	Identifier of the partially-defined face.		Edges reporting a face on their sides do not form a ring.
face has wrong mbr	Identifier of the face with wrong mbr cache.		Minimum bounding rectangle of a face does not match minimum bounding box of the collection of edges reporting the face on their sides.
hole not in advertised face	Signed identifier of an edge, identifying the ring. See GetRingEdges.		A ring of edges reporting a face on its exterior is contained in different face.
not-isolated node has not- containing_face	Identifier of the ill-defined node.		A node which is reported as being on the boundary of one or more edges is indicating a containing face.
isolated node has containing_face	Identifier of the ill-defined node.		A node which is not reported as being on the boundary of any edges is lacking the indication of a containing face.

⊠⊠	id1	id2	Meaning
isolated node has wrong containing_face	Identifier of the misrepresented node.		A node which is not reported as being on the boundary of any edges indicates a containing face which is not the actual face containing it. See GetFaceContaining-Point.
invalid next_right_edge	Identifier of the misrepresented edge.	Signed id of the edge which should be indicated as the next right edge.	The edge indicated as the next edge encountered walking on the right side of an edge is wrong.
invalid next_left_edge	Identifier of the misrepresented edge.	Signed id of the edge which should be indicated as the next left edge.	The edge indicated as the next edge encountered walking on the left side of an edge is wrong.
mixed face labeling in ring	Signed identifier of an edge, identifying the ring. See GetRingEdges.		Edges in a ring indicate conflicting faces on the walking side. This is also known as a ”Side Location Conflict”.
non-closed ring	Signed identifier of an edge, identifying the ring. See GetRingEdges.		A ring of edges formed by following next_left_edge/next_right_edg attributes starts and ends on different nodes.
face has multiple shells	Identifier of the contended face.	Signed identifier of an edge, identifying the ring. See GetRingEdges.	More than a one ring of edges indicate the same face on its interior.

1.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (false positive) ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠’edge crosses node’ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ id1 ⊠ id2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠.

Changed: 3.2.0 added optional bbox parameter, perform face labeling and edge linking checks.

⊠⊠

```
SELECT * FROM  topology.ValidateTopology('ma_topo');
      error        | id1 | id2
-------------------+-----+-----
face without edges |   1 |
```

⊠⊠

validatetopology_returntype, Topology_Load_Tiger

9.3.9 ValidateTopologyRelation

ValidateTopologyRelation — Returns info about invalid topology relation records

Synopsis

setof record **ValidateTopologyRelation**(varchar toponame);

⊠⊠

Returns a set records giving information about invalidities in the relation table of the topology.

Availability: 3.2.0

⊠⊠

ValidateTopology

9.3.10 FindTopology

FindTopology — Returns a topology record by different means.

Synopsis

topology **FindTopology**(TopoGeometry topogeom);
topology **FindTopology**(regclass layerTable, name layerColumn);
topology **FindTopology**(name layerSchema, name layerTable, name layerColumn);
topology **FindTopology**(text topoName);
topology **FindTopology**(int id);

⊠⊠

Takes a topology identifier or the identifier of a topology-related object and returns a topology.topology record.

Availability: 3.2.0

⊠⊠

```
SELECT name(findTopology('features.land_parcels', 'feature'));
   name
-----------
 city_data
(1 row)
```

⊠⊠

FindLayer

9.3.11 FindLayer

FindLayer — Returns a topology.layer record by different means.

Synopsis

topology.layer **FindLayer**(TopoGeometry tg);
topology.layer **FindLayer**(regclass layer_table, name feature_column);
topology.layer **FindLayer**(name schema_name, name table_name, name feature_column);
topology.layer **FindLayer**(integer topology_id, integer layer_id);

☒☒

Takes a layer identifier or the identifier of a topology-related object and returns a topology.layer record.

Availability: 3.2.0

☒☒

```
SELECT layer_id(findLayer('features.land_parcels', 'feature'));
 layer_id
----------
        1
(1 row)
```

☒☒

FindTopology

9.4 Topology Statistics Management

Adding elements to a topology triggers many database queries for finding existing edges that will be split, adding nodes and updating edges that will node with the new linework. For this reason it is useful that statistics about the data in the topology tables are up-to-date.

PostGIS Topology population and editing functions do not automatically update the statistics because a updating stats after each and every change in a topology would be overkill, so it is the caller's duty to take care of that.

> **Note**
> That the statistics updated by autovacuum will NOT be visible to transactions which started before autovacuum process completed, so long-running transactions will need to run ANALYZE themselves, to use updated statistics.

9.5 ☒☒☒☒☒

9.5.1 CreateTopology

CreateTopology — Creates a new topology schema and registers it in the topology.topology table.

Synopsis

integer **CreateTopology**(varchar topology_schema_name);
integer **CreateTopology**(varchar topology_schema_name, integer srid);
integer **CreateTopology**(varchar topology_schema_name, integer srid, double precision prec);
integer **CreateTopology**(varchar topology_schema_name, integer srid, double precision prec, boolean hasz);

⊠⊠

Creates a new topology schema with name `topology_name` and registers it in the `topology.topology` table. Topologies must be uniquely named. The topology tables (`edge_data`, `face`, `node`,and `relation` are created in the schema. It returns the id of the topology.

The `srid` is the spatial reference system SRID for the topology.

The tolerance `prec` is measured in the units of the spatial reference system. The tolerance defaults to 0.

`hasz` defaults to false if not specified.

This is similar to the SQL/MM ST_InitTopoGeo but has more functionality.

Availability: 1.1

Enhanced: 2.0 added the signature accepting hasZ

⊠⊠

Create a topology schema called `ma_topo` that stores edges and nodes in Massachusetts State Plane-meters (SRID = 26986). The tolerance represents 0.5 meters since the spatial reference system is meter-based.

```
SELECT topology.CreateTopology('ma_topo', 26986, 0.5);
```

Create a topology for Rhode Island called `ri_topo` in spatial reference system State Plane-feet (SRID = 3438)

```
SELECT topology.CreateTopology('ri_topo', 3438) AS topoid;
topoid
------
2
```

⊠⊠

Section 4.5, ST_InitTopoGeo, Topology_Load_Tiger

9.5.2 CopyTopology

CopyTopology — Makes a copy of a topology (nodes, edges, faces, layers and TopoGeometries) into a new schema

Synopsis

integer **CopyTopology**(varchar existing_topology_name, varchar new_name);

⊠⊠

Creates a new topology with name `new_name`, with SRID and precision copied from `existing_topology_name`. The nodes, edges and faces in `existing_topology_name` are copied into the new topology, as well as Layers and their associated TopoGeometries.

> **Note**
> The new rows in the `topology.layer` table contain synthetic values for schema_name, table_name and feature_column. This is because the TopoGeometry objects exist only as a definition and are not yet available in a user-defined table.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

Make a backup of a topology called `ma_topo`.

```
SELECT topology.CopyTopology('ma_topo', 'ma_topo_backup');
```

⊠⊠

Section 4.5, CreateTopology, RenameTopology

9.5.3 ST_InitTopoGeo

ST_InitTopoGeo — Creates a new topology schema and registers it in the topology.topology table.

Synopsis

text **ST_InitTopoGeo**(varchar topology_schema_name);

⊠⊠

This is the SQL-MM equivalent of CreateTopology. It lacks options for spatial reference system and tolerance. it returns a text description of the topology creation, instead of the topology id.

Availability: 1.1

This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.17

⊠⊠

```
SELECT topology.ST_InitTopoGeo('topo_schema_to_create') AS topocreation;
                      astopocreation
------------------------------------------------------------
 Topology-Geometry 'topo_schema_to_create' (id:7) created.
```

⊠⊠

CreateTopology

9.5.4 ST_CreateTopoGeo

ST_CreateTopoGeo — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.

Synopsis

text **ST_CreateTopoGeo**(varchar atopology, geometry acollection);

⊠⊠

⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details -- X.3.18

⊠⊠

```
-- Populate topology --
SELECT topology.ST_CreateTopoGeo('ri_topo',
 ST_GeomFromText('MULTILINESTRING((384744 236928,384750 236923,384769 236911,384799 236895,384811 236890,384833 236884,
  384844 236882,384866 236881,384879 236883,384954 236898,385087 236932,385117 236938,
  385167 236938,385203 236941,385224 236946,385233 236950,385241 236956,385254 236971,
  385260 236979,385268 236999,385273 237018,385273 237037,385271 237047,385267 237057,
  385225 237125,385210 237144,385192 237161,385167 237192,385162 237202,385159 237214,
  385159 237227,385162 237241,385166 237256,385196 237324,385209 237345,385234 237375,
  385237 237383,385238 237399,385236 237407,385227 237419,385213 237430,385193 237439,
  385174 237451,385170 237455,385169 237460,385171 237475,385181 237503,385190 237521,
  385200 237533,385206 237538,385213 237541,385221 237542,385235 237540,385242 237541,
  385249 237544,385260 237555,385270 237570,385289 237584,385292 237589,385291 237596,385284 237630))',3438)
  );

      st_createtopogeo
----------------------------
 Topology ri_topo populated


-- create tables and topo geometries --
CREATE TABLE ri.roads(gid serial PRIMARY KEY, road_name text);

SELECT topology.AddTopoGeometryColumn('ri_topo', 'ri', 'roads', 'topo', 'LINE');
```

⊠⊠

TopoGeo_LoadGeometry, AddTopoGeometryColumn, CreateTopology, DropTopology

9.5.5 TopoGeo_AddPoint

TopoGeo_AddPoint — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (split) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠.

Synopsis

integer **TopoGeo_AddPoint**(varchar atopology, geometry apoint, float8 tolerance);

⊠⊠

Adds a point to an existing topology and returns its identifier. The given point will snap to existing nodes or edges within given tolerance. An existing edge may be split by the snapped point.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

TopoGeo_AddLineString, TopoGeo_AddPolygon, TopoGeo_LoadGeometry, AddNode, CreateTopology

9.5.6 TopoGeo_AddLineString

TopoGeo_AddLineString — Adds a linestring to an existing topology using a tolerance and possibly splitting existing edges/faces.

Synopsis

SETOF integer **TopoGeo_AddLineString**(varchar atopology, geometry aline, float8 tolerance);

⊠⊠

Adds a linestring to an existing topology and returns a set of signed edge identifiers forming it up (negative identifies mean the edge goes in the opposite direction of the input linestring). The given line will snap to existing nodes or edges within given tolerance. Existing edges and faces may be split by the line. New nodes and faces may be added.

> **Note**
> Updating statistics about topologies being loaded via this function is up to caller, see maintaining statistics during topology editing and population.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 3.2.0 added support for returning signed identifier.

⊠⊠

TopoGeo_AddPoint, TopoGeo_AddPolygon, TopoGeo_LoadGeometry, AddEdge, CreateTopology

9.5.7 TopoGeo_AddPolygon

TopoGeo_AddPolygon — Adds a polygon to an existing topology using a tolerance and possibly splitting existing edges/faces. Returns face identifiers.

Synopsis

SETOF integer **TopoGeo_AddPolygon**(varchar atopology, geometry apoly, float8 tolerance);

⊠⊠

Adds a polygon to an existing topology and returns a set of face identifiers forming it up. The boundary of the given polygon will snap to existing nodes or edges within given tolerance. Existing edges and faces may be split by the boundary of the new polygon.

> **Note**
> Updating statistics about topologies being loaded via this function is up to caller, see maintaining statistics during topology editing and population.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

TopoGeo_AddPoint, TopoGeo_AddLineString, TopoGeo_LoadGeometry, AddFace, CreateTopology

9.5.8 TopoGeo_LoadGeometry

TopoGeo_LoadGeometry — Load a geometry into an existing topology, snapping and splitting as needed.

Synopsis

void **TopoGeo_LoadGeometry**(varchar atopology, geometry ageom, float8 tolerance);

⊠⊠

Loads a geometry into an existing topology. The given geometry will snap to existing nodes or edges within given tolerance. Existing edges and faces may be split as a consequence of the load.

> **Note**
> Updating statistics about topologies being loaded via this function is up to caller, see maintaining statistics during topology editing and population.

Availability: 3.5.0

⊠⊠

TopoGeo_AddPoint, TopoGeo_AddLineString, TopoGeo_AddPolygon, CreateTopology

9.6 ⊠⊠⊠⊠⊠

9.6.1 ST_AddIsoNode

ST_AddIsoNode — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (isolated) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_AddIsoNode**(varchar atopology, integer aface, geometry apoint);

⊠⊠

`atopology` ⊠⊠⊠ `aface` ID(faceid) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `apoint` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID(nodeid) ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRID) ⊠⊠⊠⊠⊠, `apoint` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`aface` ⊠ NULL ⊠⊠⊠⊠ `apoint` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1

This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X+1.3.1

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AddNode, CreateTopology, DropTopology, ST_Intersects

9.6.2 ST_AddIsoEdge

ST_AddIsoEdge — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `anode` ⊠ `anothernode` ⊠⊠⊠⊠⊠ `alinestring` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_AddIsoEdge**(varchar atopology, integer anode, integer anothernode, geometry alinestring);

☒☒

☒☒☒☒☒☒☒☒☒☒☒☒☒ anode ☒ anothernode ☒☒☒☒☒ alinestring ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ ☒☒☒☒☒☒☒☒☒ ID(edgeid) ☒☒☒☒☒☒.

alinestring ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (SRID) ☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒ NULL ☒☒☒, ☒☒☒ ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒.

alinestring ☒ anode ☒ anothernode ☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒.

anode ☒ anothernode ☒ alinestring ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Availability: 1.1

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.4

☒☒

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ST_AddIsoNode, ST_IsSimple, ST_Within

9.6.3 ST_AddEdgeNewFaces

ST_AddEdgeNewFaces — ☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒ ☒☒ 2 ☒☒☒☒☒☒☒☒.

Synopsis

integer **ST_AddEdgeNewFaces**(varchar atopology, integer anode, integer anothernode, geometry acurve);

☒☒

☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒ 2 ☒☒☒☒☒☒☒☒. ☒☒☒ ☒☒☒☒☒☒ ID ☒☒☒☒☒☒.

☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒☒ NULL ☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (☒☒☒☒☒☒☒☒☒☒☒ node ☒☒☒☒☒☒☒☒☒ ☒☒), acurve ☒ LINESTRING ☒☒☒☒☒, anode ☒ anothernode ☒ acurve ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ ☒☒☒☒☒☒☒.

acurve ☒☒☒☒☒☒☒☒☒☒☒☒☒ (SRID) ☒☒☒☒☒☒☒☒☒☒☒☒☒.

2.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.12

☒☒

☒☒

ST_RemEdgeNewFace

ST_AddEdgeModFace

9.6.4 ST_AddEdgeModFace

ST_AddEdgeModFace — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_AddEdgeModFace**(varchar atopology, integer anode, integer anothernode, geometry acurve);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠ (universe face) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ node ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠), acurve ⊠ LINESTRING ⊠⊠⊠⊠⊠, anode ⊠ anothernode ⊠ acurve ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

acurve ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRID) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.13

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⊠⊠

ST_RemEdgeModFace

ST_AddEdgeNewFaces

9.6.5 ST_RemEdgeNewFace

ST_RemEdgeNewFace — ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_RemEdgeNewFace**(varchar atopology, integer anedge);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Refuses to remove an edge participating in the definition of an existing TopoGeometry. Refuses to heal two faces if any TopoGeometry is defined by only one of them (and not the other).

⊠⊠⊠⊠⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `edge` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠), ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.14

⊠⊠

⊠⊠

ST_RemEdgeModFace

ST_AddEdgeNewFaces

9.6.6 ST_RemEdgeModFace

ST_RemEdgeModFace — Removes an edge, and if the edge separates two faces deletes one face and modifies the other face to cover the space of both.

Synopsis

integer **ST_RemEdgeModFace**(varchar atopology, integer anedge);

⊠⊠

Removes an edge, and if the removed edge separates two faces deletes one face and modifies the other face to cover the space of both. Preferentially keeps the face on the right, to be consistent with ST_AddEdgeModFace. Returns the id of the face which is preserved.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Refuses to remove an edge participating in the definition of an existing TopoGeometry. Refuses to heal two faces if any TopoGeometry is defined by only one of them (and not the other).

⊠⊠⊠⊠⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `edge` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠), ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.15

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⌧⌧

ST_AddEdgeModFace

ST_RemEdgeNewFace

9.6.7 ST_ChangeEdgeGeom

ST_ChangeEdgeGeom — ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

Synopsis

text **ST_ChangeEdgeGeom**(varchar atopology, integer anedge, geometry acurve);

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⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

If any arguments are null, the given edge does not exist in the `edge` table of the topology schema, the `acurve` is not a `LINESTRING`, or the modification would change the underlying topology then an error is thrown.

`acurve` ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (SRID) ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

⌧ `acurve` ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧.

⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

1.1.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

⌧⌧⌧⌧: 2.0.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details X.3.6

⌧⌧

```
SELECT topology.ST_ChangeEdgeGeom('ma_topo', 1,
                ST_GeomFromText('LINESTRING(227591.9 893900.4,227622.6 893844.3,227641.6 ↩
                    893816.6, 227704.5 893778.5)', 26986) );
 ----
 Edge 1 changed
```

⌧⌧

ST_AddEdgeModFace

ST_RemEdgeModFace

ST_ModEdgeSplit

9.6.8 ST_ModEdgeSplit

ST_ModEdgeSplit — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_ModEdgeSplit**(varchar atopology, integer anedge, geometry apoint);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1

⊠⊠⊠⊠: 2.0 ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ ST_ModEdgesSplit ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9

⊠⊠

```
-- Add an edge --
 SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227592 893910, 227600 ↩
     893910)', 26986) ) As edgeid;

-- edgeid-
3


-- Split the edge  --
SELECT topology.ST_ModEdgeSplit('ma_topo',  3, ST_SetSRID(ST_Point(227594,893910),26986)  ) ↩
     As node_id;
        node_id
-------------------------
7
```

⊠⊠

ST_NewEdgesSplit, ST_ModEdgeHeal, ST_NewEdgeHeal, AddEdge

9.6.9 ST_ModEdgeHeal

ST_ModEdgeHeal — Heals two edges by deleting the node connecting them, modifying the first edge and deleting the second edge. Returns the id of the deleted node.

Synopsis

int **ST_ModEdgeHeal**(varchar atopology, integer anedge, integer anotheredge);

⊠⊠

Heals two edges by deleting the node connecting them, modifying the first edge and deleting the second edge. Returns the id of the deleted node. Updates all existing joined edges and relationships accordingly.

2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9

⊠⊠

ST_ModEdgeSplit ST_NewEdgesSplit

9.6.10 ST_NewEdgeHeal

ST_NewEdgeHeal — Heals two edges by deleting the node connecting them, deleting both edges, and replacing them with an edge whose direction is the same as the first edge provided.

Synopsis

int **ST_NewEdgeHeal**(varchar atopology, integer anedge, integer anotheredge);

⊠⊠

Heals two edges by deleting the node connecting them, deleting both edges, and replacing them with an edge whose direction is the same as the first edge provided. Returns the id of the new edge replacing the healed ones. Updates all existing joined edges and relationships accordingly.

2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9

⊠⊠

ST_ModEdgeHeal ST_ModEdgeSplit ST_NewEdgesSplit

9.6.11 ST_MoveIsoNode

ST_MoveIsoNode — Moves an isolated node in a topology from one point to another. If new `apoint` geometry exists as a node an error is thrown. Returns description of move.

Synopsis

text **ST_MoveIsoNode**(varchar atopology, integer anode, geometry apoint);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ `apoint` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

If any arguments are null, the `apoint` is not a point, the existing node is not isolated (is a start or end point of an existing edge), new node location intersects an existing edge (even at the end points) or the new location is in a different face (since 3.2.0) then an exception is thrown.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRID) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 3.2.0 ensures the nod cannot be moved in a different face

This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X.3.2

⊠⊠

```
-- Add an isolated node with no face  --
SELECT topology.ST_AddIsoNode('ma_topo',  NULL, ST_GeomFromText('POINT(227579 893916)',  ↩
    26986) ) As nodeid;
 nodeid
--------
      7
-- Move the new node --
SELECT topology.ST_MoveIsoNode('ma_topo', 7,  ST_GeomFromText('POINT(227579.5 893916.5)',  ↩
    26986) ) As descrip;
                      descrip
----------------------------------------------------
Isolated Node 7 moved to location 227579.5,893916.5
```

⊠⊠

ST_AddIsoNode

9.6.12 ST_NewEdgesSplit

ST_NewEdgesSplit — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NewEdgesSplit**(varchar atopology, integer anedge, geometry apoint);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ `apoint` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID `anedge` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRID) ⊠⊠⊠⊠⊠, `apoint` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1

This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X.3.8

⊠⊠

```
-- Add an edge  --
SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227575 893917,227592 893900) ↩
    ', 26986) ) As edgeid;
-- result-
edgeid
------
        2
-- Split the new edge --
SELECT topology.ST_NewEdgesSplit('ma_topo', 2,  ST_GeomFromText('POINT(227578.5 893913.5)', ↩
     26986) ) As newnodeid;
 newnodeid
---------
       6
```

⊠⊠

ST_ModEdgeSplit ST_ModEdgeHeal ST_NewEdgeHeal AddEdge

9.6.13 ST_RemoveIsoNode

ST_RemoveIsoNode — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_RemoveIsoNode**(varchar atopology, integer anode);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X+1.3.3

⊠⊠

```
-- Remove an isolated node with no face  --
SELECT topology.ST_RemoveIsoNode('ma_topo',  7 ) As result;
         result
-------------------------
 Isolated node 7 removed
```

⊠⊠

ST_AddIsoNode

9.6.14 ST_RemoveIsoEdge

ST_RemoveIsoEdge — Removes an isolated edge and returns description of action. If the edge is not isolated, then an exception is thrown.

Synopsis

text **ST_RemoveIsoEdge**(varchar atopology, integer anedge);

⊠⊠

Removes an isolated edge and returns description of action. If the edge is not isolated, then an exception is thrown.

Availability: 1.1

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X+1.3.3

⊠⊠

```
-- Remove an isolated node with no face  --
SELECT topology.ST_RemoveIsoNode('ma_topo',  7 ) As result;
         result
-------------------------
 Isolated node 7 removed
```

⊠⊠

ST_AddIsoNode

9.7 ⊠⊠⊠⊠⊠

9.7.1 GetEdgeByPoint

GetEdgeByPoint — Finds the edge-id of an edge that intersects a given point.

Synopsis

integer **GetEdgeByPoint**(varchar atopology, geometry apoint, float8 tol1);

⊠⊠

Retrieves the id of an edge that intersects a Point.

⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (edgeid) ⊠⊠⊠⊠⊠⊠. tolerance = 0 ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

If `apoint` doesn't intersect an edge, returns 0 (zero).

If use tolerance > 0 and there is more than one edge near the point then an exception is thrown.

> **Note**
> ⊠⊠⊠⊠ tolerance = 0 ⊠⊠⊠ ST_Intersects ⊠, ⊠⊠⊠⊠⊠⊠⊠ ST_DWithin ⊠⊠⊠⊠⊠⊠.

GEOS ⊠⊠⊠⊠⊠

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠ AddEdge ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT topology.GetEdgeByPoint('ma_topo',geom, 1) As with1mtol, topology.GetEdgeByPoint(' ↩
    ma_topo',geom,0) As withnotol
FROM ST_GeomFromEWKT('SRID=26986;POINT(227622.6 893843)') As geom;
 with1mtol | withnotol
-----------+-----------
         2 |         0
```

```
SELECT topology.GetEdgeByPoint('ma_topo',geom, 1) As nearnode
FROM ST_GeomFromEWKT('SRID=26986;POINT(227591.9 893900.4)') As geom;

-- get error --
ERROR:  Two or more edges found
```

⊠⊠

AddEdge, GetNodeByPoint, GetFaceByPoint

9.7.2 GetFaceByPoint

GetFaceByPoint — Finds face intersecting a given point.

Synopsis

integer **GetFaceByPoint**(varchar atopology, geometry apoint, float8 tol1);

⊠⊠

Finds a face referenced by a Point, with given tolerance.

The function will effectively look for a face intersecting a circle having the point as center and the tolerance as radius.

If no face intersects the given query location, 0 is returned (universal face).

If more than one face intersect the query location an exception is thrown.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 3.2.0 more efficient implementation and clearer contract, stops working with invalid topologies.

⊠⊠

```
SELECT topology.GetFaceByPoint('ma_topo',geom, 10) As with1mtol, topology.GetFaceByPoint('ma_topo',geom,0) As withnotol
        FROM ST_GeomFromEWKT('POINT(234604.6 899382.0)') As geom;

         with1mtol | withnotol
        -----------+-----------
                 1 |         0
```

```
SELECT topology.GetFaceByPoint('ma_topo',geom, 1) As nearnode
        FROM ST_GeomFromEWKT('POINT(227591.9 893900.4)') As geom;

-- get error --
ERROR:  Two or more faces found
```

⊠⊠

GetFaceContainingPoint, AddFace, GetNodeByPoint, GetEdgeByPoint

9.7.3 GetFaceContainingPoint

GetFaceContainingPoint — Finds the face containing a point.

Synopsis

integer **GetFaceContainingPoint**(text atopology, geometry apoint);

⊠⊠

Returns the id of the face containing a point.

An exception is thrown if the point falls on a face boundary.

> **Note**
> The function relies on a valid topology, using edge linking and face labeling.

Availability: 3.2.0

⊠⊠

ST_GetFaceGeometry

9.7.4 GetNodeByPoint

GetNodeByPoint — Finds the node-id of a node at a point location.

Synopsis

integer **GetNodeByPoint**(varchar atopology, geometry apoint, float8 tol1);

⊠⊠

Retrieves the id of a node at a point location.

The function returns an integer (id-node) given a topology, a POINT and a tolerance. If tolerance = 0 means exact intersection, otherwise retrieves the node from an interval.

If `apoint` doesn't intersect a node, returns 0 (zero).

If use tolerance > 0 and there is more than one node near the point then an exception is thrown.

Note
⊠⊠⊠⊠ tolerance = 0 ⊠⊠⊠ ST_Intersects ⊠, ⊠⊠⊠⊠⊠⊠⊠ ST_DWithin ⊠⊠⊠⊠⊠⊠.

GEOS ⊠⊠⊠⊠⊠

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠ AddEdge ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT topology.GetNodeByPoint('ma_topo',geom, 1) As nearnode
 FROM ST_GeomFromEWKT('SRID=26986;POINT(227591.9 893900.4)') As geom;
  nearnode
----------
        2
```

```
SELECT topology.GetNodeByPoint('ma_topo',geom, 1000) As too_much_tolerance
 FROM ST_GeomFromEWKT('SRID=26986;POINT(227591.9 893900.4)') As geom;

 ----get error--
 ERROR:  Two or more nodes found
```

⊠⊠

AddEdge, GetEdgeByPoint, GetFaceByPoint

9.7.5 GetTopologyID

GetTopologyID — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **GetTopologyID**(varchar toponame);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠.

Availability: 1.1

⊠⊠

```
SELECT topology.GetTopologyID('ma_topo') As topo_id;
 topo_id
---------
       1
```

⊠⊠

CreateTopology, DropTopology, GetTopologyName, GetTopologySRID

9.7.6 GetTopologySRID

GetTopologySRID — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **GetTopologyID**(varchar toponame);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT topology.GetTopologySRID('ma_topo') As SRID;
 SRID
-------
  4326
```

⊠⊠

CreateTopology, DropTopology, GetTopologyName, GetTopologyID

9.7.7 GetTopologyName

GetTopologyName — ⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

varchar **GetTopologyName**(integer topology_id);

⊠⊠

⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.

Availability: 1.1

⊠⊠

```
SELECT topology.GetTopologyName(1) As topo_name;
 topo_name
-----------
 ma_topo
```

⊠⊠

CreateTopology, DropTopology, GetTopologyID, GetTopologySRID

9.7.8 ST_GetFaceEdges

ST_GetFaceEdges — aface ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

getfaceedges_returntype **ST_GetFaceEdges**(varchar atopology, integer aface);

⊠⊠

aface ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ (sequence) ⊠⊠⊠⊠ ID(edgeid) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠).

2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.5

⊠⊠

```
-- Returns the edges bounding face 1
SELECT (topology.ST_GetFaceEdges('tt', 1)).*;
-- result --
 sequence | edge
----------+------
        1 |   -4
        2 |    5
```

```
        3 |     7
        4 |    -6
        5 |     1
        6 |     2
        7 |     3
(7 rows)
```

```
-- Returns the sequence, edge id
-- and geometry of the edges that bound face 1
-- If you just need geom and seq, can use ST_GetFaceGeometry
SELECT t.seq, t.edge, geom
FROM topology.ST_GetFaceEdges('tt',1) As t(seq,edge)
        INNER JOIN tt.edge AS e ON abs(t.edge) = e.edge_id;
```

⊠⊠

GetRingEdges, AddFace, ST_GetFaceGeometry

9.7.9 ST_GetFaceGeometry

ST_GetFaceGeometry — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_GetFaceGeometry**(varchar atopology, integer aface);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Availability: 1.1

This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.16

⊠⊠

```
-- Returns the wkt of the polygon added with AddFace
SELECT ST_AsText(topology.ST_GetFaceGeometry('ma_topo', 1)) As facegeomwkt;
-- result --
               facegeomwkt

--------------------------------------------------------------------------------
 POLYGON((234776.9 899563.7,234896.5 899456.7,234914 899436.4,234946.6 899356.9,
234872.5 899328.7,234891 899285.4,234992.5 899145,234890.6 899069,
234755.2 899255.4,234612.7 899379.4,234776.9 899563.7))
```

⊠⊠

AddFace

9.7.10 GetRingEdges

GetRingEdges — [illegible].

Synopsis

getfaceedges_returntype **GetRingEdges**(varchar atopology, integer aring, integer max_edges=null);

[illegible]

[illegible]. [illegible] (sequence) [illegible] ID(edgeid) [illegible]. [illegible] 1 [illegible].

[illegible] ID [illegible], [illegible]. [illegible] ID [illegible], [illegible].

`max_edges` [illegible] NULL [illegible]. [illegible].

Note
[illegible].

2.0.0 [illegible].

[illegible]

ST_GetFaceEdges, GetNodeEdges

9.7.11 GetNodeEdges

GetNodeEdges — [illegible].

Synopsis

getfaceedges_returntype **GetNodeEdges**(varchar atopology, integer anode);

[illegible]

[illegible]. [illegible] ID [illegible]. [illegible] 1 [illegible]. [illegible]. [illegible]. [illegible] ([illegible]) [illegible]. [illegible].

Note
[illegible].

2.0 [illegible].

⊠⊠

getfaceedges_returntype, GetRingEdges, ST_Azimuth

9.8 ⊠⊠⊠⊠⊠⊠

9.8.1 Polygonize

Polygonize — Finds and registers all faces defined by topology edges.

Synopsis

text **Polygonize**(varchar toponame);

⊠⊠

Registers all faces that can be built out a topology edge primitives.
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ Polygonize ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠ edge ⊠⊠⊠⊠ next_left_edge ⊠ next_right_edge ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

AddFace, ST_Polygonize

9.8.2 AddNode

AddNode — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID(nodeid) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **AddNode**(varchar toponame, geometry apoint, boolean allowEdgeSplitting=false, boolean computeContainingFace=false);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. AddEdge ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, `allowEdgeSplitting` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`computeContainingFace` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> `apoint` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID(nodeid) ⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT topology.AddNode('ma_topo', ST_GeomFromText('POINT(227641.6 893816.5)', 26986) ) As ↩
    nodeid;
-- result --
nodeid
--------
 4
```

⊠⊠

AddEdge, CreateTopology

9.8.3 AddEdge

AddEdge — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ ID(edgeid) ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **AddEdge**(varchar toponame, geometry aline);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `toponame` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ ID(edgeid) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠” ⊠⊠ (universe)” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `aline` ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
aline ⊠⊠⊠ srid ⊠⊠⊠⊠⊠⊠⊠⊠⊠ srid ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

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Warning
AddEdge is deprecated as of 3.5.0. Use TopoGeo_AddLineString instead.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227575.8 893917.2,227591.9 893900.4)', 26986) ) As edgeid;
-- result-
edgeid
--------
 1

SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227591.9 893900.4,227622.6 893844.2,227641.6 893816.5,
 227704.5 893778.5)', 26986) ) As edgeid;
-- result --
edgeid
--------
 2

 SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227591.2 893900, 227591.9 893900.4,
  227704.5 893778.5)', 26986) ) As edgeid;
 -- gives error --
 ERROR:  Edge intersects (not on endpoints) with existing edge 1
```

⊠⊠

TopoGeo_AddLineString, CreateTopology, Section 4.5

9.8.4 AddFace

AddFace — ⊠⊠⊠⊠⊠⊠⊠⊠ (face primitive) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **AddFace**(varchar toponame, geometry apolygon, boolean force_new=false);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ (face primitive) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠ left_face ⊠ right_face ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ containing_face ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠ edge ⊠⊠⊠⊠ next_left_edge ⊠ next_right_edge ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`apolygon` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, `force_new` ⊠ (⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠, `force_new` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (force_new = true) ⊠⊠⊠, ⊠⊠, ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ MBR ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> `apolygon` ⊠⊠⊠ `srid` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `srid` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- first add the edges we use generate_series as an iterator (the below
-- will only work for polygons with < 10000 points because of our max in gs)
SELECT topology.AddEdge('ma_topo', ST_MakeLine(ST_PointN(geom,i), ST_PointN(geom, i + 1) )) ←
     As edgeid
    FROM (SELECT  ST_NPoints(geom) AS npt, geom
            FROM
                (SELECT ST_Boundary(ST_GeomFromText('POLYGON((234896.5 899456.7,234914  ←
                    899436.4,234946.6 899356.9,234872.5 899328.7,
                234891 899285.4,234992.5 899145, 234890.6 899069,234755.2 899255.4,
                234612.7 899379.4,234776.9 899563.7,234896.5 899456.7))', 26986) )  As geom
            )  As geoms) As facen CROSS JOIN generate_series(1,10000) As i
         WHERE i < npt;
-- result --
 edgeid
--------
      3
      4
      5
      6
      7
      8
```

```
      9
     10
     11
     12
(10 rows)
-- then add the face -

SELECT topology.AddFace('ma_topo',
    ST_GeomFromText('POLYGON((234896.5 899456.7,234914 899436.4,234946.6 899356.9,234872.5 ↩
        899328.7,
    234891 899285.4,234992.5 899145, 234890.6 899069,234755.2 899255.4,
    234612.7 899379.4,234776.9 899563.7,234896.5 899456.7))', 26986) ) As faceid;
-- result --
faceid
--------
 1
```

⊠⊠

AddEdge, CreateTopology, Section 4.5

9.8.5 ST_Simplify

ST_Simplify — ⊠⊠⊠⊠-⊠⊠ (Douglas-Peucker) ⊠⊠⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠” ⊠⊠⊠⊠” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Simplify**(TopoGeometry tg, float8 tolerance);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠-⊠⊠ (Douglas-Peucker) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠” ⊠⊠⊠⊠” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
> ⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

GEOS ⊠⊠⊠⊠⊠

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠ ST_Simplify, ST_IsSimple, ST_IsValid, ST_ModEdgeSplit

9.8.6 RemoveUnusedPrimitives

RemoveUnusedPrimitives — Removes topology primitives which not needed to define existing TopoGeometry objects.

Synopsis

int **RemoveUnusedPrimitives**(text topology_name, geometry bbox);

□□

Finds all primitives (nodes, edges, faces) that are not strictly needed to represent existing TopoGeometry objects and removes them, maintaining topology validity (edge linking, face labeling) and TopoGeometry space occupation.

No new primitive identifiers are created, but rather existing primitives are expanded to include merged faces (upon removing edges) or healed edges (upon removing nodes).

Availability: 3.3.0

□□

ST_ModEdgeHeal, ST_RemEdgeModFace

9.9 TopoGeometry □□□

9.9.1 CreateTopoGeom

CreateTopoGeom — □□□□□□□□□□□□□□□□□□□□□□□□□□□□. tg_type □ 1: [□□] □□□, 2: [□□] □□, 3: [□□] □□□, 4: □□□□□□□□.

Synopsis

topogeometry **CreateTopoGeom**(varchar toponame, integer tg_type, integer layer_id, topoelementarray tg_objs);
topogeometry **CreateTopoGeom**(varchar toponame, integer tg_type, integer layer_id);

□□

Creates a topogeometry object for layer denoted by `layer_id` and registers it in the relations table in the `toponame` schema.

`tg_type` is an integer: 1:[multi]point (punctal), 2:[multi]line (lineal), 3:[multi]poly (areal), 4:collection. `layer_id` is the layer id in the topology.layer table.

□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□, □□, □□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□.

□□□□□□□□□□□□□□□ TopoGeometry □□□□□□□□□□.

Availability: 1.1

□□: □□□□□□□□□□□

Create a topogeom in ri_topo schema for layer 2 (our ri_roads), of type (2) LINE, for the first edge (we loaded in ST_CreateTopoGeo).

```
INSERT INTO ri.ri_roads(road_name, topo) VALUES('Unknown', topology.CreateTopoGeom('ri_topo ↵
    ',2,2,'{{1,2}}'::topology.topoelementarray);
```

□□: □□□□□□□□□□□ **TopoGeometry** □□□

□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□ blockgroups □□□□□□□□□□□□□□□□□□□ TopoGeometry □□□□□□□□. □□□□□□□□□□□□□□□, □□□□□□□□□□□:

```
-- create our topo geometry column --
SELECT topology.AddTopoGeometryColumn(
        'topo_boston',
        'boston', 'blockgroups', 'topo', 'POLYGON');

-- addtopgeometrycolumn --
1

-- update our column assuming
-- everything is perfectly aligned with our edges
UPDATE boston.blockgroups AS bg
        SET topo = topology.CreateTopoGeom('topo_boston'
        ,3,1
        , foo.bfaces)
FROM (SELECT b.gid,  topology.TopoElementArray_Agg(ARRAY[f.face_id,3]) As bfaces
        FROM boston.blockgroups As b
            INNER JOIN topo_boston.face As f ON b.geom && f.mbr
        WHERE ST_Covers(b.geom, topology.ST_GetFaceGeometry('topo_boston', f.face_id))
            GROUP BY b.gid) As foo
WHERE foo.gid = bg.gid;
```

```
--the world is rarely perfect allow for some error
--count the face if 50% of it falls
-- within what we think is our blockgroup boundary
UPDATE boston.blockgroups AS bg
        SET topo = topology.CreateTopoGeom('topo_boston'
        ,3,1
        , foo.bfaces)
FROM (SELECT b.gid,  topology.TopoElementArray_Agg(ARRAY[f.face_id,3]) As bfaces
        FROM boston.blockgroups As b
            INNER JOIN topo_boston.face As f ON b.geom && f.mbr
        WHERE ST_Covers(b.geom, topology.ST_GetFaceGeometry('topo_boston', f.face_id))
        OR
 (  ST_Intersects(b.geom, topology.ST_GetFaceGeometry('topo_boston', f.face_id))
            AND ST_Area(ST_Intersection(b.geom, topology.ST_GetFaceGeometry('topo_boston',  ↵
                f.face_id) ) ) >
                ST_Area(topology.ST_GetFaceGeometry('topo_boston', f.face_id))*0.5
                )
            GROUP BY b.gid) As foo
WHERE foo.gid = bg.gid;

-- and if we wanted to convert our topogeometry back
-- to a denormalized geometry aligned with our faces and edges
-- cast the topo to a geometry
-- The really cool thing is my new geometries
-- are now aligned with my tiger street centerlines
UPDATE boston.blockgroups SET new_geom = topo::geometry;
```

⊠⊠

AddTopoGeometryColumn, toTopoGeom ST_CreateTopoGeo, ST_GetFaceGeometry, TopoElementArray, TopoElementArray_Agg

9.9.2 toTopoGeom

toTopoGeom — Converts a simple Geometry into a topo geometry.

Synopsis

topogeometry **toTopoGeom**(geometry geom, varchar toponame, integer layer_id, float8 tolerance);
topogeometry **toTopoGeom**(geometry geom, topogeometry topogeom, float8 tolerance);

⊠⊠

⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ relation ⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ TopoGeometry ⊠⊠⊠ (topogeom ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

tolerance ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠ (toponame) ⊠⊠⊠⊠⊠⊠ (layer_id) ⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 2 ⊠⊠⊠, ⊠⊠ TopoGeometry(toponame) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ clearTopoGeom ⊠⊠⊠ ⊠⊠⊠⊠⊠.

2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (workflow) ⊠⊠⊠.

```
-- do this if you don't have a topology setup already
-- creates topology not allowing any tolerance
SELECT topology.CreateTopology('topo_boston_test', 2249);
-- create a new table
CREATE TABLE nei_topo(gid serial primary key, nei varchar(30));
--add a topogeometry column to it
SELECT topology.AddTopoGeometryColumn('topo_boston_test', 'public', 'nei_topo', 'topo', ' ↩
    MULTIPOLYGON') As new_layer_id;
new_layer_id
-----------
1

--use new layer id in populating the new topogeometry column
-- we add the topogeoms to the new layer with 0 tolerance
INSERT INTO nei_topo(nei, topo)
SELECT nei,  topology.toTopoGeom(geom, 'topo_boston_test', 1)
FROM neighborhoods
WHERE gid BETWEEN 1 and 15;
```

```
--use to verify what has happened --
SELECT * FROM
    topology.TopologySummary('topo_boston_test');

-- summary--
Topology topo_boston_test (5), SRID 2249, precision 0
61 nodes, 87 edges, 35 faces, 15 topogeoms in 1 layers
Layer 1, type Polygonal (3), 15 topogeoms
 Deploy: public.nei_topo.topo
```

```

-- Shrink all TopoGeometry polygons by 10 meters
UPDATE nei_topo SET topo = ST_Buffer(clearTopoGeom(topo), -10);

-- Get the no-one-lands left by the above operation
-- I think GRASS calls this ”polygon0 layer”
SELECT ST_GetFaceGeometry('topo_boston_test', f.face_id)
  FROM topo_boston_test.face f
  WHERE f.face_id
> 0 -- don't consider the universe face
  AND NOT EXISTS ( -- check that no TopoGeometry references the face
    SELECT * FROM topo_boston_test.relation
    WHERE layer_id = 1 AND element_id = f.face_id
  );
```

□□

CreateTopology, AddTopoGeometryColumn, CreateTopoGeom, TopologySummary, clearTopoGeom

9.9.3 TopoElementArray_Agg

TopoElementArray_Agg — Returns a `topoelementarray` for a set of element_id, type arrays (topoelements).

Synopsis

topoelementarray **TopoElementArray_Agg**(topoelement set tefield);

□□

TopoElement □□□□□□ TopoElementArray □□□□□□□□□□.

2.0.0 □□□□□□□□□□□□.

□□

```
SELECT topology.TopoElementArray_Agg(ARRAY[e,t]) As tea
  FROM generate_series(1,3) As e CROSS JOIN generate_series(1,4) As t;
  tea
--------------------------------------------------------------------------
{{1,1},{1,2},{1,3},{1,4},{2,1},{2,2},{2,3},{2,4},{3,1},{3,2},{3,3},{3,4}}
```

⊠⊠

TopoElement, TopoElementArray

9.9.4 TopoElement

TopoElement — Converts a topogeometry to a topoelement.

Synopsis

topoelement **TopoElement**(topogeometry topo);

⊠⊠

Converts a TopoGeometry to a TopoElement.

Availability: 3.4.0

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (workflow) ⊠⊠⊠.

```
-- do this if you don't have a topology setup already
-- Creates topology not allowing any tolerance
SELECT TopoElement(topo)
FROM neighborhoods;
```

```
-- using as cast
SELECT topology.TopoElementArray_Agg(topo::topoelement)
FROM neighborhoods
GROUP BY city;
```

⊠⊠

TopoElementArray_Agg, TopoGeometry, TopoElement

9.10 TopoGeometry ⊠⊠⊠

9.10.1 clearTopoGeom

clearTopoGeom — Clears the content of a topo geometry.

Synopsis

topogeometry **clearTopoGeom**(topogeometry topogeom);

⊠⊠

TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠. toTopoGeom ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- Shrink all TopoGeometry polygons by 10 meters
UPDATE nei_topo SET topo = ST_Buffer(clearTopoGeom(topo), -10);
```

⊠⊠

toTopoGeom

9.10.2 TopoGeom_addElement

TopoGeom_addElement — Adds an element to the definition of a TopoGeometry.

Synopsis

topogeometry **TopoGeom_addElement**(topogeometry tg, topoelement el);

⊠⊠

TopoGeometry ⊠⊠⊠⊠⊠⊠ TopoElement ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.

2.3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- Add edge 5 to TopoGeometry tg
UPDATE mylayer SET tg = TopoGeom_addElement(tg, '{5,2}');
```

⊠⊠

TopoGeom_remElement, CreateTopoGeom

9.10.3 TopoGeom_remElement

TopoGeom_remElement — Removes an element from the definition of a TopoGeometry.

Synopsis

topogeometry **TopoGeom_remElement**(topogeometry tg, topoelement el);

□□

TopoGeometry □□□□□□□ TopoElement □□□□□□.

2.3 □□□□□□□□□□□□.

□□

```
-- Remove face 43 from TopoGeometry tg
UPDATE mylayer SET tg = TopoGeom_remElement(tg, '{43,3}');
```

□□

TopoGeom_addElement, CreateTopoGeom

9.10.4 TopoGeom_addTopoGeom

TopoGeom_addTopoGeom — Adds element of a TopoGeometry to the definition of another TopoGeometry.

Synopsis

topogeometry **TopoGeom_addTopoGeom**(topogeometry tgt, topogeometry src);

□□

Adds the elements of a TopoGeometry to the definition of another TopoGeometry, possibly changing its cached type (type attribute) to a collection, if needed to hold all elements in the source object.

The two TopoGeometry objects need be defined against the *same* topology and, if hierarchically defined, need be composed by elements of the same child layer.

Availability: 3.2

□□

```
-- Set an "overall" TopoGeometry value to be composed by all
-- elements of specific TopoGeometry values
UPDATE mylayer SET tg_overall = TopoGeom_addTopogeom(
    TopoGeom_addTopoGeom(
        clearTopoGeom(tg_overall),
        tg_specific1
    ),
    tg_specific2
);
```

□□

TopoGeom_addElement, clearTopoGeom, CreateTopoGeom

9.10.5 toTopoGeom

toTopoGeom — Adds a geometry shape to an existing topo geometry.

⊠⊠

Refer to toTopoGeom.

9.11 TopoGeometry ⊠⊠⊠

9.11.1 GetTopoGeomElementArray

GetTopoGeomElementArray — Returns a `topoelementarray` (an array of topoelements) containing the topological elements and type of the given TopoGeometry (primitive elements).

Synopsis

topoelementarray **GetTopoGeomElementArray**(varchar toponame, integer layer_id, integer tg_id);

topoelementarray **GetTopoGeomElementArray**(topogeometry tg);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠ TopoElementArray ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GetTopoGeomElements ⊠⊠⊠⊠⊠⊠⊠⊠.

tg_id ⊠ topology.layer ⊠⊠⊠⊠⊠⊠⊠ `layer_id` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠ ⊠ TopoGeometry ID ⊠⊠⊠.

Availability: 1.1

⊠⊠

⊠⊠

GetTopoGeomElements, TopoElementArray

9.11.2 GetTopoGeomElements

GetTopoGeomElements — Returns a set of `topoelement` objects containing the topological element_id,eleme of the given TopoGeometry (primitive elements).

Synopsis

setof topoelement **GetTopoGeomElements**(varchar toponame, integer layer_id, integer tg_id);

setof topoelement **GetTopoGeomElements**(topogeometry tg);

⊠⊠

Returns a set of element_id,element_type (topoelements) corresponding to primitive topology elements TopoElement (1: nodes, 2: edges, 3: faces) that a given topogeometry object in `toponame` schema is composed of.

tg_id ⊠ topology.layer ⊠⊠⊠⊠⊠⊠ `layer_id` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠ TopoGeometry ID ⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠

GetTopoGeomElementArray, TopoElement, TopoGeom_addElement, TopoGeom_remElement

9.11.3 ST_SRID

ST_SRID — Returns the spatial reference identifier for a topogeometry.

Synopsis

integer **ST_SRID**(topogeometry tg);

⊠⊠

Returns the spatial reference identifier for the ST_Geometry as defined in spatial_ref_sys table. Section 4.5

> **Note**
> spatial_ref_sys table is a table that catalogs all spatial reference systems known to PostGIS and is used for transformations from one spatial reference system to another. So verifying you have the right spatial reference system identifier is important if you plan to ever transform your geometries.

Availability: 3.2.0

This method implements the SQL/MM specification. SQL-MM 3: 14.1.5

⊠⊠

```
SELECT ST_SRID(ST_GeomFromText('POINT(-71.1043 42.315)',4326));
                --result
                4326
```

⊠⊠

Section 4.5, ST_SetSRID, ST_Transform, ST_SRID

9.12 TopoGeometry ⊠⊠⊠

9.12.1 AsGML

AsGML — TopoGeometry ⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **AsGML**(topogeometry tg);
text **AsGML**(topogeometry tg, text nsprefix_in);
text **AsGML**(topogeometry tg, regclass visitedTable);
text **AsGML**(topogeometry tg, regclass visitedTable, text nsprefix);
text **AsGML**(topogeometry tg, text nsprefix_in, integer precision, integer options);
text **AsGML**(topogeometry tg, text nsprefix_in, integer precision, integer options, regclass visitedTable);
text **AsGML**(topogeometry tg, text nsprefix_in, integer precision, integer options, regclass visitedTable, text idprefix);
text **AsGML**(topogeometry tg, text nsprefix_in, integer precision, integer options, regclass visitedTable, text idprefix, int gmlversion);

⊠⊠

TopoGeometry ⊠ GML ⊠⊠⊠⊠ GML3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `nsprefix_in` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `gml` ⊠⊠⊠⊠⊠⊠⊠⊠⊠. nsprefix ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (non-qualified) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ (⊠⊠⊠ 15) ⊠⊠⊠ (⊠⊠⊠ 1) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ ST_AsGML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`visitedTable` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (xlink:xref) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠'element_type' ⊠'element_id' (⊠⊠⊠) 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, `element_type` ⊠ `element_id` ⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
CREATE TABLE visited (
  element_type integer, element_id integer,
  unique(element_type, element_id)
);
```

`idprefix` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`gmlver` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ ST_AsGML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ 3 ⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠ CreateTopoGeom ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT topology.AsGML(topo) As rdgml
  FROM ri.roads
  WHERE road_name = 'Unknown';

-- rdgml--
<gml:TopoCurve>
    <gml:directedEdge>
        <gml:Edge gml:id="E1">
            <gml:directedNode orientation="-">
```

```
                <gml:Node gml:id="N1"/>
            </gml:directedNode>
            <gml:directedNode
></gml:directedNode>
            <gml:curveProperty>
                <gml:Curve srsName="urn:ogc:def:crs:EPSG::3438">
                    <gml:segments>
                        <gml:LineStringSegment>
                            <gml:posList srsDimension="2"
>384744 236928 384750 236923 384769 236911 384799 236895 384811 236890
                            384833 236884 384844 236882 384866 236881 384879 236883 384954  ↩
                                236898 385087 236932 385117 236938
                            385167 236938 385203 236941 385224 236946 385233 236950 385241  ↩
                                236956 385254 236971
                            385260 236979 385268 236999 385273 237018 385273 237037 385271  ↩
                                237047 385267 237057 385225 237125
                            385210 237144 385192 237161 385167 237192 385162 237202 385159  ↩
                                237214 385159 237227 385162 237241
                            385166 237256 385196 237324 385209 237345 385234 237375 385237  ↩
                                237383 385238 237399 385236 237407
                            385227 237419 385213 237430 385193 237439 385174 237451 385170  ↩
                                237455 385169 237460 385171 237475
                            385181 237503 385190 237521 385200 237533 385206 237538 385213  ↩
                                237541 385221 237542 385235 237540 385242 237541
                            385249 237544 385260 237555 385270 237570 385289 237584 385292  ↩
                                237589 385291 237596 385284 237630</gml:posList>
                        </gml:LineStringSegment>
                    </gml:segments>
                </gml:Curve>
            </gml:curveProperty>
        </gml:Edge>
    </gml:directedEdge>
</gml:TopoCurve>
```

□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

```
SELECT topology.AsGML(topo,'') As rdgml
  FROM ri.roads
  WHERE road_name = 'Unknown';

-- rdgml--
<TopoCurve>
    <directedEdge>
        <Edge id="E1">
            <directedNode orientation="-">
                <Node id="N1"/>
            </directedNode>
            <directedNode
></directedNode>
            <curveProperty>
                <Curve srsName="urn:ogc:def:crs:EPSG::3438">
                    <segments>
                        <LineStringSegment>
                            <posList srsDimension="2"
>384744 236928 384750 236923 384769 236911 384799 236895 384811 236890
                            384833 236884 384844 236882 384866 236881 384879 236883 384954  ↩
                                236898 385087 236932 385117 236938
                            385167 236938 385203 236941 385224 236946 385233 236950 385241  ↩
                                236956 385254 236971
                            385260 236979 385268 236999 385273 237018 385273 237037 385271  ↩
                                237047 385267 237057 385225 237125
                            385210 237144 385192 237161 385167 237192 385162 237202 385159  ↩
```

```
                                237214 385159 237227 385162 237241
                            385166 237256 385196 237324 385209 237345 385234 237375 385237 ↩
                                237383 385238 237399 385236 237407
                            385227 237419 385213 237430 385193 237439 385174 237451 385170 ↩
                                237455 385169 237460 385171 237475
                            385181 237503 385190 237521 385200 237533 385206 237538 385213 ↩
                                237541 385221 237542 385235 237540 385242 237541
                            385249 237544 385260 237555 385270 237570 385289 237584 385292 ↩
                                237589 385291 237596 385284 237630</posList>
                        </LineStringSegment>
                    </segments>
                </Curve>
            </curveProperty>
        </Edge>
    </directedEdge>
</TopoCurve>
```

⊠⊠

CreateTopoGeom, ST_CreateTopoGeo

9.12.2 AsTopoJSON

AsTopoJSON — TopoGeometry ⊠ TopoJSON ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **AsTopoJSON**(topogeometry tg, regclass edgeMapTable);

⊠⊠

TopoGeometry ⊠ TopoJSON ⊠⊠⊠⊠⊠⊠⊠⊠⊠. edgeMapTable ⊠ NULL ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (arc) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠ (lookup/storage) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ (compact) ” ⊠⊠” ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠” ⊠⊠ (serial)” ⊠⊠”arc_id” ⊠⊠⊠⊠⊠⊠”edge_id” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠”edge_id” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> TopoJSON ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0-⊠⊠⊠⊠⊠”edgeMapTable” ⊠⊠⊠⊠⊠⊠ 1-⊠⊠⊠⊠⊠.

⊠⊠⊠ TopoJSON ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (snippet) ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠. TopoJSON ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.2.1 ⊠⊠⊠⊠⊠⊠ (puntal) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_AsGeoJSON

□□

```
CREATE TEMP TABLE edgemap(arc_id serial, edge_id int unique);

-- header
SELECT '{ "type": "Topology", "transform": { "scale": [1,1], "translate": [0,0] }, "objects ↩
    ": {'

-- objects
UNION ALL SELECT '"' || feature_name || '": ' || AsTopoJSON(feature, 'edgemap')
FROM features.big_parcels WHERE feature_name = 'P3P4';

-- arcs
WITH edges AS (
  SELECT m.arc_id, e.geom FROM edgemap m, city_data.edge e
  WHERE e.edge_id = m.edge_id
), points AS (
  SELECT arc_id, (st_dumppoints(geom)).* FROM edges
), compare AS (
  SELECT p2.arc_id,
         CASE WHEN p1.path IS NULL THEN p2.geom
              ELSE ST_Translate(p2.geom, -ST_X(p1.geom), -ST_Y(p1.geom))
         END AS geom
  FROM points p2 LEFT OUTER JOIN points p1
  ON ( p1.arc_id = p2.arc_id AND p2.path[1] = p1.path[1]+1 )
  ORDER BY arc_id, p2.path
), arcsdump AS (
  SELECT arc_id, (regexp_matches( ST_AsGeoJSON(geom), '\[.*\]'))[1] as t
  FROM compare
), arcs AS (
  SELECT arc_id, '[' || array_to_string(array_agg(t), ',') || ']' as a FROM arcsdump
  GROUP BY arc_id
  ORDER BY arc_id
)
SELECT '}, "arcs": [' UNION ALL
SELECT array_to_string(array_agg(a), E',\n') from arcs

-- footer
UNION ALL SELECT ']}'::text as t;

-- Result:
{ "type": "Topology", "transform": { "scale": [1,1], "translate": [0,0] }, "objects": {
"P3P4": { "type": "MultiPolygon", "arcs": [[[-1]],[[6,5,-5,-4,-3,1]]]}
}, "arcs": [
 [[25,30],[6,0],[0,10],[-14,0],[0,-10],[8,0]],
 [[35,6],[0,8]],
 [[35,6],[12,0]],
 [[47,6],[0,8]],
 [[47,14],[0,8]],
 [[35,22],[12,0]],
 [[35,14],[0,8]]
 ]}
```

9.13 □□□□□□□

9.13.1 Equals

Equals — □ TopoGeometry □□□□□□□□□□□□□□□□□□□□□□□□□.

Synopsis

boolean **Equals**(topogeometry tg1, topogeometry tg2);

⊠⊠

⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠, ⊠⊠⊠, ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

⊠⊠

⊠⊠

GetTopoGeomElements, ST_Equals

9.13.2 Intersects

Intersects — ⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **Intersects**(topogeometry tg1, topogeometry tg2);

⊠⊠

⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> This function not supported for topogeometries that are geometry collections. It also can not compare topogeometries from different topologies. Also not currently supported for hierarchical topogeometries (topogeometries composed of other topogeometries).

1.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This function supports 3d and will not drop the z-index.

□□

```

```

□□

ST_Intersects

9.14 Importing and exporting Topologies

Once you have created topologies, and maybe associated topological layers, you might want to export them into a file-based format for backup or transfer into another database.

Using the standard dump/restore tools of PostgreSQL is problematic because topologies are composed by a set of tables (4 for primitives, an arbitrary number for layers) and records in metadata tables (topology.topology and topology.layer). Additionally, topology identifiers are not univoque across databases so that parameter of your topology will need to be changes upon restoring it.

In order to simplify export/restore of topologies a pair of executables are provided: `pgtopo_export` and `pgtopo_import`. Example usage:

```
pgtopo_export dev_db topo1 | pgtopo_import topo1 | psql staging_db
```

9.14.1 Using the Topology exporter

The `pgtopo_export` script takes the name of a database and a topology and outputs a dump file which can be used to import the topology (and associated layers) into a new database.

By default `pgtopo_export` writes the dump file to the standard output so that it can be piped to `pgtopo_import` or redirected to a file (refusing to write to terminal). You can optionally specify an output filename with the `-f` commandline switch.

By default `pgtopo_export` includes a dump of all layers defined against the given topology. This may be more data than you need, or may be non-working (in case your layer tables have complex dependencies) in which case you can request skipping the layers with the `--skip-layers` switch and deal with those separately.

Invoking `pgtopo_export` with the `--help` (or `-h` for short) switch will always print short usage string.

The dump file format is a compressed tar archive of a `pgtopo_export` directory containing at least a `pgtopo_dump_version` file with format version info. As of version `1` the directory contains tab-delimited CSV files with data of the topology primitive tables (node, edge_data, face, relation), the topology and layer records associated with it and (unless `--skip-layers` is given) a custom-format PostgreSQL dump of tables reported as being layers of the given topology.

9.14.2 Using the Topology importer

The `pgtopo_import` script takes a `pgtopo_export` format topology dump and a name to give to the topology to be created and outputs an SQL script reconstructing the topology and associated layers.

The generated SQL file will contain statements that create a topology with the given name, load primitive data in it, restores and registers all topology layers by properly linking all TopoGeometry values to their correct topology.

By default `pgtopo_import` reads the dump from the standard input so that it can be used in conjunction with `pgtopo_export` in a pipeline. You can optionally specify an input filename with the `-f` commandline switch.

By default `pgtopo_import` includes in the output SQL file the code to restore all layers found in the dump.

This may be unwanted or non-working in case your target database already have tables with the same name as the ones in the dump. In that case you can request skipping the layers with the `--skip-layers` switch and deal with those separately (or later).

SQL to only load and link layers to a named topology can be generated using the `--only-layers` switch. This can be useful to load layers AFTER resolving the naming conflicts or to link layers to a different topology (say a spatially-simplified version of the starting topology).

Chapter 10

,

10.1

, raster2pgsql PostGIS .

10.1.1 raster2pgsql

The raster2pgsql is a raster loader executable that loads GDAL supported raster formats into SQL suitable for loading into a PostGIS raster table. It is capable of loading folders of raster files as well as creating overviews of rasters.

Since the raster2pgsql is compiled as part of PostGIS most often (unless you compile your own GDAL library), the raster types supported by the executable will be the same as those compiled in the GDAL dependency library. To get a list of raster types your particular raster2pgsql supports use the -G switch.

> **Note**
> (factor) , . http://trac.osgeo.org/postgis/ticket/1764 .

10.1.1.1 Example Usage

100x100 :

```
# -s use srid 4326
# -I create spatial index
# -C use standard raster constraints
# -M vacuum analyze after load
# *.tif load all these files
# -F include a filename column in the raster table
# -t tile the output 100x100
# public.demelevation load into this table
raster2pgsql -s 4326 -I -C -M -F -t 100x100 *.tif public.demelevation
> elev.sql

# -d connect to this database
# -f read this file after connecting
psql -d gisdb -f elev.sql
```

> **Note**
> If you do not specify the schema as part of the target table name, the table will be created in the default schema of the database or user you are connecting with.

UNIX ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
raster2pgsql -s 4326 -I -C -M *.tif -F -t 100x100 public.demelevation | psql -d gisdb
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ aerial ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ 2 ⊠⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠ DB ⊠⊠⊠) ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ -e ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠). ⊠⊠⊠⊠ 128x128 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ -F ⊠⊠⊠⊠”filename” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
raster2pgsql -I -C -e -Y -F -s 26986 -t 128x128  -l 2,4 bostonaerials2008/*.jpg aerials. ↩
    boston | psql -U postgres -d gisdb -h localhost -p 5432
```

```
--get a list of raster types supported:
raster2pgsql -G
```

-G ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
Available GDAL raster formats:
  Virtual Raster
  GeoTIFF
  National Imagery Transmission Format
  Raster Product Format TOC format
  ECRG TOC format
  Erdas Imagine Images (.img)
  CEOS SAR Image
  CEOS Image
  ...
  Arc/Info Export E00 GRID
  ZMap Plus Grid
  NOAA NGS Geoid Height Grids
```

10.1.1.2 raster2pgsql options

-? ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-G ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

c|a|d|p -- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠**:**

- **-c** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-a** ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠⊠⊠.
- **-d** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-p** ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

- **-C** `raster_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-x** ⊠⊠⊠⊠ (extent) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. -C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- **-r** ⊠⊠⊠⊠⊠ (regular blocking) ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. -C ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

- **-s <SRID>** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠, ⊠⊠⊠ SRID ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-b BAND** ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (1-⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ (,) ⊠⊠ ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-t TILE_SIZE** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `TILE_SIZE` ⊠⊠⊠ x ⊠⊠⊠⊠ ⊠⊠⊠⊠, ⊠⊠"auto" ⊠⊠.
- **-P** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (padding) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-R, --register** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (DB ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
  ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-l OVERVIEW_FACTOR** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ (,) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠ `o_overview factor_table` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ `overview factor` ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (placeholder) ⊠⊠ `table` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, -R ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-N NODATA** "NODATA" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

- **-f COLUMN** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠'rast' ⊠⊠⊠.
- **-F** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-n COLUMN** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. -F ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-q** PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-I** ⊠⊠⊠⊠⊠⊠ GiST ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-M** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (vacuum analyze) ⊠⊠⊠⊠.
- **-k** Keeps empty tiles and skips NODATA value checks for each raster band. Note you save time in checking, but could end up with far more junk rows in your database and those junk rows are not marked as empty tiles.
- **-T tablespace** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. -X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠ ⊠) ⊠⊠⊠.
- **-X tablespace** ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. -I ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- **-Y max_rows_per_copy=50** Use copy statements instead of insert statements. Optionally specify `max_rows_per_copy`; default 50 when not specified.

-e ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ (transaction) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-E ENDIAN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (endianness) ⊠⊠⊠⊠⊠⊠⊠. XDR ⊠ 0, ⊠⊠ ⊠⊠ NDR ⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠, NDR ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

-V version ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠. ⊠⊠, 0 ⊠⊠⊠⊠⊠⊠⊠⊠.

10.1.2 PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1. ⊠⊠⊠:

```
CREATE TABLE myrasters(rid serial primary key, rast raster);
```

2. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_MakeEmptyRast
⊠⊠⊠ ST_AddBand ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

   ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_AsRaster ⊠⊠⊠, ⊠⊠⊠ ST_Union , ST_MapAlgebraF
⊠⊠⊠⊠⊠⊠ (algebra) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

   ⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_Transform ⊠
⊠⊠.

3. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
CREATE INDEX myrasters_rast_st_convexhull_idx ON myrasters USING gist( ST_ConvexHull( ↩
    rast) );
```

   ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (convex hull) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_ConvexHull ⊠⊠⊠⊠⊠
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> PostGIS 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (envelop) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠
> ⊠. ⊠⊠⊠.

4. AddRasterConstraints ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

10.1.3 Using ”out db” cloud rasters

The `raster2pgsql` tool uses GDAL to access raster data, and can take advantage of a key GDAL feature: the ability to read from rasters that are stored remotely in cloud ”object stores” (e.g. AWS S3, Google Cloud Storage).

Efficient use of cloud stored rasters requires the use of a ”cloud optimized” format. The most well-known and widely used is the ”cloud optimized GeoTIFF” format. Using a non-cloud format, like a JPEG, or an un-tiled TIFF will result in very poor performance, as the system will have to download the entire raster each time it needs to access a subset.

First, load your raster into the cloud storage of your choice. Once it is loaded, you will have a URI to access it with, either an ”http” URI, or sometimes a URI specific to the service. (e.g., ”s3://bucket/object”). To access non-public buckets, you will need to supply GDAL config options to authenticate your connection. Note that this command is *reading* from the cloud raster and *writing* to the database.

```
AWS_ACCESS_KEY_ID=xxxxxxxxxxxxxxxxxxxx \
AWS_SECRET_ACCESS_KEY=xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx \
raster2pgsql \
  -s 990000 \
  -t 256x256 \
  -I \
  -R \
  /vsis3/your.bucket.com/your_file.tif \
  your_table \
  | psql your_db
```

Once the table is loaded, you need to give the database permission to read from remote rasters, by setting two permissions, postgis.enable_outdb_rasters and postgis.gdal_enabled_drivers.

```
SET postgis.enable_outdb_rasters = true;
SET postgis.gdal_enabled_drivers TO 'ENABLE_ALL';
```

To make the changes sticky, set them directly on your database. You will need to re-connect to experience the new settings.

```
ALTER DATABASE your_db SET postgis.enable_outdb_rasters = true;
ALTER DATABASE your_db SET postgis.gdal_enabled_drivers TO 'ENABLE_ALL';
```

For non-public rasters, you may have to provide access keys to read from the cloud rasters. The same keys you used to write the `raster2pgsql` call can be set for use inside the database, with the postgis.gdal_vsi_options configuration. Note that multiple options can be set by space-separating the `key=value` pairs.

```
SET postgis.gdal_vsi_options = 'AWS_ACCESS_KEY_ID=xxxxxxxxxxxxxxxxxxxx
AWS_SECRET_ACCESS_KEY=xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx';
```

Once you have the data loaded and permissions set you can interact with the raster table like any other raster table, using the same functions. The database will handle all the mechanics of connecting to the cloud data when it needs to read pixel data.

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1. `raster_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
2. `raster_overviews` ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ `-l` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

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`raster_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ `raster_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `-C` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ `raster_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ AddRasterConstraints ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- `r_table_catalog` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `r_table_schema` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `r_table_name` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `r_raster_column` ⊠⊠⊠⊠⊠⊠ `r_table_name` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `srid` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Section 4.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `scale_x` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠) ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `scale_x` ⊠⊠⊠⊠, `scale_x` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ST_ScaleX ⊠⊠⊠⊠⊠⊠⊠.

- scale_y ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (☒☒) ☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ scale_y ☒☒☒☒, scale_y ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒ ST_ScaleY ☒☒☒☒☒☒☒.
- blocksize_x ☒☒☒☒☒☒☒☒☒ (☒☒☒☒☒☒☒☒☒) ☒☒☒. ☒☒☒☒☒☒ ST_Width ☒☒☒☒☒☒☒.
- blocksize_y ☒☒☒☒☒☒☒☒☒ (☒☒☒☒☒☒☒☒☒) ☒☒☒. ☒☒☒☒☒☒ ST_Height ☒☒☒☒☒☒☒.
- same_alignment ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒ ST_SameAlignment ☒☒☒☒☒☒☒.
- regular_blocking ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒.
- num_bands ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ST_NumBands
- pixel_types ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. pixel_types ☒☒☒ ST_BandPixelType ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- nodata_values ☒☒☒☒☒☒ nodata_value ☒☒☒☒☒☒☒☒☒ (double precision) ☒ (數) ☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒ ST_BandNoDataValue ☒☒☒☒☒☒☒☒☒☒☒☒☒.
- out_db ☒☒. ☒☒☒ ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- extent ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (extent) ☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ ☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒ DropRasterConstraints ☒☒☒☒☒☒☒☒☒☒☒ AddRasterConstraints ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- spatial_index ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

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raster_overviews ☒☒ ☒☒☒☒☒☒. ☒☒☒☒☒☒☒ raster_columns ☒ raster_overviews ☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒ ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ ☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒ -l ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒ AddOverviewConstraints ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

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> **Note**
> raster_overviews ☒☒☒☒☒☒ raster_columns ☒☒☒☒☒☒☒☒☒☒☒☒☒☒. raster_columns ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ raster_overviews ☒ raster_columns ☒☒☒☒ ☒ (join) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

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2. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ ☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒ (rule-of-thumb) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

raster_overviews ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

- `o_table_catalog` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `o_table_schema` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `o_table_name` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `o_raster_column` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `r_table_catalog` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `r_table_schema` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `r_table_name` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `r_raster_column` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `overview_factor` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. raster2pgsql ⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 125x125 ⊠⊠⊠⊠⊠⊠ 5000x5000 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (5000*5000)/(125*125) = 1600 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ o_2 (l=2) ⊠⊠⊠⊠⊠⊠⊠⊠ (1600/2^2) = 400 ⊠, o_3 (l=3) ⊠⊠⊠⊠⊠⊠⊠⊠ (1600/2^3) = 200 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ (scrap) ⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. raster2pgsql ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠ 2^overview_factor ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

10.3 PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

The fact that PostGIS raster provides you with SQL functions to render rasters in known image formats gives you a lot of options for rendering them. For example you can use OpenOffice / LibreOffice for rendering as demonstrated in Rendering PostGIS Raster graphics with LibreOffice Base Reports. In addition you can use a wide variety of languages as demonstrated in this section.

10.3.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_AsPNG ⊠⊠⊠⊠⊠⊠ PHP ⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠, PHP PostgreSQL ⊠⊠⊠⊠⊠⊠ ST_AsGDALRaster ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1, 2, 3 ⊠⊠⊠ PHP ⊠⊠⊠⊠⊠⊠ (request stream) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ PHP ⊠⊠⊠⊠⊠⊠⊠"img src" HTML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (combine) ⊠⊠⊠⊠⊠ WGS84 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Union ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (union) ⊠⊠, ST_Transform ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_AsPNG ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PNG ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
http://mywebserver/test_raster.php?srid=2249
```

⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
<?php
/** contents of test_raster.php **/
$conn_str ='dbname=mydb host=localhost port=5432 user=myuser password=mypwd';
$dbconn = pg_connect($conn_str);
header('Content-Type: image/png');
/**If a particular projection was requested use it otherwise use mass state plane meters ↩
    **/
if (!empty( $_REQUEST['srid'] ) &amp;&amp; is_numeric( $_REQUEST['srid']) ){
```

```
                $input_srid = intval($_REQUEST['srid']);
}
else { $input_srid = 26986; }
/** The set bytea_output may be needed for PostgreSQL 9.0+, but not for 8.4 **/
$sql = "set bytea_output='escape';
SELECT ST_AsPNG(ST_Transform(
                        ST_AddBand(ST_Union(rast,1), ARRAY[ST_Union(rast,2),ST_Union(rast ↩
                            ,3)])
                                ,$input_srid) ) As new_rast
 FROM aerials.boston
        WHERE
         ST_Intersects(rast, ST_Transform(ST_MakeEnvelope(-71.1217, 42.227, -71.1210,  ↩
             42.218,4326),26986) )";
$result = pg_query($sql);
$row = pg_fetch_row($result);
pg_free_result($result);
if ($row === false) return;
echo pg_unescape_bytea($row[0]);
?>
```

10.3.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_AsPNG ⊠⊠⊠⊠⊠⊠ ASP.NET C# ⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠, npgsql PostgreSQL .NET ⊠⊠⊠⊠⊠ ST_AsGDALRaster ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1, 2, 3 ⊠⊠⊠ PHP ⊠⊠⊠⊠⊠⊠ (request stream) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ PHP ⊠⊠⊠⊠⊠⊠⊠"img src" HTML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ npgsql PostgreSQL .NET ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. http://npgsql.projects.postgresql.org/- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ASP.NET bin ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (combine) ⊠⊠⊠⊠⊠ WGS84 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Union ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (union) ⊠⊠, ST_Transform ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_AsPNG ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PNG ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠ C# ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Section 10.3.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
http://mywebserver/test_raster.php?srid=2249
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
 -- web.config connection string section --
<connectionStrings>
    <add name="DSN"
        connectionString="server=localhost;database=mydb;Port=5432;User Id=myuser;password= ↩
            mypwd"/>
</connectionStrings>
```

```
// Code for TestRaster.ashx
<%@ WebHandler Language="C#" Class="TestRaster" %>
using System;
using System.Data;
using System.Web;
using Npgsql;

public class TestRaster : IHttpHandler
{
        public void ProcessRequest(HttpContext context)
        {

                context.Response.ContentType = "image/png";
```

```
                context.Response.BinaryWrite(GetResults(context));

        }

        public bool IsReusable {
                get { return false; }
        }

        public byte[] GetResults(HttpContext context)
        {
                byte[] result = null;
                NpgsqlCommand command;
                string sql = null;
                int input_srid = 26986;
        try {
                    using (NpgsqlConnection conn = new NpgsqlConnection(System. ↩
                        Configuration.ConfigurationManager.ConnectionStrings["DSN"]. ↩
                        ConnectionString)) {
                            conn.Open();

                if (context.Request["srid"] != null)
                {
                    input_srid = Convert.ToInt32(context.Request["srid"]);
                }
                sql = @"SELECT ST_AsPNG(
                            ST_Transform(
                                        ST_AddBand(
                                ST_Union(rast,1), ARRAY[ST_Union(rast,2),ST_Union(rast,3)])
                                                    ,:input_srid) ) As new_rast
                        FROM aerials.boston
                                WHERE
                                    ST_Intersects(rast,
                                    ST_Transform(ST_MakeEnvelope(-71.1217, 42.227,  ↩
                                        -71.1210, 42.218,4326),26986) )";
                            command = new NpgsqlCommand(sql, conn);
                command.Parameters.Add(new NpgsqlParameter("input_srid", input_srid));


                            result = (byte[]) command.ExecuteScalar();
                conn.Close();
                        }

                }
        catch (Exception ex)
        {
            result = null;
            context.Response.Write(ex.Message.Trim());
        }
                return result;
        }
}
```

10.3.3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Java ⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Java ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. http://jdbc.postgresql.org/download.html⊠⊠⊠⊠ PostgreSQL JDBC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

```
set env CLASSPATH .:..\postgresql-9.0-801.jdbc4.jar
javac SaveQueryImage.java
jar cfm SaveQueryImage.jar Manifest.txt *.class
```

⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧:

```
java -jar SaveQueryImage.jar ”SELECT ST_AsPNG(ST_AsRaster(ST_Buffer(ST_Point(1,5),10, ' ↩
    quad_segs=2'),150, 150, '8BUI',100));” ”test.png”
```

```
-- Manifest.txt --
Class-Path: postgresql-9.0-801.jdbc4.jar
Main-Class: SaveQueryImage
```

```
// Code for SaveQueryImage.java
import java.sql.Connection;
import java.sql.SQLException;
import java.sql.PreparedStatement;
import java.sql.ResultSet;
import java.io.*;

public class SaveQueryImage {
  public static void main(String[] argv) {
      System.out.println(”Checking if Driver is registered with DriverManager.”);

      try {
        //java.sql.DriverManager.registerDriver (new org.postgresql.Driver());
        Class.forName(”org.postgresql.Driver”);
      }
      catch (ClassNotFoundException cnfe) {
        System.out.println(”Couldn't find the driver!”);
        cnfe.printStackTrace();
        System.exit(1);
      }

      Connection conn = null;

      try {
        conn = DriverManager.getConnection(”jdbc:postgresql://localhost:5432/mydb”,”myuser ↩
            ”, ”mypwd”);
        conn.setAutoCommit(false);

        PreparedStatement sGetImg = conn.prepareStatement(argv[0]);

        ResultSet rs = sGetImg.executeQuery();

                FileOutputStream fout;
                try
                {
                        rs.next();
                        /** Output to file name requested by user **/
                        fout = new FileOutputStream(new File(argv[1]) );
                        fout.write(rs.getBytes(1));
                        fout.close();
                }
                catch(Exception e)
                {
                        System.out.println(”Can't create file”);
                        e.printStackTrace();
                }

        rs.close();
```

```
                sGetImg.close();
        conn.close();
      }
      catch (SQLException se) {
        System.out.println(”Couldn't connect: print out a stack trace and exit.”);
        se.printStackTrace();
        System.exit(1);
      }
  }
}
```

10.3.4 PLPython ⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PLPython ⊠⊠⊠⊠⊠⊠⊠. PLPython ⊠⊠⊠⊠⊠⊠⊠. PLPythonu ⊠ PLPythonu3u ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
CREATE OR REPLACE FUNCTION write_file (param_bytes bytea, param_filepath text)
RETURNS text
AS $$
f = open(param_filepath, 'wb+')
f.write(param_bytes)
return param_filepath
$$ LANGUAGE plpythonu;
```

```
--write out 5 images to the PostgreSQL server in varying sizes
-- note the postgresql daemon account needs to have write access to folder
-- this echos back the file names created;
 SELECT write_file(ST_AsPNG(
        ST_AsRaster(ST_Buffer(ST_Point(1,5),j*5, 'quad_segs=2'),150*j, 150*j, '8BUI',100)),
         'C:/temp/slices'|| j || '.png')
         FROM generate_series(1,5) As j;

     write_file
---------------------
 C:/temp/slices1.png
 C:/temp/slices2.png
 C:/temp/slices3.png
 C:/temp/slices4.png
 C:/temp/slices5.png
```

10.3.5 PSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠ PSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PSQL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ PSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT oid, lowrite(lo_open(oid, 131072), png) As num_bytes
 FROM
 ( VALUES (lo_create(0),
   ST_AsPNG( (SELECT rast FROM aerials.boston WHERE rid=1) )
  ) ) As v(oid,png);
-- you'll get an output something like --
   oid   | num_bytes
---------+-----------
 2630819 |     74860
```

```
-- next note the oid and do this replacing the c:/test.png to file path location
-- on your local computer
 \lo_export 2630819 'C:/temp/aerial_samp.png'

-- this deletes the file from large object storage on db
SELECT lo_unlink(2630819);
```

Chapter 11

⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

raster ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Section 10.1 ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
CREATE TABLE dummy_rast(rid integer, rast raster);
INSERT INTO dummy_rast(rid, rast)
VALUES (1,
('01' -- little endian (uint8 ndr)
||
'0000' -- version (uint16 0)
||
'0000' -- nBands (uint16 0)
||
'0000000000000040' -- scaleX (float64 2)
||
'0000000000000840' -- scaleY (float64 3)
||
'000000000000E03F' -- ipX (float64 0.5)
||
'000000000000E03F' -- ipY (float64 0.5)
||
'0000000000000000' -- skewX (float64 0)
||
'0000000000000000' -- skewY (float64 0)
||
'00000000' -- SRID (int32 0)
||
'0A00' -- width (uint16 10)
||
'1400' -- height (uint16 20)
)::raster
),
-- Raster: 5 x 5 pixels, 3 bands, PT_8BUI pixel type, NODATA = 0
(2,  ('01000003009A9999999999A93F9A9999999999A9BF000000E02B274A' ||
'41000000007719564100000000000000000000000000000000 ←
    FFFFFFFF050005000400FDFEFDFEFEFDFEFEFDF9FAFEF' ||
' ←
    EFCF9FBFDFEFEFDFCFAFEFEFE04004E627AADD16076B4F9FE6370A9F5FE59637AB0E54F58617087040046566487A1506
    ')::raster);
```

11.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

11.1.1 geomval

geomval — (⊠⊠⊠⊠⊠⊠⊠⊠⊠) geom ⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) val, ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

geomval ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, .geom ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ val ⊠⊠⊠⊠⊠⊠. ST_DumpAsPolygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

Section 13.6

11.1.2 addbandarg

addbandarg — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_AddBand ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_AddBand ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

index integer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1-⊠⊠⊠⊠⊠⊠. NULL ⊠⊠⊠, ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

pixeltype text ST_BandPixelType ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

initialvalue double precision ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

nodataval double precision ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠. NULL ⊠⊠⊠, ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_AddBand

11.1.3 rastbandarg

rastbandarg — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

rast raster ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

nband integer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1-⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_MapAlgebra (callback function version)

11.1.4 raster

raster — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

raster is a spatial data type used to represent raster data such as those imported from JPEGs, TIFFs, PNGs, digital elevation models. Each raster has 1 or more bands each having a set of pixel values. Rasters can be georeferenced.

> **Note**
> GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_ConvexHull ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠

⊠⊠.

⊠⊠⊠⊠⊠	⊠⊠
⊠⊠	⊠⊠⊠

⊠⊠

Chapter 11

11.1.5 reclassarg

reclassarg — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Reclass ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Reclass ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

nband integer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

reclassexpr text ⊠⊠⊠⊠⊠⊠ range:map_range ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ':' ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. '(' ⊠'>' ⊠, ')' ⊠⊠⊠⊠, ']' ⊠'<' ⊠⊠⊠⊠ ⊠, '[' ⊠'>' ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
1. [a-b] = a <= x <= b

2. (a-b] = a < x <= b

3. [a-b) = a <= x < b
```

```
4. (a-b) = a < x < b
```

’(’ □□□□□□□□□□□□ (a-b) □ a-b □□□□□□□□□□.

pixeltype text ST_BandPixelType □□□□□□□□□□□□□□□□□□□□□.

nodataval double precision NODATA □□□□□□□□□. □□□□□□□□□□□□□□□□□□, □□ □□□□□□□□□.

□: □□ 2 □ 255 □ NODATA □□ 8BUI □□□□□□□□.

```
SELECT ROW(2, '0-100:1-10, 101-500:11-150,501 - 10000: 151-254', '8BUI', 255)::reclassarg;
```

□: □□ 1 □ NODATA □□□□□□□□ 1BB □□□□□□□□.

```
SELECT ROW(1, '0-100]:0, (100-255:1', '1BB', NULL)::reclassarg;
```

□□

ST_Reclass

11.1.6 summarystats

summarystats — ST_SummaryStats □ ST_SummaryStatsAgg □□□□□□□□□□□□□□□□.

□□

ST_SummaryStats □ ST_SummaryStatsAgg □□□□□□□□□□□□□□□□.

count integer □□□□□□□□□□□□□□□□□.

sum double precision □□□□□□□□□□□□□.

mean double precision □□□□□□□□□□□□□□□□.

stddev double precision □□□□□□□□□□□□□□□□.

min double precision □□□□□□□□□□□□□□□.

max double precision □□□□□□□□□□□□□□□.

□□

ST_SummaryStats, ST_SummaryStatsAgg

11.1.7 unionarg

unionarg — □□□□□□□□□ UNION □□□□□□□□□□ ST_Union □□□□□□□□□□□□□□□□ □□□.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ UNION ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Union ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

nband integer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1-⊠⊠⊠⊠⊠⊠.

uniontype text UNION ⊠⊠⊠⊠⊠⊠⊠⊠. ST_Union ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_Union

11.2 ⊠⊠⊠⊠⊠

11.2.1 AddRasterConstraints

AddRasterConstraints — Adds raster constraints to a loaded raster table for a specific column that constrains spatial ref, scaling, blocksize, alignment, bands, band type and a flag to denote if raster column is regularly blocked. The table must be loaded with data for the constraints to be inferred. Returns true if the constraint setting was accomplished and issues a notice otherwise.

Synopsis

boolean **AddRasterConstraints**(name rasttable, name rastcolumn, boolean srid=true, boolean scale_x=true, boolean scale_y=true, boolean blocksize_x=true, boolean blocksize_y=true, boolean same_alignment=true, boolean regular_blocking=false, boolean num_bands=true , boolean pixel_types=true , boolean nodata_values=true , boolean out_db=true , boolean extent=true);
boolean **AddRasterConstraints**(name rasttable, name rastcolumn, text[] VARIADIC constraints);
boolean **AddRasterConstraints**(name rastschema, name rasttable, name rastcolumn, text[] VARIADIC constraints);
boolean **AddRasterConstraints**(name rastschema, name rasttable, name rastcolumn, boolean srid=true, boolean scale_x=true, boolean scale_y=true, boolean blocksize_x=true, boolean blocksize_y=true, boolean same_alignment=true, boolean regular_blocking=false, boolean num_bands=true, boolean pixel_types=true, boolean nodata_values=true , boolean out_db=true , boolean extent=true);

⊠⊠

`raster_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `rastschema` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `srid` ⊠ SPATIAL_REF_SYS ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`raster2pgsql` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Section 10.2.1 ⊠⊠⊠⊠⊠⊠⊠.

- `blocksize` ⊠ X ⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `blocksize_x` ⊠ X ⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.
- `blocksize_y` ⊠ Y ⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.
- `extent` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `num_bands` ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- pixel_types ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ N ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- regular_blocking ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠.
- same_alignment ensures they all have same alignment meaning any two tiles you compare will return true for. Refer to ST_SameAlignment.
- srid ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ⊠⊠ -- ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ DropRasterConstraints ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
CREATE TABLE myrasters(rid SERIAL primary key, rast raster);
INSERT INTO myrasters(rast)
SELECT ST_AddBand(ST_MakeEmptyRaster(1000, 1000, 0.3, -0.3, 2, 2, 0, 0,4326), 1, '8BSI'::text, -129, NULL);

SELECT AddRasterConstraints('myrasters'::name, 'rast'::name);


-- verify if registered correctly in the raster_columns view --
SELECT srid, scale_x, scale_y, blocksize_x, blocksize_y, num_bands, pixel_types, nodata_values
    FROM raster_columns
    WHERE r_table_name = 'myrasters';

 srid | scale_x | scale_y | blocksize_x | blocksize_y | num_bands | pixel_types| nodata_values
------+---------+---------+-------------+-------------+-----------+-------------+---------------

 4326 |       2 |       2 |        1000 |        1000 |         1 | {8BSI}      | {0}
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
CREATE TABLE public.myrasters2(rid SERIAL primary key, rast raster);
INSERT INTO myrasters2(rast)
SELECT ST_AddBand(ST_MakeEmptyRaster(1000, 1000, 0.3, -0.3, 2, 2, 0, 0,4326), 1, '8BSI'::text, -129, NULL);
```

```
SELECT AddRasterConstraints('public'::name, 'myrasters2'::name, 'rast'::name,' ↩
    regular_blocking', 'blocksize');
-- get notice--
NOTICE:  Adding regular blocking constraint
NOTICE:  Adding blocksize-X constraint
NOTICE:  Adding blocksize-Y constraint
```

⊠⊠

Section 10.2.1, ST_AddBand, ST_MakeEmptyRaster, DropRasterConstraints, ST_BandPixelType, ST_SRID

11.2.2 DropRasterConstraints

DropRasterConstraints — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **DropRasterConstraints**(name rasttable, name rastcolumn, boolean srid, boolean scale_x, boolean scale_y, boolean blocksize_x, boolean blocksize_y, boolean same_alignment, boolean regular_blocking, boolean num_bands=true, boolean pixel_types=true, boolean nodata_values=true, boolean out_db=true , boolean extent=true);
boolean **DropRasterConstraints**(name rastschema, name rasttable, name rastcolumn, boolean srid=true, boolean scale_x=true, boolean scale_y=true, boolean blocksize_x=true, boolean blocksize_y=true, boolean same_alignment=true, boolean regular_blocking=false, boolean num_bands=true, boolean pixel_types=true, boolean nodata_values=true, boolean out_db=true , boolean extent=true);
boolean **DropRasterConstraints**(name rastschema, name rasttable, name rastcolumn, text[] constraints);

⊠⊠

AddRasterConstraints ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
DROP TABLE mytable
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠.

```
ALTER TABLE mytable DROP COLUMN rast
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `raster_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ `raster_columns` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□

```
SELECT DropRasterConstraints ('myrasters','rast');
----RESULT output ---
t

-- verify change in raster_columns --
SELECT srid, scale_x, scale_y, blocksize_x, blocksize_y, num_bands, pixel_types, ↩
    nodata_values
    FROM raster_columns
    WHERE r_table_name = 'myrasters';

 srid | scale_x | scale_y | blocksize_x | blocksize_y | num_bands | pixel_types| ↩
     nodata_values
------+---------+---------+-------------+-------------+-----------+-------------+-------------- ↩

    0 |         |         |             |             |           |             |
```

□□

AddRasterConstraints

11.2.3 AddOverviewConstraints

AddOverviewConstraints — □□□□□□□□□□□□□□□□□ (overview) □□□□□□.

Synopsis

boolean **AddOverviewConstraints**(name ovschema, name ovtable, name ovcolumn, name refschema, name reftable, name refcolumn, int ovfactor);
boolean **AddOverviewConstraints**(name ovtable, name ovcolumn, name reftable, name refcolumn, int ovfactor);

□□

`raster_overviews` □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

`ovfactor` □□□□□□□□□□□□□□□□□ (乘數) □□□□□□. `ovfactor` □□□□□□□□□□□□□.

`ovschema` □ `refschema` □□□□□□□□□□, `search_path` □□□□□□□□□□□□□□□□□□□□□ □.

2.0.0 □□□□□□□□□□□□.

□□

```
CREATE TABLE res1 AS SELECT
ST_AddBand(
  ST_MakeEmptyRaster(1000, 1000, 0, 0, 2),
  1, '8BSI'::text, -129, NULL
) r1;

CREATE TABLE res2 AS SELECT
ST_AddBand(
```

```
  ST_MakeEmptyRaster(500, 500, 0, 0, 4),
  1, '8BSI'::text, -129, NULL
) r2;

SELECT AddOverviewConstraints('res2', 'r2', 'res1', 'r1', 2);

-- verify if registered correctly in the raster_overviews view --
SELECT o_table_name ot, o_raster_column oc,
       r_table_name rt, r_raster_column rc,
       overview_factor f
FROM raster_overviews WHERE o_table_name = 'res2';
  ot  | oc |  rt  | rc | f
------+----+------+----+---
 res2 | r2 | res1 | r1 | 2
(1 row)
```

⊠⊠

Section 10.2.2, DropOverviewConstraints, ST_CreateOverview, AddRasterConstraints

11.2.4 DropOverviewConstraints

DropOverviewConstraints — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (overview) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **DropOverviewConstraints**(name ovschema, name ovtable, name ovcolumn);
boolean **DropOverviewConstraints**(name ovtable, name ovcolumn);

⊠⊠

`raster_overviews` ⊠⊠ ⊠⊠⊠.

`ovschema` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, `search_path` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

Section 10.2.2, AddOverviewConstraints, DropRasterConstraints

11.2.5 PostGIS_GDAL_Version

PostGIS_GDAL_Version — PostGIS ⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **PostGIS_GDAL_Version**();

□□

PostGIS □□□□□□□ GDAL □□□□□□□□□□□□□□. □ GDAL □□□□□□□□□□□□□□□□□ □□□□□□□□□□.

□□

```
SELECT PostGIS_GDAL_Version();
       postgis_gdal_version
-----------------------------------
 GDAL 1.11dev, released 2013/04/13
```

□□

postgis.gdal_datapath

11.2.6 PostGIS_Raster_Lib_Build_Date

PostGIS_Raster_Lib_Build_Date — □□□□□□□□□□□□□□□□□□□□□.

Synopsis

text **PostGIS_Raster_Lib_Build_Date**();

□□

□□□□□□□□□□□□□□.

□□

```
SELECT PostGIS_Raster_Lib_Build_Date();
postgis_raster_lib_build_date
-----------------------------
2010-04-28 21:15:10
```

□□

PostGIS_Raster_Lib_Version

11.2.7 PostGIS_Raster_Lib_Version

PostGIS_Raster_Lib_Version — □□□□□□□□□□□□□□□□□□.

Synopsis

text **PostGIS_Raster_Lib_Version**();

□□

□□□□□□□□□□□□□□□□□□.

□□

```
SELECT PostGIS_Raster_Lib_Version();
postgis_raster_lib_version
-----------------------------
 2.0.0
```

□□

PostGIS_Lib_Version

11.2.8 ST_GDALDrivers

ST_GDALDrivers — Returns a list of raster formats supported by PostGIS through GDAL. Only those formats with can_write=True can be used by ST_AsGDALRaster

Synopsis

setof record **ST_GDALDrivers**(integer OUT idx, text OUT short_name, text OUT long_name, text OUT can_read, text OUT can_write, text OUT create_options);

□□

Returns a list of raster formats short_name,long_name and creator options of each format supported by GDAL. Use the short_name as input in the `format` parameter of ST_AsGDALRaster. Options vary depending on what drivers your libgdal was compiled with. `create_options` returns an xml formatted set of CreationOptionList/Option consisting of name and optional `type`, `description` and set of `VALUE` for each creator option for the specific driver.

Changed: 2.5.0 - add can_read and can_write columns.

□□□□: 2.0.6, 2.1.3 □□ - GUC □□□□□□ gdal_enabled_drivers □□□□□□□□□, □□□□□□□ □□□□□□□□□□□□□□□.

2.0.0 □□□□□□□□□□□□. GDAL 1.6.0 □□□□□□□□□□.

□□: □□□□□□

```
SET postgis.gdal_enabled_drivers = 'ENABLE_ALL';
SELECT short_name, long_name, can_write
FROM st_gdaldrivers()
ORDER BY short_name;

   short_name    |                          long_name                           | can_write
-----------------+--------------------------------------------------------------+-----------
 AAIGrid         | Arc/Info ASCII Grid                                          | t
 ACE2            | ACE2                                                         | f
 ADRG            | ARC Digitized Raster Graphics                                | f
```

```
 AIG              | Arc/Info Binary Grid                                         | f
 AirSAR           | AirSAR Polarimetric Image                                    | f
 ARG              | Azavea Raster Grid format                                    | t
 BAG              | Bathymetry Attributed Grid                                   | f
 BIGGIF           | Graphics Interchange Format (.gif)                           | f
 BLX              | Magellan topo (.blx)                                         | t
 BMP              | MS Windows Device Independent Bitmap                         | f
 BSB              | Maptech BSB Nautical Charts                                  | f
 PAux             | PCI .aux Labelled                                            | f
 PCIDSK           | PCIDSK Database File                                         | f
 PCRaster         | PCRaster Raster File                                         | f
 PDF              | Geospatial PDF                                               | f
 PDS              | NASA Planetary Data System                                   | f
 PDS4             | NASA Planetary Data System 4                                 | t
 PLMOSAIC         | Planet Labs Mosaics API                                      | f
 PLSCENES         | Planet Labs Scenes API                                       | f
 PNG              | Portable Network Graphics                                    | t
 PNM              | Portable Pixmap Format (netpbm)                              | f
 PRF              | Racurs PHOTOMOD PRF                                          | f
 R                | R Object Data Store                                          | t
 Rasterlite       | Rasterlite                                                   | t
 RDA              | DigitalGlobe Raster Data Access driver                       | f
 RIK              | Swedish Grid RIK (.rik)                                      | f
 RMF              | Raster Matrix Format                                         | f
 ROI_PAC          | ROI_PAC raster                                               | f
 RPFTOC           | Raster Product Format TOC format                             | f
 RRASTER          | R Raster                                                     | f
 RS2              | RadarSat 2 XML Product                                       | f
 RST              | Idrisi Raster A.1                                            | t
 SAFE             | Sentinel-1 SAR SAFE Product                                  | f
 SAGA             | SAGA GIS Binary Grid (.sdat, .sg-grd-z)                      | t
 SAR_CEOS         | CEOS SAR Image                                               | f
 SDTS             | SDTS Raster                                                  | f
 SENTINEL2        | Sentinel 2                                                   | f
 SGI              | SGI Image File Format 1.0                                    | f
 SNODAS           | Snow Data Assimilation System                                | f
 SRP              | Standard Raster Product (ASRP/USRP)                          | f
 SRTMHGT          | SRTMHGT File Format                                          | t
 Terragen         | Terragen heightfield                                         | f
 TIL              | EarthWatch .TIL                                              | f
 TSX              | TerraSAR-X Product                                           | f
 USGSDEM          | USGS Optional ASCII DEM (and CDED)                           | t
 VICAR            | MIPL VICAR file                                              | f
 VRT              | Virtual Raster                                               | t
 WCS              | OGC Web Coverage Service                                     | f
 WMS              | OGC Web Map Service                                          | t
 WMTS             | OGC Web Map Tile Service                                     | t
 XPM              | X11 PixMap Format                                            | t
 XYZ              | ASCII Gridded XYZ                                            | t
 ZMap             | ZMap Plus Grid                                               | t
```

□□: □□□□□□□□□□□□□

```
-- Output the create options XML column of JPEG as a table  --
-- Note you can use these creator options in ST_AsGDALRaster options argument
SELECT (xpath('@name', g.opt))[1]::text As oname,
       (xpath('@type', g.opt))[1]::text As otype,
       (xpath('@description', g.opt))[1]::text As descrip
FROM (SELECT unnest(xpath('/CreationOptionList/Option', create_options::xml)) As opt
FROM  st_gdaldrivers()
```

```
WHERE short_name = 'JPEG') As g;

       oname        |  otype  |      descrip
--------------------+---------+-------------------------------------------------
 PROGRESSIVE        | boolean | whether to generate a progressive JPEG
 QUALITY            | int     | good=100, bad=0, default=75
 WORLDFILE          | boolean | whether to generate a worldfile
 INTERNAL_MASK      | boolean | whether to generate a validity mask
 COMMENT            | string  | Comment
 SOURCE_ICC_PROFILE | string  | ICC profile encoded in Base64
 EXIF_THUMBNAIL     | boolean | whether to generate an EXIF thumbnail(overview).
                                By default its max dimension will be 128
 THUMBNAIL_WIDTH    | int     | Forced thumbnail width
 THUMBNAIL_HEIGHT   | int     | Forced thumbnail height
(9 rows)
```

```
-- raw xml output for creator options for GeoTiff --
SELECT create_options
FROM st_gdaldrivers()
WHERE short_name = 'GTiff';

<CreationOptionList>
    <Option name="COMPRESS" type="string-select">
        <Value
>NONE</Value>
        <Value
>LZW</Value>
        <Value
>PACKBITS</Value>
        <Value
>JPEG</Value>
        <Value
>CCITTRLE</Value>
        <Value
>CCITTFAX3</Value>
        <Value
>CCITTFAX4</Value>
        <Value
>DEFLATE</Value>
    </Option>
    <Option name="PREDICTOR" type="int" description="Predictor Type"/>
    <Option name="JPEG_QUALITY" type="int" description="JPEG quality 1-100" default="75"/>
    <Option name="ZLEVEL" type="int" description="DEFLATE compression level 1-9" default ↩
        ="6"/>
    <Option name="NBITS" type="int" description="BITS for sub-byte files (1-7), sub-uint16  ↩
        (9-15), sub-uint32 (17-31)"/>
    <Option name="INTERLEAVE" type="string-select" default="PIXEL">
        <Value
>BAND</Value>
        <Value
>PIXEL</Value>
    </Option>
    <Option name="TILED" type="boolean" description="Switch to tiled format"/>
    <Option name="TFW" type="boolean" description="Write out world file"/>
    <Option name="RPB" type="boolean" description="Write out .RPB (RPC) file"/>
    <Option name="BLOCKXSIZE" type="int" description="Tile Width"/>
    <Option name="BLOCKYSIZE" type="int" description="Tile/Strip Height"/>
    <Option name="PHOTOMETRIC" type="string-select">
        <Value
>MINISBLACK</Value>
        <Value
```

```
>MINISWHITE</Value>
        <Value
>PALETTE</Value>
        <Value
>RGB</Value>
        <Value
>CMYK</Value>
        <Value
>YCBCR</Value>
        <Value
>CIELAB</Value>
        <Value
>ICCLAB</Value>
        <Value
>ITULAB</Value>
    </Option>
    <Option name="SPARSE_OK" type="boolean" description="Can newly created files have ←
        missing blocks?" default="FALSE"/>
    <Option name="ALPHA" type="boolean" description="Mark first extrasample as being alpha ←
        "/>
    <Option name="PROFILE" type="string-select" default="GDALGeoTIFF">
        <Value
>GDALGeoTIFF</Value>
        <Value
>GeoTIFF</Value>
        <Value
>BASELINE</Value>
    </Option>
    <Option name="PIXELTYPE" type="string-select">
        <Value
>DEFAULT</Value>
        <Value
>SIGNEDBYTE</Value>
    </Option>
    <Option name="BIGTIFF" type="string-select" description="Force creation of BigTIFF file ←
        ">
        <Value
>YES</Value>
        <Value
>NO</Value>
        <Value
>IF_NEEDED</Value>
        <Value
>IF_SAFER</Value>
    </Option>
    <Option name="ENDIANNESS" type="string-select" default="NATIVE" description="Force ←
        endianness of created file. For DEBUG purpose mostly">
        <Value
>NATIVE</Value>
        <Value
>INVERTED</Value>
        <Value
>LITTLE</Value>
        <Value
>BIG</Value>
    </Option>
    <Option name="COPY_SRC_OVERVIEWS" type="boolean" default="NO" description="Force copy ←
        of overviews of source dataset (CreateCopy())"/>
</CreationOptionList>

-- Output the create options XML column for GTiff as a table --
SELECT (xpath('@name', g.opt))[1]::text As oname,
```

```
       (xpath('@type', g.opt))[1]::text As otype,
       (xpath('@description', g.opt))[1]::text As descrip,
       array_to_string(xpath('Value/text()', g.opt),', ') As vals
FROM (SELECT unnest(xpath('/CreationOptionList/Option', create_options::xml)) As opt
FROM  st_gdaldrivers()
WHERE short_name = 'GTiff') As g;

       oname        |     otype     |                              descrip  ←
                     |                                    vals
--------------------+---------------+------------------------------------------------------------

 COMPRESS            | string-select |  ←
                                                                          | NONE, LZW,  ←
    PACKBITS, JPEG, CCITTRLE, CCITTFAX3, CCITTFAX4, DEFLATE
 PREDICTOR           | int           | Predictor Type  ←
                                                     |
 JPEG_QUALITY        | int           | JPEG quality 1-100  ←
                                                 |
 ZLEVEL              | int           | DEFLATE compression level 1-9  ←
                                          |
 NBITS               | int           | BITS for sub-byte files (1-7), sub-uint16 (9-15), sub ←
    -uint32 (17-31) |
 INTERLEAVE          | string-select |  ←
                                                                          | BAND, PIXEL
 TILED               | boolean       | Switch to tiled format  ←
                                                         |
 TFW                 | boolean       | Write out world file  ←
                                                           |
 RPB                 | boolean       | Write out .RPB (RPC) file  ←
                                                      |
 BLOCKXSIZE          | int           | Tile Width  ←
                                                                       |
 BLOCKYSIZE          | int           | Tile/Strip Height  ←
                                                               |
 PHOTOMETRIC         | string-select |  ←
                                                                          | MINISBLACK,  ←
    MINISWHITE, PALETTE, RGB, CMYK, YCBCR, CIELAB, ICCLAB, ITULAB
 SPARSE_OK           | boolean       | Can newly created files have missing blocks?  ←
                             |
 ALPHA               | boolean       | Mark first extrasample as being alpha  ←
                                    |
 PROFILE             | string-select |  ←
                                                                          | GDALGeoTIFF,  ←
    GeoTIFF, BASELINE
 PIXELTYPE           | string-select |  ←
                                                                          | DEFAULT,  ←
    SIGNEDBYTE
 BIGTIFF             | string-select | Force creation of BigTIFF file  ←
                                          | YES, NO, IF_NEEDED, IF_SAFER
 ENDIANNESS          | string-select | Force endianness of created file. For DEBUG purpose  ←
    mostly           | NATIVE, INVERTED, LITTLE, BIG
 COPY_SRC_OVERVIEWS | boolean       | Force copy of overviews of source dataset (CreateCopy ←
    ())             |
(19 rows)
```

▯▯

ST_AsGDALRaster, ST_SRID, postgis.gdal_enabled_drivers

11.2.9 ST_Contour

ST_Contour — Generates a set of vector contours from the provided raster band, using the GDAL contouring algorithm.

Synopsis

setof record **ST_Contour**(raster rast, integer bandnumber=1, double precision level_interval=100.0, double precision level_base=0.0, double precision[] fixed_levels=ARRAY[], boolean polygonize=false);

⊠⊠

Generates a set of vector contours from the provided raster band, using the GDAL contouring algorithm.

When the `fixed_levels` parameter is a non-empty array, the `level_interval` and `level_base` parameters are ignored.

Input parameters are:

rast The raster to generate the contour of

bandnumber The band to generate the contour of

level_interval The elevation interval between contours generated

level_base The "base" relative to which contour intervals are applied, this is normally zero, but could be different. To generate 10m contours at 5, 15, 25, ... the LEVEL_BASE would be 5.

fixed_levels The elevation interval between contours generated

polygonize If `true`, contour polygons will be created, rather than polygon lines.

Return values are a set of records with the following attributes:

geom The geometry of the contour line.

id A unique identifier given to the contour line by GDAL.

value The raster value the line represents. For an elevation DEM input, this would be the elevation of the output contour.

Availability: 3.2.0

⊠⊠

```
WITH c AS (
SELECT (ST_Contour(rast, 1, fixed_levels => ARRAY[100.0, 200.0, 300.0])).*
FROM dem_grid WHERE rid = 1
)
SELECT st_astext(geom), id, value
FROM c;
```

⊠⊠

ST_InterpolateRaster

11.2.10 ST_InterpolateRaster

ST_InterpolateRaster — Interpolates a gridded surface based on an input set of 3-d points, using the X- and Y-values to position the points on the grid and the Z-value of the points as the surface elevation.

Synopsis

raster **ST_InterpolateRaster**(geometry input_points, text algorithm_options, raster template, integer template_band_num=1);

⊠⊠

Interpolates a gridded surface based on an input set of 3-d points, using the X- and Y-values to position the points on the grid and the Z-value of the points as the surface elevation. There are five interpolation algorithms available: inverse distance, inverse distance nearest-neighbor, moving average, nearest neighbor, and linear interpolation. See the gdal_grid documentation for more details on the algorithms and their parameters. For more information on how interpolations are calculated, see the GDAL grid tutorial.

Input parameters are:

input_points The points to drive the interpolation. Any geometry with Z-values is acceptable, all points in the input will be used.

algorithm_options A string defining the algorithm and algorithm options, in the format used by gdal_grid. For example, for an inverse-distance interpolation with a smoothing of 2, you would use ”invdist:smoothing=2.0”

template A raster template to drive the geometry of the output raster. The width, height, pixel size, spatial extent and pixel type will be read from this template.

template_band_num By default the first band in the template raster is used to drive the output raster, but that can be adjusted with this parameter.

Availability: 3.2.0

⊠⊠

```
SELECT ST_InterpolateRaster(
    'MULTIPOINT(10.5 9.5 1000, 11.5 8.5 1000, 10.5 8.5 500, 11.5 9.5 500)'::geometry,
    'invdist:smoothing:2.0',
    ST_AddBand(ST_MakeEmptyRaster(200, 400, 10, 10, 0.01, -0.005, 0, 0), '16BSI')
)
```

⊠⊠

ST_Contour

11.2.11 UpdateRasterSRID

UpdateRasterSRID — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠.

Synopsis

raster **UpdateRasterSRID**(name schema_name, name table_name, name column_name, integer new_srid);
raster **UpdateRasterSRID**(name table_name, name column_name, integer new_srid);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠, ⊠⊠⊠⊠⊠ SRID) ⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

UpdateGeometrySRID

11.2.12 ST_CreateOverview

ST_CreateOverview — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

regclass **ST_CreateOverview**(regclass tab, name col, int factor, text algo='NearestNeighbor');

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `1/factor` ⊠⊠⊠⊠⊠⊠).

`raster_overviews` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠'NearestNeighbor', 'Bilinear', 'Cubic', 'CubicSpline', ⊠⊠⊠'Lanczos' ⊠⊠⊠⊠⊠. ⊠⊠ ⊠⊠⊠⊠ GDAL Warp resampling methods ⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

Output to generally better quality but slower to product format

```
SELECT ST_CreateOverview('mydata.mytable'::regclass, 'rast', 2, 'Lanczos');
```

Output to faster to process default nearest neighbor

```
SELECT ST_CreateOverview('mydata.mytable'::regclass, 'rast', 2);
```

⊠⊠

ST_Retile, AddOverviewConstraints, AddRasterConstraints, Section 10.2.2

11.3 ⊠⊠⊠⊠⊠⊠ (constructor)

11.3.1 ST_AddBand

ST_AddBand — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

(1) raster **ST_AddBand**(raster rast, addbandarg[] addbandargset);
(2) raster **ST_AddBand**(raster rast, integer index, text pixeltype, double precision initialvalue=0, double precision nodataval=NULL);
(3) raster **ST_AddBand**(raster rast, text pixeltype, double precision initialvalue=0, double precision nodataval=NULL);
(4) raster **ST_AddBand**(raster torast, raster fromrast, integer fromband=1, integer torastindex=at_end);
(5) raster **ST_AddBand**(raster torast, raster[] fromrasts, integer fromband=1, integer torastindex=at_end);
(6) raster **ST_AddBand**(raster rast, integer index, text outdbfile, integer[] outdbindex, double precision nodataval=NULL);
(7) raster **ST_AddBand**(raster rast, text outdbfile, integer[] outdbindex, integer index=at_end, double precision nodataval=NULL);

⊠⊠

Returns a raster with a new band added in given position (index), of given type, of given initial value, and of given nodata value. If no index is specified, the band is added to the end. If no `fromband` is specified, band 1 is assumed. Pixel type is a string representation of one of the pixel types specified in ST_BandPixelType. If an existing index is specified all subsequent bands >= that index are incremented by 1. If an initial value greater than the max of the pixel type is specified, then the initial value is set to the highest value allowed by the pixel type.

addbandarg ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠, ⊠⊠ addbandarg ⊠⊠⊠⊠⊠⊠ addbandarg ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 5 ⊠⊠⊠, `torast` ⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `fromband` ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠ (累計) ⊠⊠⊠.

`outdbfile` ⊠⊠⊠⊠⊠⊠⊠ 6 ⊠ 7 ⊠⊠⊠, `outdbfile` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ addbandarg ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠ DB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠

```
-- Add another band of type 8 bit unsigned integer with pixels initialized to 200
UPDATE dummy_rast
    SET rast = ST_AddBand(rast,'8BUI'::text,200)
WHERE rid = 1;
```

```
-- Create an empty raster 100x100 units, with upper left  right at 0, add 2 bands (band 1 is 0/1 boolean bit switch, band2 allows values 0-15)
-- uses addbandargs
INSERT INTO dummy_rast(rid,rast)
    VALUES(10, ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 1, -1, 0, 0, 0),
    ARRAY[
        ROW(1, '1BB'::text, 0, NULL),
        ROW(2, '4BUI'::text, 0, NULL)
            ]::addbandarg[]
     )
    );

-- output meta data of raster bands to verify all is right --
SELECT  (bmd).*
FROM (SELECT ST_BandMetaData(rast,generate_series(1,2)) As bmd
    FROM dummy_rast WHERE rid = 10) AS foo;
 --result --
 pixeltype | nodatavalue | isoutdb | path
-----------+----------------+-------------+---------+------
 1BB       |             | f       |
 4BUI      |             | f       |


-- output meta data of raster -
SELECT  (rmd).width, (rmd).height, (rmd).numbands
FROM (SELECT ST_MetaData(rast) As rmd
    FROM dummy_rast WHERE rid = 10) AS foo;
-- result --
 upperleftx | upperlefty | width | height | scalex | scaley | skewx | skewy | srid | numbands
------------+------------+-------+--------+------------+------------+-------+-------+------+----------
          0 |          0 |   100 |    100 |      1 |     -1 |     0 |     0 |   0 |        2
```

□□: □□□□□□□□□

```
SELECT
    *
FROM ST_BandMetadata(
    ST_AddBand(
        ST_MakeEmptyRaster(10, 10, 0, 0, 1, -1, 0, 0, 0),
        ARRAY[
            ROW(NULL, '8BUI', 255, 0),
            ROW(NULL, '16BUI', 1, 2),
            ROW(2, '32BUI', 100, 12),
            ROW(2, '32BF', 3.14, -1)
        ]::addbandarg[]
    ),
    ARRAY[]::integer[]
);

 bandnum | pixeltype | nodatavalue | isoutdb | path
---------+-----------+-------------+---------+------
       1 | 8BUI      |           0 | f       |
       2 | 32BF      |          -1 | f       |
       3 | 32BUI     |          12 | f       |
       4 | 16BUI     |           2 | f       |
```

```
-- Aggregate the 1st band of a table of like rasters into a single raster
-- with as many bands as there are test_types and as many rows (new rasters) as there are mice
-- NOTE: The ORDER BY test_type is only supported in PostgreSQL 9.0+
-- for 8.4 and below it usually works to order your data in a subselect (but not guaranteed )
-- The resulting raster will have a band for each test_type alphabetical by test_type
-- For mouse lovers: No mice were harmed in this exercise
SELECT
    mouse,
    ST_AddBand(NULL, array_agg(rast ORDER BY test_type), 1) As rast
FROM mice_studies
GROUP BY mouse;
```

☒☒: ☒☒☒ DB ☒☒☒☒

```
SELECT
    *
FROM ST_BandMetadata(
    ST_AddBand(
        ST_MakeEmptyRaster(10, 10, 0, 0, 1, -1, 0, 0, 0),
        '/home/raster/mytestraster.tif'::text, NULL::int[]
    ),
    ARRAY[]::integer[]
);

 bandnum | pixeltype | nodatavalue | isoutdb | path
---------+-----------+-------------+---------+------
       1 | 8BUI      |             | t       | /home/raster/mytestraster.tif
       2 | 8BUI      |             | t       | /home/raster/mytestraster.tif
       3 | 8BUI      |             | t       | /home/raster/mytestraster.tif
```

☒☒

ST_BandMetaData, ST_BandPixelType, ST_MakeEmptyRaster, ST_MetaData, ST_NumBands, ST_Reclass

11.3.2 ST_AsRaster

ST_AsRaster — PostGIS ☒☒☒ PostGIS ☒☒☒☒☒☒☒☒☒.

Synopsis

raster **ST_AsRaster**(geometry geom, raster ref, text pixeltype, double precision value=1, double precision nodataval=0, boolean touched=false);
raster **ST_AsRaster**(geometry geom, raster ref, text[] pixeltype=ARRAY['8BUI'], double precision[] value=ARRAY[1], double precision[] nodataval=ARRAY[0], boolean touched=false);
raster **ST_AsRaster**(geometry geom, double precision scalex, double precision scaley, double precision gridx, double precision gridy, text pixeltype, double precision value=1, double precision nodataval=0, double precision skewx=0, double precision skewy=0, boolean touched=false);
raster **ST_AsRaster**(geometry geom, double precision scalex, double precision scaley, double precision gridx=NULL, double precision gridy=NULL, text[] pixeltype=ARRAY['8BUI'], double precision[] value=ARRAY[1], double precision[] nodataval=ARRAY[0], double precision skewx=0, double precision skewy=0, boolean touched=false);

raster **ST_AsRaster**(geometry geom, double precision scalex, double precision scaley, text pixeltype, double precision value=1, double precision nodataval=0, double precision upperleftx=NULL, double precision upperlefty=NULL, double precision skewx=0, double precision skewy=0, boolean touched=false);
raster **ST_AsRaster**(geometry geom, double precision scalex, double precision scaley, text[] pixeltype, double precision[] value=ARRAY[1], double precision[] nodataval=ARRAY[0], double precision upperleftx=NULL, double precision upperlefty=NULL, double precision skewx=0, double precision skewy=0, boolean touched=false);
raster **ST_AsRaster**(geometry geom, integer width, integer height, double precision gridx, double precision gridy, text pixeltype, double precision value=1, double precision nodataval=0, double precision skewx=0, double precision skewy=0, boolean touched=false);
raster **ST_AsRaster**(geometry geom, integer width, integer height, double precision gridx=NULL, double precision gridy=NULL, text[] pixeltype=ARRAY['8BUI'], double precision[] value=ARRAY[1], double precision[] nodataval=ARRAY[0], double precision skewx=0, double precision skewy=0, boolean touched=false);
raster **ST_AsRaster**(geometry geom, integer width, integer height, text pixeltype, double precision value=1, double precision nodataval=0, double precision upperleftx=NULL, double precision upperlefty=NULL, double precision skewx=0, double precision skewy=0, boolean touched=false);
raster **ST_AsRaster**(geometry geom, integer width, integer height, text[] pixeltype, double precision[] value=ARRAY[1], double precision[] nodataval=ARRAY[0], double precision upperleftx=NULL, double precision upperlefty=NULL, double precision skewx=0, double precision skewy=0, boolean touched=false);

⊠⊠

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⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (scalex, scaley ⊠ gridx, gridy), ⊠⊠⊠⊠, NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠, ⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (scalex & scaley ⊠ skewx & skewy) ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ width & height ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ ⊠⊠⊠⊠⊠, ⊠⊠⊠ scalex & scaley ⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (width & height) ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (scalex & scaley ⊠ skewx & skewy) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (gridx & gridy) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (upperleftx & upperlefty)) ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (pixeltype[]), ⊠⊠⊠⊠⊠⊠ (value) ⊠⊠⊠ NODTATA ⊠⊠⊠⊠ (nodataval) ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 8BUI, ⊠⊠⊠⊠ 1, NODATA ⊠⊠ 0 ⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠.

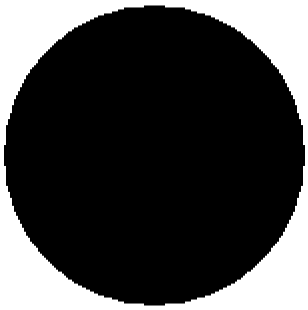
⊠⊠⊠⊠ touched ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ALL_TOUCHED ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠ ST_AsPNG ⊠⊠⊠ ST_AsGDALRaster ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ JPEG ⊠⊠ PNG ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

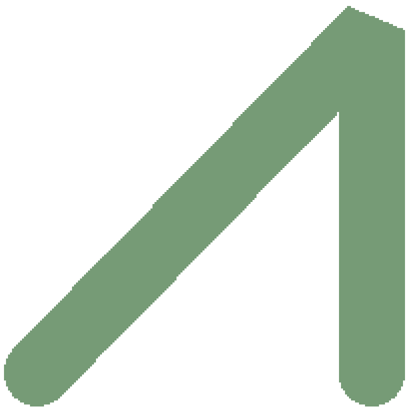
> **Note**
> ⊠⊠⊠⊠⊠⊠⊠, TIN, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: PNG ⊠⊠⊠⊠⊠⊠⊠⊠⊠



⊠⊠⊠⊠

```
-- this will output a black circle taking up 150 x 150 pixels --
SELECT ST_AsPNG(ST_AsRaster(ST_Buffer(ST_Point(1,5),10),150, 150));
```



PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
-- the bands map to RGB bands - the value (118,154,118) - teal  --
SELECT ST_AsPNG(
    ST_AsRaster(
        ST_Buffer(
            ST_GeomFromText('LINESTRING(50 50,150 150,150 50)'), 10,'join=bevel'),
            200,200,ARRAY['8BUI', '8BUI', '8BUI'], ARRAY[118,154,118], ARRAY[0,0,0]));
```

⊠⊠

ST_BandPixelType, ST_Buffer, ST_GDALDrivers, ST_AsGDALRaster, ST_AsPNG, ST_AsJPEG, ST_SRID

11.3.3 ST_Band

ST_Band — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠.

Synopsis

raster **ST_Band**(raster rast, integer[] nbands = ARRAY[1]);
raster **ST_Band**(raster rast, integer nband);
raster **ST_Band**(raster rast, text nbands, character delimiter=,);

⊠⊠

Returns one or more bands of an existing raster as a new raster. Useful for building new rasters from existing rasters or export of only selected bands of a raster or rearranging the order of bands in a raster. If no band is specified or any of specified bands does not exist in the raster, then all bands are returned. Used as a helper function in various functions such as for deleting a band.

> **Warning**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ nbands ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ , ⊠ ’1,2,3’ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Band(rast, ’1@2@3’, ’@’) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Band(rast, ’{1,2,3}’::int[]); ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ text ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- Make 2 new rasters: 1 containing band 1 of dummy, second containing band 2 of dummy and ↩
   then reclassified as a 2BUI
SELECT ST_NumBands(rast1) As numb1, ST_BandPixelType(rast1) As pix1,
 ST_NumBands(rast2) As numb2,  ST_BandPixelType(rast2) As pix2
FROM (
    SELECT ST_Band(rast) As rast1, ST_Reclass(ST_Band(rast,3), '100-200):1, [200-254:2', '2 ↩
        BUI') As rast2
        FROM dummy_rast
        WHERE rid = 2) As foo;

 numb1 | pix1 | numb2 | pix2
-------+------+-------+------
     1 | 8BUI |     1 | 2BUI
```

```
-- Return bands 2 and 3. Using array cast syntax
SELECT ST_NumBands(ST_Band(rast, '{2,3}'::int[])) As num_bands
    FROM dummy_rast WHERE rid=2;

num_bands
----------
2

-- Return bands 2 and 3. Use array to define bands
SELECT ST_NumBands(ST_Band(rast, ARRAY[2,3])) As num_bands
    FROM dummy_rast
WHERE rid=2;
```

		
⊠⊠ *(rast ⊠)*	*dupe_band*	*sing_band*

```
--Make a new raster with 2nd band of original and 1st band repeated twice,
and another with just the third band
SELECT rast, ST_Band(rast, ARRAY[2,1,1]) As dupe_band,
    ST_Band(rast, 3) As sing_band
FROM samples.than_chunked
WHERE rid=35;
```

⊠⊠

ST_AddBand, ST_NumBands, ST_Reclass, Chapter 11

11.3.4 ST_MakeEmptyCoverage

ST_MakeEmptyCoverage — Cover georeferenced area with a grid of empty raster tiles.

Synopsis

raster **ST_MakeEmptyCoverage**(integer tilewidth, integer tileheight, integer width, integer height, double precision upperleftx, double precision upperlefty, double precision scalex, double precision scaley, double precision skewx, double precision skewy, integer srid=unknown);

⊠⊠

Create a set of raster tiles with ST_MakeEmptyRaster. Grid dimension is `width` & `height`. Tile dimension is `tilewidth` & `tileheight`. The covered georeferenced area is from upper left corner (`upperleftx`, `upperlefty`) to lower right corner (`upperleftx` + `width` * `scalex`, `upperlefty` + `height` * `scaley`).

> **Note**
> Note that scaley is generally negative for rasters and scalex is generally positive. So lower right corner will have a lower y value and higher x value than the upper left corner.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□□□

Create 16 tiles in a 4x4 grid to cover the WGS84 area from upper left corner (22, 77) to lower right corner (55, 33).

```
SELECT (ST_MetaData(tile)).* FROM ST_MakeEmptyCoverage(1, 1, 4, 4, 22, 33, (55 - 22)/(4):: ↩
    float, (33 - 77)/(4)::float, 0., 0., 4326) tile;

 upperleftx | upperlefty | width | height | scalex | scaley | skewx | skewy | srid | ↩
     numbands
-------------------------------------------------------------------------------------
         22 |         33 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                    0
      30.25 |         33 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                 0
       38.5 |         33 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                  0
      46.75 |         33 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                 0
         22 |         22 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                    0
      30.25 |         22 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                 0
       38.5 |         22 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                  0
      46.75 |         22 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                 0
         22 |         11 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                    0
      30.25 |         11 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                 0
       38.5 |         11 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                  0
      46.75 |         11 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                 0
         22 |          0 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                    0
      30.25 |          0 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                 0
       38.5 |          0 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                  0
      46.75 |          0 |     1 |      1 |   8.25 |    -11 |     0 |     0 | 4326 | ↩
                 0
```

□□

ST_MakeEmptyRaster

11.3.5 ST_MakeEmptyRaster

ST_MakeEmptyRaster — □□□□□ (□□ & □□), □□□ X □ Y, □□□□, □□ (scalex, scaley, skewx & skewy) □□□□□□□□□□ (SRID) □□□□□ (□□□□□) □□□□□□□□□. □□□□□□□□□, □□□□□, □□□□□ SRID □□□□□□□□□□□□□. SRID □□□□□□, □□□□□□□□□ 0(unknown) □□□□□□□.

Synopsis

raster **ST_MakeEmptyRaster**(raster rast);
raster **ST_MakeEmptyRaster**(integer width, integer height, float8 upperleftx, float8 upperlefty, float8 scalex, float8 scaley, float8 skewx, float8 skewy, integer srid=unknown);
raster **ST_MakeEmptyRaster**(integer width, integer height, float8 upperleftx, float8 upperlefty, float8 pixelsize);

⊠⊠

⊠⊠⊠⊠⊠ (⊠⊠ & ⊠⊠), ⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X(upperleftx) ⊠⊠⊠⊠ Y(upperlefty), ⊠⊠⊠⊠, ⊠⊠ (scalex, scaley, skewx & skewy) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRID) ⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (pixelsize) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. scalex ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, scaley ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. skewx ⊠ skewy ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠⊠⊠. ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_AddBand ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_SetValue ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
INSERT INTO dummy_rast(rid,rast)
VALUES(3, ST_MakeEmptyRaster( 100, 100, 0.0005, 0.0005, 1, 1, 0, 0, 4326) );

--use an existing raster as template for new raster
INSERT INTO dummy_rast(rid,rast)
SELECT 4, ST_MakeEmptyRaster(rast)
FROM dummy_rast WHERE rid = 3;

-- output meta data of rasters we just added
SELECT rid, (md).*
FROM (SELECT rid, ST_MetaData(rast) As md
    FROM dummy_rast
    WHERE rid IN(3,4)) As foo;

-- output --
 rid | upperleftx | upperlefty | width | height | scalex | scaley | skewx | skewy | srid | numbands
-----+------------+------------+-------+--------+------------+------------+-------+-------+------+--

   3 |     0.0005 |     0.0005 |   100 |    100 |          1 |          1 |    0  |     0 | 4326 |        0
   4 |     0.0005 |     0.0005 |   100 |    100 |          1 |          1 |    0  |     0 | 4326 |        0
```

⊠⊠

ST_AddBand, ST_MetaData, ST_ScaleX, ST_ScaleY, ST_SetValue, ST_SkewX, , ST_SkewY

11.3.6 ST_Tile

ST_Tile — ⊠⊠.

Synopsis

setof raster **ST_Tile**(raster rast, int[] nband, integer width, integer height, boolean padwithnodata=FALSE, double precision nodataval=NULL);
setof raster **ST_Tile**(raster rast, integer nband, integer width, integer height, boolean padwithnodata=FALSE, double precision nodataval=NULL);
setof raster **ST_Tile**(raster rast, integer width, integer height, boolean padwithnodata=FALSE, double precision nodataval=NULL);

⊠⊠

⊠⊠⊠.

`padwithnodata` = FALSE ⊠⊠⊠, ⊠⊠. `padwithnodata` = TRUE ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠ (padding) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠ NODATA ⊠ (⊠) ⊠⊠⊠⊠⊠⊠⊠⊠, `nodataval` ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ DB ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ DB ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
WITH foo AS (
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', 1, 0), 2, '8BUI', 10, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, 0, 1, -1, 0, 0, 0), 1, '8BUI', 2, 0), 2, '8BUI', 20, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, 0, 1, -1, 0, 0, 0), 1, '8BUI', 3, 0), 2, '8BUI', 30, 0) AS rast UNION ALL

    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, -3, 1, -1, 0, 0, 0), 1, '8BUI', 4, 0), 2, '8BUI', 40, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, -3, 1, -1, 0, 0, 0), 1, '8BUI', 5, 0), 2, '8BUI', 50, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, -3, 1, -1, 0, 0, 0), 1, '8BUI', 6, 0), 2, '8BUI', 60, 0) AS rast UNION ALL

    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, -6, 1, -1, 0, 0, 0), 1, '8BUI', 7, 0), 2, '8BUI', 70, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, -6, 1, -1, 0, 0, 0), 1, '8BUI', 8, 0), 2, '8BUI', 80, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, -6, 1, -1, 0, 0, 0), 1, '8BUI', 9, 0), 2, '8BUI', 90, 0) AS rast
), bar AS (
    SELECT ST_Union(rast) AS rast FROM foo
), baz AS (
    SELECT ST_Tile(rast, 3, 3, TRUE) AS rast FROM bar
)
SELECT
    ST_DumpValues(rast)
FROM baz;
```

```
              st_dumpvalues
------------------------------------------
 (1,"{{1,1,1},{1,1,1},{1,1,1}}")
 (2,"{{10,10,10},{10,10,10},{10,10,10}}")
 (1,"{{2,2,2},{2,2,2},{2,2,2}}")
 (2,"{{20,20,20},{20,20,20},{20,20,20}}")
 (1,"{{3,3,3},{3,3,3},{3,3,3}}")
 (2,"{{30,30,30},{30,30,30},{30,30,30}}")
 (1,"{{4,4,4},{4,4,4},{4,4,4}}")
 (2,"{{40,40,40},{40,40,40},{40,40,40}}")
 (1,"{{5,5,5},{5,5,5},{5,5,5}}")
 (2,"{{50,50,50},{50,50,50},{50,50,50}}")
 (1,"{{6,6,6},{6,6,6},{6,6,6}}")
 (2,"{{60,60,60},{60,60,60},{60,60,60}}")
 (1,"{{7,7,7},{7,7,7},{7,7,7}}")
 (2,"{{70,70,70},{70,70,70},{70,70,70}}")
 (1,"{{8,8,8},{8,8,8},{8,8,8}}")
 (2,"{{80,80,80},{80,80,80},{80,80,80}}")
 (1,"{{9,9,9},{9,9,9},{9,9,9}}")
 (2,"{{90,90,90},{90,90,90},{90,90,90}}")
(18 rows)
```

```
WITH foo AS (
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', ↩
         1, 0), 2, '8BUI', 10, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, 0, 1, -1, 0, 0, 0), 1, '8BUI', ↩
         2, 0), 2, '8BUI', 20, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, 0, 1, -1, 0, 0, 0), 1, '8BUI', ↩
         3, 0), 2, '8BUI', 30, 0) AS rast UNION ALL

    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, -3, 1, -1, 0, 0, 0), 1, '8BUI ↩
        ', 4, 0), 2, '8BUI', 40, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, -3, 1, -1, 0, 0, 0), 1, '8BUI ↩
        ', 5, 0), 2, '8BUI', 50, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, -3, 1, -1, 0, 0, 0), 1, '8BUI ↩
        ', 6, 0), 2, '8BUI', 60, 0) AS rast UNION ALL

    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, -6, 1, -1, 0, 0, 0), 1, '8BUI ↩
        ', 7, 0), 2, '8BUI', 70, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, -6, 1, -1, 0, 0, 0), 1, '8BUI ↩
        ', 8, 0), 2, '8BUI', 80, 0) AS rast UNION ALL
    SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, -6, 1, -1, 0, 0, 0), 1, '8BUI ↩
        ', 9, 0), 2, '8BUI', 90, 0) AS rast
), bar AS (
    SELECT ST_Union(rast) AS rast FROM foo
), baz AS (
    SELECT ST_Tile(rast, 3, 3, 2) AS rast FROM bar
)
SELECT
    ST_DumpValues(rast)
FROM baz;

              st_dumpvalues
------------------------------------------
 (1,"{{10,10,10},{10,10,10},{10,10,10}}")
 (1,"{{20,20,20},{20,20,20},{20,20,20}}")
 (1,"{{30,30,30},{30,30,30},{30,30,30}}")
 (1,"{{40,40,40},{40,40,40},{40,40,40}}")
 (1,"{{50,50,50},{50,50,50},{50,50,50}}")
 (1,"{{60,60,60},{60,60,60},{60,60,60}}")
 (1,"{{70,70,70},{70,70,70},{70,70,70}}")
 (1,"{{80,80,80},{80,80,80},{80,80,80}}")
```

```
 (1,"{{90,90,90},{90,90,90},{90,90,90}}")
(9 rows)
```

⊠⊠

ST_Union, ST_Retile

11.3.7 ST_Retile

ST_Retile — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

SETOF raster **ST_Retile**(regclass tab, name col, geometry ext, float8 sfx, float8 sfy, int tw, int th, text algo='NearestNeighbor');

⊠⊠

⊠⊠⊠⊠⊠ (`sfx`, `sfy`) ⊠⊠⊠⊠⊠ (`tw`, `th`) ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (`tab`, `col`) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ (`ext`) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠'NearestNeighbor', 'Bilinear', 'Cubic', 'CubicSpline', ⊠⊠⊠'Lanczos' ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ GDAL Warp resampling methods ⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

ST_CreateOverview

11.3.8 ST_FromGDALRaster

ST_FromGDALRaster — ⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_FromGDALRaster**(bytea gdaldata, integer srid=NULL);

⊠⊠

⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `gdaldata` ⊠ bytea ⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`srid` ⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `srid` ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
WITH foo AS (
    SELECT ST_AsPNG(ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 0.1,  ↩
        -0.1, 0, 0, 4326), 1, '8BUI', 1, 0), 2, '8BUI', 2, 0), 3, '8BUI', 3, 0)) AS png
),
bar AS (
    SELECT 1 AS rid, ST_FromGDALRaster(png) AS rast FROM foo
    UNION ALL
    SELECT 2 AS rid, ST_FromGDALRaster(png, 3310) AS rast FROM foo
)
SELECT
    rid,
    ST_Metadata(rast) AS metadata,
    ST_SummaryStats(rast, 1) AS stats1,
    ST_SummaryStats(rast, 2) AS stats2,
    ST_SummaryStats(rast, 3) AS stats3
FROM bar
ORDER BY rid;

 rid |         metadata          |    stats1     |    stats2     |     stats3
-----+---------------------------+---------------+---------------+----------------
   1 | (0,0,2,2,1,-1,0,0,0,3)    | (4,4,1,0,1,1) | (4,8,2,0,2,2) | (4,12,3,0,3,3)
   2 | (0,0,2,2,1,-1,0,0,3310,3) | (4,4,1,0,1,1) | (4,8,2,0,2,2) | (4,12,3,0,3,3)
(2 rows)
```

⊠⊠

ST_AsGDALRaster

11.4 ⊠⊠⊠⊠⊠⊠ (accessor)

11.4.1 ST_GeoReference

ST_GeoReference — ⊠⊠ (world) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠ ESRI ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠. ⊠⊠⊠⊠ GDAL ⊠⊠⊠.

Synopsis

text **ST_GeoReference**(raster rast, text format=GDAL);

⊠⊠

⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ (carriage) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠ ESRI ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠'GDAL' ⊠⊠'ESRI' ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

GDAL:

```
scalex
skewy
skewx
scaley
```

```
upperleftx
upperlefty
```

ESRI:

```
scalex
skewy
skewx
scaley
upperleftx + scalex*0.5
upperlefty + scaley*0.5
```

⊠⊠

```
SELECT ST_GeoReference(rast, 'ESRI') As esri_ref, ST_GeoReference(rast, 'GDAL') As gdal_ref
 FROM dummy_rast WHERE rid=1;

   esri_ref   |   gdal_ref
--------------+--------------
 2.0000000000 | 2.0000000000
 0.0000000000 : 0.0000000000
 0.0000000000 : 0.0000000000
 3.0000000000 : 3.0000000000
 1.5000000000 : 0.5000000000
 2.0000000000 : 0.5000000000
```

⊠⊠

ST_SetGeoReference, ST_ScaleX, ST_ScaleY

11.4.2 ST_Height

ST_Height — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_Height**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT rid, ST_Height(rast) As rastheight
FROM dummy_rast;

 rid | rastheight
-----+------------
   1 |         20
   2 |          5
```

⊠⊠

ST_Width

11.4.3 ST_IsEmpty

ST_IsEmpty — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (width = 0, height = 0) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

Synopsis

boolean **ST_IsEmpty**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (width = 0, height = 0) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_IsEmpty(ST_MakeEmptyRaster(100, 100, 0, 0, 0, 0, 0, 0))
st_isempty |
-----------+
f          |


SELECT ST_IsEmpty(ST_MakeEmptyRaster(0, 0, 0, 0, 0, 0, 0, 0))
st_isempty |
-----------+
t          |
```

⊠⊠

ST_HasNoBand

11.4.4 ST_MemSize

ST_MemSize — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠.

Synopsis

integer **ST_MemSize**(raster rast);

□□

□□□□□□□□□□□□□□ (□□□□□□) □□□□□.

□□□□ PostgreSQL □□□□□□ pg_column_size, pg_size_pretty, pg_relation_size, pg_total_relation_size □□□□□□□□□.

> **Note**
> □□□□□□□□□□□□□□ pg_relation_size □ ST_MemSize □□□□□□□□□□□□□□□□ □□□. □□□□ pg_relation_size □□□ TOAST □□□□□□□□□□□□□□ TOAST □□□□□ □□□□□□□□□□□□□□□□□□□□. pg_column_size □□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□.
> pg_total_relation_size □□□□□□, TOAST □□□□□□□□□□□□□□□□□.

2.2.0 □□□□□□□□□□□□.

□□

```
SELECT ST_MemSize(ST_AsRaster(ST_Buffer(ST_Point(1,5),10,1000),150, 150, '8BUI')) As ↩
    rast_mem;

        rast_mem
        --------
        22568
```

□□

11.4.5 ST_MetaData

ST_MetaData — □□□□□□□□□□, □□ (skew), □□□, □□□□□□□□□□□□□□□□□□□□.

Synopsis

record **ST_MetaData**(raster rast);

□□

□□□□□□□□□□, □□ (skew), □□□, □□□□□□□□□□□□□□□□□□□□. □□□□□□□□□ □□□□□: upperleftx | upperlefty | width | height | scalex | scaley | skewx | skewy | srid | numbands

□□

```
SELECT rid, (foo.md).*
 FROM (SELECT rid, ST_MetaData(rast) As md
FROM dummy_rast) As foo;

 rid | upperleftx | upperlefty | width | height | scalex | scaley | skewx | skewy | srid |  ↩
    numbands
 ----+------------+------------+-------+--------+--------+-----------+-------+-------+------+-------
```

```
   1 |        0.5 |        0.5 |    10 |     20 |      2 |      3 |     0 |     0 |    0 | ↩
            0
   2 | 3427927.75 |    5793244 |     5 |      5 |   0.05 |  -0.05 |     0 |     0 |    0 | ↩
            3
```

⊠⊠

ST_BandMetaData, ST_NumBands

11.4.6 ST_NumBands

ST_NumBands — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_NumBands**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT rid, ST_NumBands(rast) As numbands
FROM dummy_rast;

rid | numbands
----+----------
  1 |        0
  2 |        3
```

⊠⊠

ST_Value

11.4.7 ST_PixelHeight

ST_PixelHeight — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

double precision **ST_PixelHeight**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_PixelWidth ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_Height(rast) As rastheight, ST_PixelHeight(rast) As pixheight,
 ST_ScaleX(rast) As scalex, ST_ScaleY(rast) As scaley, ST_SkewX(rast) As skewx,
        ST_SkewY(rast) As skewy
FROM dummy_rast;

 rastheight | pixheight | scalex | scaley | skewx | skewy
------------+-----------+--------+--------+-------+----------
         20 |         3 |      2 |      3 |     0 |        0
          5 |      0.05 |   0.05 |  -0.05 |     0 |        0
```

⊠⊠: 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_Height(rast) As rastheight, ST_PixelHeight(rast) As pixheight,
 ST_ScaleX(rast) As scalex, ST_ScaleY(rast) As scaley, ST_SkewX(rast) As skewx,
        ST_SkewY(rast) As skewy
FROM (SELECT ST_SetSKew(rast,0.5,0.5) As rast
        FROM dummy_rast) As skewed;

rastheight |     pixheight     | scalex | scaley | skewx | skewy
-----------+-------------------+--------+--------+-------+----------
        20 |  3.04138126514911 |      2 |      3 |   0.5 |      0.5
         5 | 0.502493781056044 |   0.05 |  -0.05 |   0.5 |      0.5
```

⊠⊠

ST_PixelWidth, ST_ScaleX, ST_ScaleY, ST_SkewX, ST_SkewY

11.4.8 ST_PixelWidth

ST_PixelWidth — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

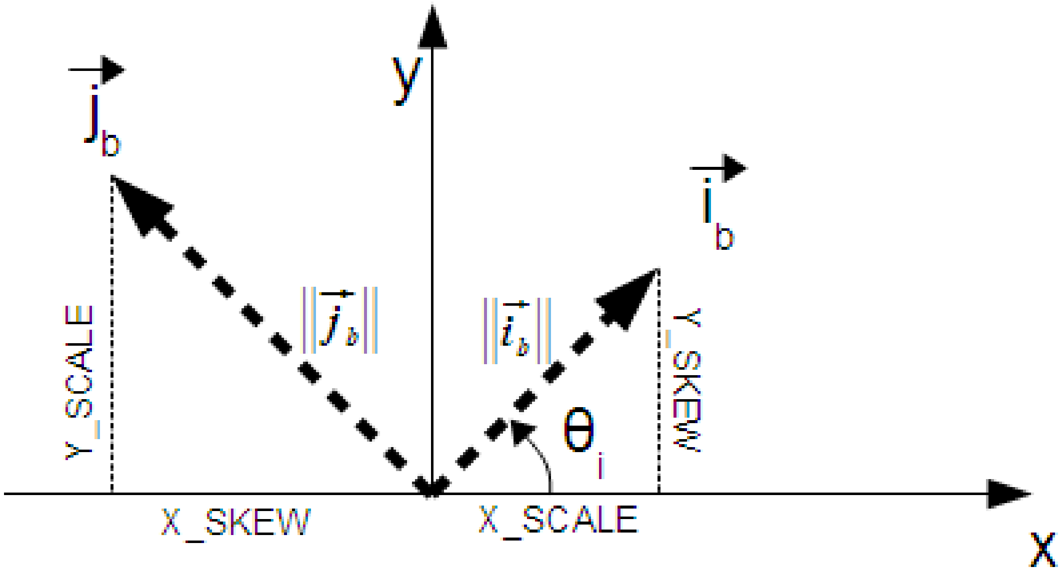
Synopsis

double precision **ST_PixelWidth**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:



⊠⊠⊠⊠: *i* ⊠⊠⊠⊠⊠⊠⊠⊠
⊠⊠⊠⊠: *j* ⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_Width(rast) As rastwidth, ST_PixelWidth(rast) As pixwidth,
    ST_ScaleX(rast) As scalex, ST_ScaleY(rast) As scaley, ST_SkewX(rast) As skewx,
    ST_SkewY(rast) As skewy
    FROM dummy_rast;

    rastwidth | pixwidth | scalex | scaley | skewx | skewy
    -----------+----------+--------+--------+-------+----------
    10 |        2 |      2 |      3 |     0 |        0
     5 |     0.05 |   0.05 |  -0.05 |     0 |        0
```

⊠⊠: 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT ST_Width(rast) As rastwidth, ST_PixelWidth(rast) As pixwidth,
    ST_ScaleX(rast) As scalex, ST_ScaleY(rast) As scaley, ST_SkewX(rast) As skewx,
    ST_SkewY(rast) As skewy
    FROM (SELECT ST_SetSkew(rast,0.5,0.5) As rast
    FROM dummy_rast) As skewed;

    rastwidth |     pixwidth      | scalex | scaley | skewx | skewy
    -----------+-------------------+--------+--------+-------+----------
    10 |  2.06155281280883 |      2 |      3 |   0.5 |      0.5
     5 | 0.502493781056044 |   0.05 |  -0.05 |   0.5 |      0.5
```

⊠⊠

ST_PixelHeight, ST_ScaleX, ST_ScaleY, ST_SkewX, ST_SkewY

11.4.9 ST_ScaleX

ST_ScaleX — [illegible] X [illegible].

Synopsis

float8 **ST_ScaleX**(raster rast);

[illegible]

[illegible] X [illegible]. [illegible] [illegible] [illegible].

[illegible]: 2.0.0 [illegible] WKTRaster [illegible] ST_PixelSizeX [illegible].

[illegible]

```
SELECT rid, ST_ScaleX(rast) As rastpixwidth
FROM dummy_rast;

 rid | rastpixwidth
-----+--------------
   1 |            2
   2 |         0.05
```

[illegible]

ST_Width

11.4.10 ST_ScaleY

ST_ScaleY — [illegible] Y [illegible].

Synopsis

float8 **ST_ScaleY**(raster rast);

[illegible]

[illegible] Y [illegible]. [illegible]. [illegible] [illegible] [illegible].

[illegible]: 2.0.0 [illegible] WKTRaster [illegible] ST_PixelSizeY [illegible].

[illegible]

```
SELECT rid, ST_ScaleY(rast) As rastpixheight
FROM dummy_rast;

 rid | rastpixheight
-----+---------------
   1 |             3
   2 |         -0.05
```

□□

ST_Height

11.4.11 ST_RasterToWorldCoord

ST_RasterToWorldCoord — □□□□□□□□□□□□□□□□□□□□□ X, Y(□□, □□) □□□□□□□□. □□□□ 1 □□□□□□□.

Synopsis

record **ST_RasterToWorldCoord**(raster rast, integer xcolumn, integer yrow);

□□

□□□□□□□□□□□□□□□□□□□□□ X, Y(□□, □□) □□□□□□. □□□ X, Y □□□□□□□□□ □□□□□□□□□□□. □□□□□□□ 1 □□□□□□□□□□□□□□□□□□□ 0, □□, □□□□□□□□ □□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□.

2.1.0 □□□□□□□□□□□□.

□□

```
-- non-skewed raster
SELECT
    rid,
    (ST_RasterToWorldCoord(rast,1, 1)).*,
    (ST_RasterToWorldCoord(rast,2, 2)).*
FROM dummy_rast

 rid | longitude  | latitude | longitude |  latitude
-----+------------+----------+-----------+------------
   1 |        0.5 |      0.5 |       2.5 |        3.5
   2 | 3427927.75 |  5793244 | 3427927.8 | 5793243.95
```

```
-- skewed raster
SELECT
    rid,
    (ST_RasterToWorldCoord(rast, 1, 1)).*,
    (ST_RasterToWorldCoord(rast, 2, 3)).*
FROM (
    SELECT
        rid,
        ST_SetSkew(rast, 100.5, 0) As rast
    FROM dummy_rast
) As foo

 rid | longitude  | latitude | longitude | latitude
-----+------------+----------+-----------+-----------
   1 |        0.5 |      0.5 |     203.5 |       6.5
   2 | 3427927.75 |  5793244 | 3428128.8 | 5793243.9
```

⊠⊠

ST_RasterToWorldCoordX, ST_RasterToWorldCoordY, ST_SetSkew

11.4.12 ST_RasterToWorldCoordX

ST_RasterToWorldCoordX — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_RasterToWorldCoordX**(raster rast, integer xcolumn);
float8 **ST_RasterToWorldCoordX**(raster rast, integer xcolumn, integer yrow);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_ScaleX, ST_SkewX, ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠ ST_Raster2WorldCoordX ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- non-skewed raster providing column is sufficient
SELECT rid, ST_RasterToWorldCoordX(rast,1) As x1coord,
    ST_RasterToWorldCoordX(rast,2) As x2coord,
    ST_ScaleX(rast) As pixelx
FROM dummy_rast;

 rid |  x1coord   |  x2coord  | pixelx
-----+------------+-----------+--------
   1 |        0.5 |       2.5 |      2
   2 | 3427927.75 | 3427927.8 |   0.05
```

```
-- for fun lets skew it
SELECT rid, ST_RasterToWorldCoordX(rast, 1, 1) As x1coord,
    ST_RasterToWorldCoordX(rast, 2, 3) As x2coord,
    ST_ScaleX(rast) As pixelx
FROM (SELECT rid, ST_SetSkew(rast, 100.5, 0) As rast FROM dummy_rast) As foo;

 rid |  x1coord   |  x2coord  | pixelx
-----+------------+-----------+--------
   1 |        0.5 |     203.5 |      2
   2 | 3427927.75 | 3428128.8 |   0.05
```

⊠⊠

ST_ScaleX, ST_RasterToWorldCoordY, ST_SetSkew, ST_SkewX

11.4.13 ST_RasterToWorldCoordY

ST_RasterToWorldCoordY — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_RasterToWorldCoordY**(raster rast, integer yrow);
float8 **ST_RasterToWorldCoordY**(raster rast, integer xcolumn, integer yrow);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_ScaleY, ST_SkewY, ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠ ST_Raster2WorldCoordY ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- non-skewed raster providing row is sufficient
SELECT rid, ST_RasterToWorldCoordY(rast,1) As y1coord,
    ST_RasterToWorldCoordY(rast,3) As y2coord,
    ST_ScaleY(rast) As pixely
FROM dummy_rast;

 rid | y1coord |  y2coord  | pixely
-----+---------+-----------+--------
   1 |     0.5 |       6.5 |      3
   2 | 5793244 | 5793243.9 |  -0.05
```

```
-- for fun lets skew it
SELECT rid, ST_RasterToWorldCoordY(rast,1,1) As y1coord,
    ST_RasterToWorldCoordY(rast,2,3) As y2coord,
    ST_ScaleY(rast) As pixely
FROM (SELECT rid, ST_SetSkew(rast,0,100.5) As rast FROM dummy_rast) As foo;

 rid | y1coord |  y2coord  | pixely
-----+---------+-----------+--------
   1 |     0.5 |       107 |      3
   2 | 5793244 | 5793344.4 |  -0.05
```

⊠⊠

ST_ScaleY, ST_RasterToWorldCoordX, ST_SetSkew, ST_SkewY

11.4.14 ST_Rotation

ST_Rotation — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_Rotation**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, NaN ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT rid, ST_Rotation(ST_SetScale(ST_SetSkew(rast, sqrt(2)), sqrt(2))) as rot FROM ↩
    dummy_rast;

 rid |        rot
-----+-------------------
   1 | 0.785398163397448
   2 | 0.785398163397448
```

⊠⊠

ST_SetRotation, ST_SetScale, ST_SetSkew

11.4.15 ST_SkewX

ST_SkewX — ⊠⊠⊠⊠ X ⊠⊠⊠ (skew)(⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_SkewX**(raster rast);

⊠⊠

⊠⊠⊠⊠ X ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT rid, ST_SkewX(rast) As skewx, ST_SkewY(rast) As skewy,
    ST_GeoReference(rast) as georef
FROM dummy_rast;

 rid | skewx | skewy |       georef
-----+-------+-------+--------------------
   1 |     0 |     0 | 2.0000000000
                     : 0.0000000000
                     : 0.0000000000
                     : 3.0000000000
                     : 0.5000000000
                     : 0.5000000000
                     :
   2 |     0 |     0 | 0.0500000000
                     : 0.0000000000
                     : 0.0000000000
                     : -0.0500000000
                     : 3427927.7500000000
                     : 5793244.0000000000
```

⊠⊠

ST_GeoReference, ST_SkewY, ST_SetSkew

11.4.16 ST_SkewY

ST_SkewY — ⊠⊠⊠⊠ Y ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_SkewY**(raster rast);

⊠⊠

⊠⊠⊠⊠ Y ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT rid, ST_SkewX(rast) As skewx, ST_SkewY(rast) As skewy,
    ST_GeoReference(rast) as georef
FROM dummy_rast;

 rid | skewx | skewy |       georef
-----+-------+-------+--------------------
   1 |     0 |     0 | 2.0000000000
                     : 0.0000000000
                     : 0.0000000000
                     : 3.0000000000
                     : 0.5000000000
                     : 0.5000000000
                     :
```

```
   2 |     0 |     0 | 0.0500000000
                     : 0.0000000000
                     : 0.0000000000
                     : -0.0500000000
                     : 3427927.7500000000
                     : 5793244.0000000000
```

⊠⊠

ST_GeoReference, ST_SkewX, ST_SetSkew

11.4.17 ST_SRID

ST_SRID — spatial_ref_sys ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_SRID**(raster rast);

⊠⊠

spatial_ref_sys ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> PostGIS 2.0 ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠ -1 ⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_SRID(rast) As srid
FROM dummy_rast WHERE rid=1;

srid
----------------
0
```

⊠⊠

Section 4.5, ST_SRID

11.4.18 ST_Summary

ST_Summary — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_Summary**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_Summary(
    ST_AddBand(
        ST_AddBand(
            ST_AddBand(
                ST_MakeEmptyRaster(10, 10, 0, 0, 1, -1, 0, 0, 0)
                , 1, '8BUI', 1, 0
            )
            , 2, '32BF', 0, -9999
        )
        , 3, '16BSI', 0, NULL
    )
);

                            st_summary
------------------------------------------------------------------
 Raster of 10x10 pixels has 3 bands and extent of BOX(0 -10,10 0)+
     band 1 of pixtype 8BUI is in-db with NODATA value of 0      +
     band 2 of pixtype 32BF is in-db with NODATA value of -9999  +
     band 3 of pixtype 16BSI is in-db with no NODATA value
(1 row)
```

⊠⊠

ST_MetaData, ST_BandMetaData, ST_Summary ST_Extent

11.4.19 ST_UpperLeftX

ST_UpperLeftX — ⊠⊠⊠⊠⊠⊠⊠ X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_UpperLeftX**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠ X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECt rid, ST_UpperLeftX(rast) As ulx
FROM dummy_rast;

 rid |    ulx
-----+------------
   1 |        0.5
   2 | 3427927.75
```

□□

ST_UpperLeftY, ST_GeoReference, Box3D

11.4.20 ST_UpperLeftY

ST_UpperLeftY — □□□□□□□ Y □□□□□□□□□□□□□□□□□□.

Synopsis

float8 **ST_UpperLeftY**(raster rast);

□□

□□□□□□□ Y □□□□□□□□□□□□□□□□□□.

□□

```
SELECT rid, ST_UpperLeftY(rast) As uly
FROM dummy_rast;

 rid |   uly
-----+---------
   1 |     0.5
   2 | 5793244
```

□□

ST_UpperLeftX, ST_GeoReference, Box3D

11.4.21 ST_Width

ST_Width — □□□□□□□□□□□□□□□□□.

Synopsis

integer **ST_Width**(raster rast);

□□

□□□□□□□□□□□□□□□□□.

⊠⊠

```
SELECT ST_Width(rast) As rastwidth
FROM dummy_rast WHERE rid=1;

rastwidth
----------------
10
```

⊠⊠

ST_Height

11.4.22 ST_WorldToRasterCoord

ST_WorldToRasterCoord — ⊠⊠⊠⊠⊠⊠⊠ X, Y(⊠⊠, ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

record **ST_WorldToRasterCoord**(raster rast, geometry pt);
record **ST_WorldToRasterCoord**(raster rast, double precision longitude, double precision latitude);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠ X, Y(⊠⊠, ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT
    rid,
    (ST_WorldToRasterCoord(rast,3427927.8,20.5)).*,
    (ST_WorldToRasterCoord(rast,ST_GeomFromText('POINT(3427927.8 20.5)',ST_SRID(rast)))).*
FROM dummy_rast;

 rid | columnx |   rowy    | columnx |   rowy
-----+---------+-----------+---------+-----------
   1 | 1713964 |         7 | 1713964 |         7
   2 |       2 | 115864471 |       2 | 115864471
```

⊠⊠

ST_WorldToRasterCoordX, ST_WorldToRasterCoordY, ST_RasterToWorldCoordX, ST_RasterToWorldCoordY, ST_SRID

11.4.23 ST_WorldToRasterCoordX

ST_WorldToRasterCoordX — ⊠⊠⊠⊠⊠ (pt) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠ (xw, yw) ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_WorldToRasterCoordX**(raster rast, geometry pt);
integer **ST_WorldToRasterCoordX**(raster rast, double precision xw);
integer **ST_WorldToRasterCoordX**(raster rast, double precision xw, double precision yw);

⊠⊠

⊠⊠⊠⊠⊠ (pt) ⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠ (xw, yw) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠ xw ⊠ yw ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ xw ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠ ST_World2RasterCoordX ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT rid, ST_WorldToRasterCoordX(rast,3427927.8) As xcoord,
        ST_WorldToRasterCoordX(rast,3427927.8,20.5) As xcoord_xwyw,
        ST_WorldToRasterCoordX(rast,ST_GeomFromText('POINT(3427927.8 20.5)',ST_SRID(rast))) ↩
            As ptxcoord
FROM dummy_rast;

 rid | xcoord  |  xcoord_xwyw   | ptxcoord
-----+---------+---------+----------
   1 | 1713964 | 1713964 |  1713964
   2 |       1 |       1 |        1
```

⊠⊠

ST_RasterToWorldCoordX, ST_RasterToWorldCoordY, ST_SRID

11.4.24 ST_WorldToRasterCoordY

ST_WorldToRasterCoordY — ⊠⊠⊠⊠⊠ (pt) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠ (xw, yw) ⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_WorldToRasterCoordY**(raster rast, geometry pt);
integer **ST_WorldToRasterCoordY**(raster rast, double precision xw);
integer **ST_WorldToRasterCoordY**(raster rast, double precision xw, double precision yw);

⊠⊠

⊠⊠⊠⊠⊠ (pt) ⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠ (xw, yw) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ xw ⊠ yw ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ xw ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠ ST_World2RasterCoordY ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT rid, ST_WorldToRasterCoordY(rast,20.5) As ycoord,
        ST_WorldToRasterCoordY(rast,3427927.8,20.5) As ycoord_xwyw,
        ST_WorldToRasterCoordY(rast,ST_GeomFromText('POINT(3427927.8 20.5)',ST_SRID(rast))) ↩
             As ptycoord
FROM dummy_rast;

 rid |  ycoord   | ycoord_xwyw | ptycoord
-----+-----------+-------------+-----------
   1 |         7 |           7 |         7
   2 | 115864471 |   115864471 | 115864471
```

⊠⊠

ST_RasterToWorldCoordX, ST_RasterToWorldCoordY, ST_SRID

11.5 ⊠⊠⊠⊠⊠⊠⊠⊠

11.5.1 ST_BandMetaData

ST_BandMetaData — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

(1) record **ST_BandMetaData**(raster rast, integer band=1);
(2) record **ST_BandMetaData**(raster rast, integer[] band);

⊠⊠

Returns basic meta data about a raster band. Columns returned: pixeltype, nodatavalue, isoutdb, path, outdbbandnum, filesize, filetimestamp.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> If band has no NODATA value, nodatavalue are NULL.

> **Note**
> If isoutdb is False, path, outdbbandnum, filesize and filetimestamp are NULL. If outdb access is disabled, filesize and filetimestamp will also be NULL.

Enhanced: 2.5.0 to include *outdbbandnum*, *filesize* and *filetimestamp* for outdb rasters.

⊠⊠: ⊠⊠ 1

```
SELECT
    rid,
    (foo.md).*
FROM (
    SELECT
        rid,
        ST_BandMetaData(rast, 1) AS md
    FROM dummy_rast
    WHERE rid=2
) As foo;

 rid | pixeltype | nodatavalue | isoutdb | path | outdbbandnum
-----+-----------+---- --------+---------+------+--------------
   2 | 8BUI      |           0 | f       |      |
```

⊠⊠: ⊠⊠ 2

```
WITH foo AS (
    SELECT
        ST_AddBand(NULL::raster, '/home/pele/devel/geo/postgis-git/raster/test/regress/ ↩
            loader/Projected.tif', NULL::int[]) AS rast
)
SELECT
    *
FROM ST_BandMetadata(
    (SELECT rast FROM foo),
    ARRAY[1,3,2]::int[]
);

 bandnum | pixeltype | nodatavalue | isoutdb |                                      path  ↩
                                        | outdbbandnum  | filesize | filetimestamp |
---------+-----------+-------------+---------+-------------------------------------------------------

       1 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/raster/test ↩
           /regress/loader/Projected.tif      |             1  |    12345 |    1521807257 |
       3 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/raster/test ↩
           /regress/loader/Projected.tif      |             3  |    12345 |    1521807257 |
       2 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/raster/test ↩
           /regress/loader/Projected.tif      |             2  |    12345 |    1521807257 |
```

⊠⊠

ST_MetaData, ST_BandPixelType

11.5.2 ST_BandNoDataValue

ST_BandNoDataValue — ⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠ 1 ⊠⊠⊠⊠⊠⊠.

Synopsis

double precision **ST_BandNoDataValue**(raster rast, integer bandnum=1);

⊠⊠

⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_BandNoDataValue(rast,1) As bnval1,
    ST_BandNoDataValue(rast,2) As bnval2, ST_BandNoDataValue(rast,3) As bnval3
FROM dummy_rast
WHERE rid = 2;

 bnval1 | bnval2 | bnval3
--------+--------+--------
      0 |      0 |      0
```

⊠⊠

ST_NumBands

11.5.3 ST_BandIsNoData

ST_BandIsNoData — ⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_BandIsNoData**(raster rast, integer band, boolean forceChecking=true);
boolean **ST_BandIsNoData**(raster rast, boolean forceChecking=true);

⊠⊠

⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ isnodata ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ FALSE ⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠ (⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠, ST_SetBandNodataValue() ⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠, ⊠⊠ ST_SetBandIsNodata() ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_SetBandIsNoData ⊠⊠⊠⊠⊠⊠ ⊠.

□□

```
-- Create dummy table with one raster column
create table dummy_rast (rid integer, rast raster);

-- Add raster with two bands, one pixel/band. In the first band, nodatavalue = pixel value ↩
    = 3.
-- In the second band, nodatavalue = 13, pixel value = 4
insert into dummy_rast values(1,
(
'01' -- little endian (uint8 ndr)
||
'0000' -- version (uint16 0)
||
'0200' -- nBands (uint16 0)
||
'17263529ED684A3F' -- scaleX (float64 0.000805965234044584)
||
'F9253529ED684ABF' -- scaleY (float64 -0.00080596523404458)
||
'1C9F33CE69E352C0' -- ipX (float64 -75.5533328537098)
||
'718F0E9A27A44840' -- ipY (float64 49.2824585505576)
||
'ED50EB853EC32B3F' -- skewX (float64 0.000211812383858707)
||
'7550EB853EC32B3F' -- skewY (float64 0.000211812383858704)
||
'E6100000' -- SRID (int32 4326)
||
'0100' -- width (uint16 1)
||
'0100' -- height (uint16 1)
||
'6' -- hasnodatavalue and isnodata value set to true.
||
'2' -- first band type (4BUI)
||
'03' -- novalue==3
||
'03' -- pixel(0,0)==3 (same that nodata)
||
'0' -- hasnodatavalue set to false
||
'5' -- second band type (16BSI)
||
'0D00' -- novalue==13
||
'0400' -- pixel(0,0)==4
)::raster
);

select st_bandisnodata(rast, 1) from dummy_rast where rid = 1; -- Expected true
select st_bandisnodata(rast, 2) from dummy_rast where rid = 1; -- Expected false
```

□□

ST_BandNoDataValue, ST_NumBands, ST_SetBandNoDataValue, ST_SetBandIsNoData

11.5.4 ST_BandPath

ST_BandPath — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. bandnum ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_BandPath**(raster rast, integer bandnum=1);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. DB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
```

⊠⊠

11.5.5 ST_BandFileSize

ST_BandFileSize — Returns the file size of a band stored in file system. If no bandnum specified, 1 is assumed.

Synopsis

bigint **ST_BandFileSize**(raster rast, integer bandnum=1);

⊠⊠

Returns the file size of a band stored in file system. Throws an error if called with an in db band, or if outdb access is not enabled.

This function is typically used in conjunction with ST_BandPath() and ST_BandFileTimestamp() so a client can determine if the filename of a outdb raster as seen by it is the same as the one seen by the server.

Availability: 2.5.0

⊠⊠

```
SELECT ST_BandFileSize(rast,1) FROM dummy_rast WHERE rid = 1;

 st_bandfilesize
-----------------
          240574
```

11.5.6 ST_BandFileTimestamp

ST_BandFileTimestamp — Returns the file timestamp of a band stored in file system. If no bandnum specified, 1 is assumed.

Synopsis

bigint **ST_BandFileTimestamp**(raster rast, integer bandnum=1);

⊠⊠

Returns the file timestamp (number of seconds since Jan 1st 1970 00:00:00 UTC) of a band stored in file system. Throws an error if called with an in db band, or if outdb access is not enabled.

This function is typically used in conjunction with ST_BandPath() and ST_BandFileSize() so a client can determine if the filename of a outdb raster as seen by it is the same as the one seen by the server.

Availability: 2.5.0

⊠⊠

```
SELECT ST_BandFileTimestamp(rast,1) FROM dummy_rast WHERE rid = 1;

 st_bandfiletimestamp
----------------------
           1521807257
```

11.5.7 ST_BandPixelType

ST_BandPixelType — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. bandnum ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_BandPixelType**(raster rast, integer bandnum=1);

⊠⊠

Returns name describing data type and size of values stored in each cell of given band.

11 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- 1BB - 1 ⊠⊠⊠⊠
- 2BUI - ⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠
- 4BUI - ⊠⊠⊠⊠ 4 ⊠⊠⊠⊠⊠⊠
- 8BSI - ⊠⊠⊠⊠ 8 ⊠⊠⊠⊠⊠⊠
- 8BUI - ⊠⊠⊠⊠ 8 ⊠⊠⊠⊠⊠⊠
- 16BSI - ⊠⊠⊠⊠ 16 ⊠⊠⊠⊠⊠⊠
- 16BUI - ⊠⊠⊠⊠ 16 ⊠⊠⊠⊠⊠⊠

- 32BSI - ⊠⊠⊠⊠ 32 ⊠⊠⊠⊠⊠
- 32BUI - ⊠⊠⊠⊠ 32 ⊠⊠⊠⊠⊠
- 32BF - 32 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠
- 64BF - 64 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠

```
SELECT ST_BandPixelType(rast,1) As btype1,
    ST_BandPixelType(rast,2) As btype2, ST_BandPixelType(rast,3) As btype3
FROM dummy_rast
WHERE rid = 2;

 btype1 | btype2 | btype3
--------+--------+--------
 8BUI   | 8BUI   | 8BUI
```

⊠⊠

ST_NumBands

11.5.8 ST_MinPossibleValue

ST_MinPossibleValue — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

integer **ST_MinPossibleValue**(text pixeltype);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_MinPossibleValue('16BSI');

 st_minpossiblevalue
---------------------
              -32768


SELECT ST_MinPossibleValue('8BUI');

 st_minpossiblevalue
---------------------
                   0
```

⊠⊠

ST_BandPixelType

11.5.9 ST_HasNoBand

ST_HasNoBand — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_HasNoBand**(raster rast, integer bandnum=1);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT rid, ST_HasNoBand(rast) As hb1, ST_HasNoBand(rast,2) as hb2,
ST_HasNoBand(rast,4) as hb4, ST_NumBands(rast) As numbands
FROM dummy_rast;

rid | hb1 | hb2 | hb4 | numbands
-----+-----+-----+-----+----------
1 | t   | t   | t   |        0
2 | f   | f   | t   |        3
```

⊠⊠

ST_NumBands

11.6 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (setter)

11.6.1 ST_PixelAsPolygon

ST_PixelAsPolygon — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_PixelAsPolygon**(raster rast, integer columnx, integer rowy);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- get raster pixel polygon
SELECT i,j, ST_AsText(ST_PixelAsPolygon(foo.rast, i,j)) As b1pgeom
FROM dummy_rast As foo
    CROSS JOIN generate_series(1,2) As i
    CROSS JOIN generate_series(1,1) As j
WHERE rid=2;

 i | j |                                                    b1pgeom
---+---+-----------------------------------------------------------------------------
 1 | 1 | POLYGON((3427927.75 5793244,3427927.8 5793244,3427927.8 5793243.95,...
 2 | 1 | POLYGON((3427927.8 5793244,3427927.85 5793244,3427927.85 5793243.95, ..
```

⊠⊠

ST_DumpAsPolygons, ST_PixelAsPolygons, ST_PixelAsPoint, ST_PixelAsPoints, ST_PixelAsCentroid, ST_PixelAsCentroids, ST_Intersection, ST_AsText

11.6.2 ST_PixelAsPolygons

ST_PixelAsPolygons — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

setof record **ST_PixelAsPolygons**(raster rast, integer band=1, boolean exclude_nodata_value=TRUE);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠ X, Y ⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.

Return record format: *geom* geometry, *val* double precision, *x* integer, *y* integers.

> **Note**
> When *exclude_nodata_value* = TRUE, only those pixels whose values are not NODATA are returned as points.

> **Note**
> ST_PixelAsPolygons ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_DumpAsPolygons ⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.1 ⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□

```
-- get raster pixel polygon
SELECT (gv).x, (gv).y, (gv).val, ST_AsText((gv).geom) geom
FROM (SELECT ST_PixelAsPolygons(
                 ST_SetValue(ST_SetValue(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 0.001,
                    -0.001, 0.001, 0.001, 4269),
                                                    '8BUI'::text, 1, 0),
                                         2, 2, 10),
                             1, 1, NULL)
) gv
) foo;

 x | y | val |                geom
---+---+-----------------------------------------------------------------------------
 1 | 1 |     | POLYGON((0 0,0.001 0.001,0.002 0,0.001 -0.001,0 0))
 1 | 2 |   1 | POLYGON((0.001 -0.001,0.002 0,0.003 -0.001,0.002 -0.002,0.001 -0.001))
 2 | 1 |   1 | POLYGON((0.001 0.001,0.002 0.002,0.003 0.001,0.002 0,0.001 0.001))
 2 | 2 |  10 | POLYGON((0.002 0,0.003 0.001,0.004 0,0.003 -0.001,0.002 0))
```

□□

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPoint, ST_PixelAsPoints, ST_PixelAsCentroid, ST_Pixel
ST_AsText

11.6.3 ST_PixelAsPoint

ST_PixelAsPoint — □□□□□□□□□□□□□□□□□□□□□□.

Synopsis

geometry **ST_PixelAsPoint**(raster rast, integer columnx, integer rowy);

□□

□□□□□□□□□□□□□□□□□□□□□□.

2.1.0 □□□□□□□□□□□□.

□□

```
SELECT ST_AsText(ST_PixelAsPoint(rast, 1, 1)) FROM dummy_rast WHERE rid = 1;

   st_astext
----------------
 POINT(0.5 0.5)
```

□□

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPolygons, ST_PixelAsPoints, ST_PixelAsCentroid,
ST_PixelAsCentroids

11.6.4 ST_PixelAsPoints

ST_PixelAsPoints — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

setof record **ST_PixelAsPoints**(raster rast, integer band=1, boolean exclude_nodata_value=TRUE);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Return record format: *geom* geometry, *val* double precision, *x* integer, *y* integers.

> **Note**
> When *exclude_nodata_value* = TRUE, only those pixels whose values are not NODATA are returned as points.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.1 ⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT x, y, val, ST_AsText(geom) FROM (SELECT (ST_PixelAsPoints(rast, 1)).* FROM
    dummy_rast WHERE rid = 2) foo;

 x | y | val |          st_astext
---+---+-----+------------------------------
 1 | 1 | 253 | POINT(3427927.75 5793244)
 2 | 1 | 254 | POINT(3427927.8 5793244)
 3 | 1 | 253 | POINT(3427927.85 5793244)
 4 | 1 | 254 | POINT(3427927.9 5793244)
 5 | 1 | 254 | POINT(3427927.95 5793244)
 1 | 2 | 253 | POINT(3427927.75 5793243.95)
 2 | 2 | 254 | POINT(3427927.8 5793243.95)
 3 | 2 | 254 | POINT(3427927.85 5793243.95)
 4 | 2 | 253 | POINT(3427927.9 5793243.95)
 5 | 2 | 249 | POINT(3427927.95 5793243.95)
 1 | 3 | 250 | POINT(3427927.75 5793243.9)
 2 | 3 | 254 | POINT(3427927.8 5793243.9)
 3 | 3 | 254 | POINT(3427927.85 5793243.9)
 4 | 3 | 252 | POINT(3427927.9 5793243.9)
 5 | 3 | 249 | POINT(3427927.95 5793243.9)
 1 | 4 | 251 | POINT(3427927.75 5793243.85)
 2 | 4 | 253 | POINT(3427927.8 5793243.85)
 3 | 4 | 254 | POINT(3427927.85 5793243.85)
 4 | 4 | 254 | POINT(3427927.9 5793243.85)
 5 | 4 | 253 | POINT(3427927.95 5793243.85)
 1 | 5 | 252 | POINT(3427927.75 5793243.8)
 2 | 5 | 250 | POINT(3427927.8 5793243.8)
 3 | 5 | 254 | POINT(3427927.85 5793243.8)
 4 | 5 | 254 | POINT(3427927.9 5793243.8)
 5 | 5 | 254 | POINT(3427927.95 5793243.8)
```

⊠⊠

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPolygons, ST_PixelAsPoint, ST_PixelAsCentroid, ST_PixelAsCentroids

11.6.5 ST_PixelAsCentroid

ST_PixelAsCentroid — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_PixelAsCentroid**(raster rast, integer x, integer y);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_AsText(ST_PixelAsCentroid(rast, 1, 1)) FROM dummy_rast WHERE rid = 1;

  st_astext
--------------
 POINT(1.5 2)
```

⊠⊠

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPolygons, ST_PixelAsPoint, ST_PixelAsPoints, ST_Pixel

11.6.6 ST_PixelAsCentroids

ST_PixelAsCentroids — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

setof record **ST_PixelAsCentroids**(raster rast, integer band=1, boolean exclude_nodata_value=TRUE);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Return record format: *geom* geometry, *val* double precision, *x* integer, *y* integers.

> **Note**
> When *exclude_nodata_value* = TRUE, only those pixels whose values are not NODATA are returned as points.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.1 ⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
--LATERAL syntax requires PostgreSQL 9.3+
SELECT x, y, val, ST_AsText(geom)
    FROM (SELECT dp.* FROM dummy_rast, LATERAL ST_PixelAsCentroids(rast, 1) AS dp WHERE rid ↩
         = 2) foo;
 x | y | val |           st_astext
---+---+-----+------------------------------
 1 | 1 | 253 | POINT(3427927.775 5793243.975)
 2 | 1 | 254 | POINT(3427927.825 5793243.975)
 3 | 1 | 253 | POINT(3427927.875 5793243.975)
 4 | 1 | 254 | POINT(3427927.925 5793243.975)
 5 | 1 | 254 | POINT(3427927.975 5793243.975)
 1 | 2 | 253 | POINT(3427927.775 5793243.925)
 2 | 2 | 254 | POINT(3427927.825 5793243.925)
 3 | 2 | 254 | POINT(3427927.875 5793243.925)
 4 | 2 | 253 | POINT(3427927.925 5793243.925)
 5 | 2 | 249 | POINT(3427927.975 5793243.925)
 1 | 3 | 250 | POINT(3427927.775 5793243.875)
 2 | 3 | 254 | POINT(3427927.825 5793243.875)
 3 | 3 | 254 | POINT(3427927.875 5793243.875)
 4 | 3 | 252 | POINT(3427927.925 5793243.875)
 5 | 3 | 249 | POINT(3427927.975 5793243.875)
 1 | 4 | 251 | POINT(3427927.775 5793243.825)
 2 | 4 | 253 | POINT(3427927.825 5793243.825)
 3 | 4 | 254 | POINT(3427927.875 5793243.825)
 4 | 4 | 254 | POINT(3427927.925 5793243.825)
 5 | 4 | 253 | POINT(3427927.975 5793243.825)
 1 | 5 | 252 | POINT(3427927.775 5793243.775)
 2 | 5 | 250 | POINT(3427927.825 5793243.775)
 3 | 5 | 254 | POINT(3427927.875 5793243.775)
 4 | 5 | 254 | POINT(3427927.925 5793243.775)
 5 | 5 | 254 | POINT(3427927.975 5793243.775)
```

⊠⊠

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPolygons, ST_PixelAsPoint, ST_PixelAsPoints, ST_Pixel

11.6.7 ST_Value

ST_Value — ⊠⊠ columnx, rowy ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, nodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

double precision **ST_Value**(raster rast, geometry pt, boolean exclude_nodata_value=true);
double precision **ST_Value**(raster rast, integer band, geometry pt, boolean exclude_nodata_value=true, text resample='nearest');
double precision **ST_Value**(raster rast, integer x, integer y, boolean exclude_nodata_value=true);
double precision **ST_Value**(raster rast, integer band, integer x, integer y, boolean exclude_nodata_value=tru

⊠⊠

⊠⊠⊠ columnx, rowy ⊠⊠. ⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ nodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

The allowed values of the resample parameter are "nearest" which performs the default nearest-neighbor resampling, and "bilinear" which performs a bilinear interpolation to estimate the value between pixel centers.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- get raster values at particular postgis geometry points
-- the srid of your geometry should be same as for your raster
SELECT rid, ST_Value(rast, foo.pt_geom) As b1pval, ST_Value(rast, 2, foo.pt_geom) As b2pval
FROM dummy_rast CROSS JOIN (SELECT ST_SetSRID(ST_Point(3427927.77, 5793243.76), 0) As ↩
    pt_geom) As foo
WHERE rid=2;

 rid | b1pval | b2pval
-----+--------+--------
   2 |    252 |     79


-- general fictitious example using a real table
SELECT rid, ST_Value(rast, 3, sometable.geom) As b3pval
FROM sometable
WHERE ST_Intersects(rast,sometable.geom);
```

```
SELECT rid, ST_Value(rast, 1, 1, 1) As b1pval,
    ST_Value(rast, 2, 1, 1) As b2pval, ST_Value(rast, 3, 1, 1) As b3pval
FROM dummy_rast
WHERE rid=2;

 rid | b1pval | b2pval | b3pval
-----+--------+--------+--------
   2 |    253 |     78 |     70
```

```
--- Get all values in bands 1,2,3 of each pixel --
SELECT x, y, ST_Value(rast, 1, x, y) As b1val,
    ST_Value(rast, 2, x, y) As b2val, ST_Value(rast, 3, x, y) As b3val
FROM dummy_rast CROSS JOIN
generate_series(1, 1000) As x CROSS JOIN generate_series(1, 1000) As y
WHERE rid =  2 AND x <= ST_Width(rast) AND y <= ST_Height(rast);

 x | y | b1val | b2val | b3val
---+---+-------+-------+-------
 1 | 1 |   253 |    78 |    70
 1 | 2 |   253 |    96 |    80
 1 | 3 |   250 |    99 |    90
 1 | 4 |   251 |    89 |    77
 1 | 5 |   252 |    79 |    62
 2 | 1 |   254 |    98 |    86
 2 | 2 |   254 |   118 |   108
 :
 :
```

```
--- Get all values in bands 1,2,3 of each pixel same as above but returning the upper left  ↩
    point point of each pixel --
SELECT ST_AsText(ST_SetSRID(
    ST_Point(ST_UpperLeftX(rast) + ST_ScaleX(rast)*x,
        ST_UpperLeftY(rast) + ST_ScaleY(rast)*y),
        ST_SRID(rast))) As uplpt
    , ST_Value(rast, 1, x, y) As b1val,
    ST_Value(rast, 2, x, y) As b2val, ST_Value(rast, 3, x, y) As b3val
FROM dummy_rast CROSS JOIN
generate_series(1,1000) As x CROSS JOIN generate_series(1,1000) As y
WHERE rid =  2 AND x <= ST_Width(rast) AND y <= ST_Height(rast);

            uplpt            | b1val | b2val | b3val
-----------------------------+-------+-------+-------
 POINT(3427929.25 5793245.5) |   253 |    78 |    70
 POINT(3427929.25 5793247)   |   253 |    96 |    80
 POINT(3427929.25 5793248.5) |   250 |    99 |    90
:
```

```
--- Get a polygon formed by union of all pixels
    that fall in a particular value range and intersect particular polygon --
SELECT ST_AsText(ST_Union(pixpolyg)) As shadow
FROM (SELECT ST_Translate(ST_MakeEnvelope(
        ST_UpperLeftX(rast), ST_UpperLeftY(rast),
            ST_UpperLeftX(rast) + ST_ScaleX(rast),
            ST_UpperLeftY(rast) + ST_ScaleY(rast), 0
            ), ST_ScaleX(rast)*x, ST_ScaleY(rast)*y
        ) As pixpolyg, ST_Value(rast, 2, x, y) As b2val
    FROM dummy_rast CROSS JOIN
generate_series(1,1000) As x CROSS JOIN generate_series(1,1000) As y
WHERE rid =  2
    AND x <= ST_Width(rast) AND y <= ST_Height(rast)) As foo
WHERE
    ST_Intersects(
        pixpolyg,
        ST_GeomFromText('POLYGON((3427928 5793244,3427927.75 5793243.75,3427928  ↩
            5793243.75,3427928 5793244))',0)
```

```
        ) AND b2val != 254;


        shadow
------------------------------------------------------------------------------------
 MULTIPOLYGON(((3427928 5793243.9,3427928 5793243.85,3427927.95 5793243.85,3427927.95  ↩
     5793243.9,
 3427927.95 5793243.95,3427928 5793243.95,3427928.05 5793243.95,3427928.05  ↩
     5793243.9,3427928 5793243.9)),((3427927.95 5793243.9,3427927.95 579324
3.85,3427927.9 5793243.85,3427927.85 5793243.85,3427927.85 5793243.9,3427927.9  ↩
    5793243.9,3427927.9 5793243.95,
3427927.95 5793243.95,3427927.95 5793243.9)),((3427927.85 5793243.75,3427927.85  ↩
    5793243.7,3427927.8 5793243.7,3427927.8 5793243.75
,3427927.8 5793243.8,3427927.8 5793243.85,3427927.85 5793243.85,3427927.85  ↩
    5793243.8,3427927.85 5793243.75)),
((3427928.05 5793243.75,3427928.05 5793243.7,3427928 5793243.7,3427927.95  ↩
    5793243.7,3427927.95 5793243.75,3427927.95 5793243.8,3427
927.95 5793243.85,3427928 5793243.85,3427928 5793243.8,3427928.05 5793243.8,
3427928.05 5793243.75)),((3427927.95 5793243.75,3427927.95 5793243.7,3427927.9  ↩
    5793243.7,3427927.85 5793243.7,
3427927.85 5793243.75,3427927.85 5793243.8,3427927.85 5793243.85,3427927.9 5793243.85,
3427927.95 5793243.85,3427927.95 5793243.8,3427927.95 5793243.75)))
```

```
--- Checking all the pixels of a large raster tile can take a long time.
--- You can dramatically improve speed at some lose of precision by orders of magnitude
--  by sampling pixels using the step optional parameter of generate_series.
--  This next example does the same as previous but by checking 1 for every 4 (2x2) pixels  ↩
    and putting in the last checked
--  putting in the checked pixel as the value for subsequent 4

SELECT ST_AsText(ST_Union(pixpolyg)) As shadow
FROM (SELECT ST_Translate(ST_MakeEnvelope(
        ST_UpperLeftX(rast), ST_UpperLeftY(rast),
            ST_UpperLeftX(rast) + ST_ScaleX(rast)*2,
            ST_UpperLeftY(rast) + ST_ScaleY(rast)*2, 0
            ), ST_ScaleX(rast)*x, ST_ScaleY(rast)*y
        ) As pixpolyg, ST_Value(rast, 2, x, y) As b2val
    FROM dummy_rast CROSS JOIN
generate_series(1,1000,2) As x CROSS JOIN generate_series(1,1000,2) As y
WHERE rid =  2
    AND x <= ST_Width(rast)  AND y <= ST_Height(rast)  ) As foo
WHERE
    ST_Intersects(
        pixpolyg,
        ST_GeomFromText('POLYGON((3427928 5793244,3427927.75 5793243.75,3427928  ↩
            5793243.75,3427928 5793244))',0)
        ) AND b2val != 254;

        shadow
------------------------------------------------------------------------------------
 MULTIPOLYGON(((3427927.9 5793243.85,3427927.8 5793243.85,3427927.8 5793243.95,
 3427927.9 5793243.95,3427928 5793243.95,3427928.1 5793243.95,3427928.1 5793243.85,3427928  ↩
     5793243.85,3427927.9 5793243.85)),
 ((3427927.9 5793243.65,3427927.8 5793243.65,3427927.8 5793243.75,3427927.8  ↩
     5793243.85,3427927.9 5793243.85,
 3427928 5793243.85,3427928 5793243.75,3427928.1 5793243.75,3427928.1 5793243.65,3427928  ↩
     5793243.65,3427927.9 5793243.65)))
```

□□

ST_SetValue, ST_DumpAsPolygons, ST_NumBands, ST_PixelAsPolygon, ST_ScaleX, ST_ScaleY, ST_UpperLe
ST_UpperLeftY, ST_SRID, ST_AsText, ST_Point, ST_MakeEnvelope, ST_Intersects, ST_Intersection

11.6.8 ST_NearestValue

ST_NearestValue — columnx □ rowy, □□ NODATA □□□□□□□□□□□□.

Synopsis

double precision **ST_NearestValue**(raster rast, integer bandnum, geometry pt, boolean exclude_nodata_val
double precision **ST_NearestValue**(raster rast, geometry pt, boolean exclude_nodata_value=true);
double precision **ST_NearestValue**(raster rast, integer bandnum, integer columnx, integer rowy, boolean exclude_nodata_value=true);
double precision **ST_NearestValue**(raster rast, integer columnx, integer rowy, boolean exclude_nodata_valu

□□

□□□ columnx, rowy □□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ NODATA □□□□□□□□□□□. columnx, rowy □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ NODATA □□□, □□□□ columnx, rowy □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ NODATA □□□□□□□□□□□□□□□.

□□□□□ 1 □□□□□□□, □□□□□□□□□□□□ bandnum □ 1 □□□□□□□. exclude_nodata_value □□□□□□□□□□□, nodata □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. exclude_nodata_value □□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□.

2.1.0 □□□□□□□□□□□□□□.

> **Note**
> ST_NearestValue □□□□□□□□ ST_Value □□□□□□□□□□□.

□□

```
-- pixel 2x2 has value
SELECT
    ST_Value(rast, 2, 2) AS value,
    ST_NearestValue(rast, 2, 2) AS nearestvalue
FROM (
    SELECT
        ST_SetValue(
            ST_SetValue(
                ST_SetValue(
                    ST_SetValue(
                        ST_SetValue(
                            ST_AddBand(
                                ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
                                '8BUI'::text, 1, 0
                            ),
                            1, 1, 0.
                        ),
```

```
                        2, 3, 0.
                    ),
                    3, 5, 0.
                ),
                4, 2, 0.
            ),
            5, 4, 0.
        ) AS rast
) AS foo

 value | nearestvalue
-------+--------------
     1 |            1
```

```
-- pixel 2x3 is NODATA
SELECT
    ST_Value(rast, 2, 3) AS value,
    ST_NearestValue(rast, 2, 3) AS nearestvalue
FROM (
    SELECT
        ST_SetValue(
            ST_SetValue(
                ST_SetValue(
                    ST_SetValue(
                        ST_SetValue(
                            ST_AddBand(
                                ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
                                '8BUI'::text, 1, 0
                            ),
                            1, 1, 0.
                        ),
                        2, 3, 0.
                    ),
                    3, 5, 0.
                ),
                4, 2, 0.
            ),
            5, 4, 0.
        ) AS rast
) AS foo

 value | nearestvalue
-------+--------------
       |            1
```

□□

ST_Neighborhood, ST_Value

11.6.9 ST_SetZ

ST_SetZ — Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the Z dimension using the requested resample algorithm.

Synopsis

geometry **ST_SetZ**(raster rast, geometry geom, text resample=nearest, integer band=1);

⊠⊠

Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the Z dimensions using the requested resample algorithm.

The `resample` parameter can be set to "nearest" to copy the values from the cell each vertex falls within, or "bilinear" to use bilinear interpolation to calculate a value that takes neighboring cells into account also.

Availability: 3.2.0

⊠⊠

```
--
-- 2x2 test raster with values
--
-- 10 50
-- 40 20
--
WITH test_raster AS (
SELECT
ST_SetValues(
  ST_AddBand(
    ST_MakeEmptyRaster(width => 2, height => 2,
      upperleftx => 0, upperlefty => 2,
      scalex => 1.0, scaley => -1.0,
      skewx => 0, skewy => 0, srid => 4326),
    index => 1, pixeltype => '16BSI',
    initialvalue => 0,
    nodataval => -999),
  1,1,1,
  newvalueset =>ARRAY[ARRAY[10.0::float8, 50.0::float8], ARRAY[40.0::float8, 20.0::float8 ↩
      ]]) AS rast
)
SELECT
ST_AsText(
  ST_SetZ(
    rast,
    band => 1,
    geom => 'SRID=4326;LINESTRING(1.0 1.9, 1.0 0.2)'::geometry,
    resample => 'bilinear'
))
FROM test_raster

            st_astext
----------------------------------
 LINESTRING Z (1 1.9 38,1 0.2 27)
```

⊠⊠

ST_Value, ST_SetSRID

11.6.10 ST_SetM

ST_SetM — Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the M dimension using the requested resample algorithm.

Synopsis

geometry **ST_SetM**(raster rast, geometry geom, text resample=nearest, integer band=1);

☒☒

Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the M dimensions using the requested resample algorithm.

The `resample` parameter can be set to "nearest" to copy the values from the cell each vertex falls within, or "bilinear" to use bilinear interpolation to calculate a value that takes neighboring cells into account also.

Availability: 3.2.0

☒☒

```
--
-- 2x2 test raster with values
--
-- 10 50
-- 40 20
--
WITH test_raster AS (
SELECT
ST_SetValues(
  ST_AddBand(
    ST_MakeEmptyRaster(width => 2, height => 2,
      upperleftx => 0, upperlefty => 2,
      scalex => 1.0, scaley => -1.0,
      skewx => 0, skewy => 0, srid => 4326),
    index => 1, pixeltype => '16BSI',
    initialvalue => 0,
    nodataval => -999),
  1,1,1,
  newvalueset =>ARRAY[ARRAY[10.0::float8, 50.0::float8], ARRAY[40.0::float8, 20.0::float8 ←
      ]]) AS rast
)
SELECT
ST_AsText(
  ST_SetM(
    rast,
    band => 1,
    geom => 'SRID=4326;LINESTRING(1.0 1.9, 1.0 0.2)'::geometry,
    resample => 'bilinear'
))
FROM test_raster

            st_astext
----------------------------------
 LINESTRING M (1 1.9 38,1 0.2 27)
```

☒☒

ST_Value, ST_SetSRID

11.6.11 ST_Neighborhood

ST_Neighborhood — columnx □ rowy, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□ NODATA □□□□□□□□□□□□□□□ 2 □□□□□□□□□□.

Synopsis

double precision[][] **ST_Neighborhood**(raster rast, integer bandnum, integer columnX, integer rowY, integer distanceX, integer distanceY, boolean exclude_nodata_value=true);
double precision[][] **ST_Neighborhood**(raster rast, integer columnX, integer rowY, integer distanceX, integer distanceY, boolean exclude_nodata_value=true);
double precision[][] **ST_Neighborhood**(raster rast, integer bandnum, geometry pt, integer distanceX, integer distanceY, boolean exclude_nodata_value=true);
double precision[][] **ST_Neighborhood**(raster rast, geometry pt, integer distanceX, integer distanceY, boolean exclude_nodata_value=true);

□□

columnx □ rowy, □□ □□□ NODATA □□□□□□□□□□□□□□□ 2 □□□□□□□□□□□. distanceX □ distanceY □□□□ □□□□□□□□□□□□□□□ X □ Y □□□□□□□□□. □□□□, □□□□□□□□□□ X □□□□ 3 □□□ □□□□□ Y □□□□ 2 □□□□□□□□□□□□□□□□□□□□□. 2 □□□□□□□□□ columnx □ rowy □ □□□□□□□□□□□□□□□□□□□□□□□.

□□□□□ 1 □□□□□□, □□□□□□□□□□ bandnum □ 1 □□□□□□. exclude_nodata_value □□ □□□□□□□□, nodata □□□□□□□□□□□□□□□□□□□□□□□□□□□. exclude_nodata_value □□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□.

> **Note**
> □□□□ 2 □□□□□□□□□□□□□□□□ 2 * (distanceX|distanceY) + 1 □□□. □□□ distanceX □ distanceY □□□ 1 □□□, □□□□□□□ 3x3 □□□□□□.

> **Note**
> ST_Min4ma, ST_Sum4ma, ST_Mean4ma □□□□□□□□□□□□□□□□□ 2 □□□□□□□□ □□□□□□□□□.

2.1.0 □□□□□□□□□□□□.

□□

```
-- pixel 2x2 has value
SELECT
    ST_Neighborhood(rast, 2, 2, 1, 1)
FROM (
    SELECT
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
                '8BUI'::text, 1, 0
            ),
```

```
            1, 1, 1, ARRAY[
                [0, 1, 1, 1, 1],
                [1, 1, 1, 0, 1],
                [1, 0, 1, 1, 1],
                [1, 1, 1, 1, 0],
                [1, 1, 0, 1, 1]
            ]::double precision[],
            1
        ) AS rast
) AS foo

         st_neighborhood
---------------------------------
{{NULL,1,1},{1,1,1},{1,NULL,1}}
```

```
-- pixel 2x3 is NODATA
SELECT
    ST_Neighborhood(rast, 2, 3, 1, 1)
FROM (
    SELECT
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
                '8BUI'::text, 1, 0
            ),
            1, 1, 1, ARRAY[
                [0, 1, 1, 1, 1],
                [1, 1, 1, 0, 1],
                [1, 0, 1, 1, 1],
                [1, 1, 1, 1, 0],
                [1, 1, 0, 1, 1]
            ]::double precision[],
            1
        ) AS rast
) AS foo

       st_neighborhood
------------------------------
 {{1,1,1},{1,NULL,1},{1,1,1}}
```

```
-- pixel 3x3 has value
-- exclude_nodata_value = FALSE
SELECT
    ST_Neighborhood(rast, 3, 3, 1, 1, false)
FROM ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
                '8BUI'::text, 1, 0
            ),
            1, 1, 1, ARRAY[
                [0, 1, 1, 1, 1],
                [1, 1, 1, 0, 1],
                [1, 0, 1, 1, 1],
                [1, 1, 1, 1, 0],
                [1, 1, 0, 1, 1]
            ]::double precision[],
            1
        ) AS rast

      st_neighborhood
---------------------------
```

```
{{1,1,0},{0,1,1},{1,1,1}}
```

⊠⊠

ST_NearestValue, ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Range4ma, ST_Distinct4ma, ST_StdDev4ma

11.6.12 ST_SetValue

ST_SetValue — ⊠⊠⊠ columnx, rowy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_SetValue**(raster rast, integer bandnum, geometry geom, double precision newvalue);
raster **ST_SetValue**(raster rast, geometry geom, double precision newvalue);
raster **ST_SetValue**(raster rast, integer bandnum, integer columnx, integer rowy, double precision newvalue);
raster **ST_SetValue**(raster rast, integer columnx, integer rowy, double precision newvalue);

⊠⊠

Returns modified raster resulting from setting the specified pixels' values to new value for the designated band given the raster's row and column or a geometry. If no band is specified, then band 1 is assumed.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_SetValue() ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ⊠⊠⊠⊠ ST_SetValues() ⊠ geomval[] ⊠⊠⊠⊠⊠⊠⊠⊠ (wrapper) ⊠⊠⊠.

⊠⊠

```
                -- Geometry example
SELECT (foo.geomval).val, ST_AsText(ST_Union((foo.geomval).geom))
FROM (SELECT ST_DumpAsPolygons(
        ST_SetValue(rast,1,
                ST_Point(3427927.75, 5793243.95),
                50)
            ) As geomval
FROM dummy_rast
where rid = 2) As foo
WHERE (foo.geomval).val < 250
GROUP BY (foo.geomval).val;

 val |                                                     st_astext
-----+-------------------------------------------------------------------
  50 | POLYGON((3427927.75 5793244,3427927.75 5793243.95,3427927.8 579324 ...
 249 | POLYGON((3427927.95 5793243.95,3427927.95 5793243.85,3427928 57932 ...
```

```
-- Store the changed raster --
    UPDATE dummy_rast SET rast = ST_SetValue(rast,1, ST_Point(3427927.75, 5793243.95),100)
        WHERE rid = 2   ;
```

⊠⊠

ST_Value, ST_DumpAsPolygons

11.6.13 ST_SetValues

ST_SetValues — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_SetValues**(raster rast, integer nband, integer columnx, integer rowy, double precision[][] newvalueset, boolean[][] noset=NULL, boolean keepnodata=FALSE);
raster **ST_SetValues**(raster rast, integer nband, integer columnx, integer rowy, double precision[][] newvalueset, double precision nosetvalue, boolean keepnodata=FALSE);
raster **ST_SetValues**(raster rast, integer nband, integer columnx, integer rowy, integer width, integer height, double precision newvalue, boolean keepnodata=FALSE);
raster **ST_SetValues**(raster rast, integer columnx, integer rowy, integer width, integer height, double precision newvalue, boolean keepnodata=FALSE);
raster **ST_SetValues**(raster rast, integer nband, geomval[] geomvalset, boolean keepnodata=FALSE);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`keepnodata` ⊠ TRUE ⊠⊠⊠, NODATA ⊠⊠⊠⊠⊠⊠ `newvalueset` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 1 ⊠⊠⊠, `columnx`, `rowy` ⊠⊠⊠⊠⊠ `newvalueset` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ `newvalueset` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `noset` ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠). ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 2 ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ `noset` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `nosetvalue` ⊠⊠⊠⊠⊠⊠⊠. `newvalueset` ⊠⊠⊠ `nosetvalue` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 3 ⊠⊠⊠, `columnx`, `rowy` ⊠⊠⊠⊠, `width` ⊠ `height` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 4 ⊠ `rast` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠.

⊠⊠ 5 ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ geomval ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ POINT ⊠⊠ MULTIPOINT ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□: □□ 1

```
/*
The ST_SetValues() does the following...

+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 1 | 1 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |    =
>    | 1 | 9 | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 9 | 9 |
+ - + - + - +          + - + - + - +
*/
SELECT
    (poly).x,
    (poly).y,
    (poly).val
FROM (
SELECT
    ST_PixelAsPolygons(
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                1, '8BUI', 1, 0
            ),
            1, 2, 2, ARRAY[[9, 9], [9, 9]]::double precision[][]
        )
    ) AS poly
) foo
ORDER BY 1, 2;

 x | y | val
---+---+-----
 1 | 1 |   1
 1 | 2 |   1
 1 | 3 |   1
 2 | 1 |   1
 2 | 2 |   9
 2 | 3 |   9
 3 | 1 |   1
 3 | 2 |   9
 3 | 3 |   9
```

```
/*
The ST_SetValues() does the following...

+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 9 | 9 | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |    =
>    | 9 |   | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 9 | 9 | 9 |
+ - + - + - +          + - + - + - +
*/
SELECT
    (poly).x,
```

```
    (poly).y,
    (poly).val
FROM (
SELECT
    ST_PixelAsPolygons(
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                1, '8BUI', 1, 0
            ),
            1, 1, 1, ARRAY[[9, 9, 9], [9, NULL, 9], [9, 9, 9]]::double precision[][]
        )
    ) AS poly
) foo
ORDER BY 1, 2;

 x | y | val
---+---+-----
 1 | 1 |   9
 1 | 2 |   9
 1 | 3 |   9
 2 | 1 |   9
 2 | 2 |
 2 | 3 |   9
 3 | 1 |   9
 3 | 2 |   9
 3 | 3 |   9
```

```
/*
The ST_SetValues() does the following...

+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 9 | 9 | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |    =>    | 1 |   | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 9 | 9 | 9 |
+ - + - + - +          + - + - + - +
*/
SELECT
    (poly).x,
    (poly).y,
    (poly).val
FROM (
SELECT
    ST_PixelAsPolygons(
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                1, '8BUI', 1, 0
            ),
            1, 1, 1,
                ARRAY[[9, 9, 9], [9, NULL, 9], [9, 9, 9]]::double precision[][],
                ARRAY[[false], [true]]::boolean[][]
        )
    ) AS poly
) foo
ORDER BY 1, 2;

 x | y | val
---+---+-----
```

```
 1 | 1 |   9
 1 | 2 |   1
 1 | 3 |   9
 2 | 1 |   9
 2 | 2 |
 2 | 3 |   9
 3 | 1 |   9
 3 | 2 |   9
 3 | 3 |   9
```

```
/*
The ST_SetValues() does the following...

+ - + - + - +          + - + - + - +
|   | 1 | 1 |          |   | 9 | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |    =>    | 1 |   | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 9 | 9 | 9 |
+ - + - + - +          + - + - + - +
*/
SELECT
    (poly).x,
    (poly).y,
    (poly).val
FROM (
SELECT
    ST_PixelAsPolygons(
        ST_SetValues(
            ST_SetValue(
                ST_AddBand(
                    ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                    1, '8BUI', 1, 0
                ),
                1, 1, 1, NULL
            ),
            1, 1, 1,
                ARRAY[[9, 9, 9], [9, NULL, 9], [9, 9, 9]]::double precision[][],
                ARRAY[[false], [true]]::boolean[][],
                TRUE
        )
    ) AS poly
) foo
ORDER BY 1, 2;

 x | y | val
---+---+-----
 1 | 1 |
 1 | 2 |   1
 1 | 3 |   9
 2 | 1 |   9
 2 | 2 |
 2 | 3 |   9
 3 | 1 |   9
 3 | 2 |   9
 3 | 3 |   9
```

□□: □□ 2

```
/*
The ST_SetValues() does the following...

+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 1 | 1 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |    =>    | 1 | 9 | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 9 | 9 |
+ - + - + - +          + - + - + - +
*/
SELECT
    (poly).x,
    (poly).y,
    (poly).val
FROM (
SELECT
    ST_PixelAsPolygons(
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                1, '8BUI', 1, 0
            ),
            1, 1, 1, ARRAY[[-1, -1, -1], [-1, 9, 9], [-1, 9, 9]]::double precision[][], -1
        )
    ) AS poly
) foo
ORDER BY 1, 2;

 x | y | val
---+---+-----
 1 | 1 |   1
 1 | 2 |   1
 1 | 3 |   1
 2 | 1 |   1
 2 | 2 |   9
 2 | 3 |   9
 3 | 1 |   1
 3 | 2 |   9
 3 | 3 |   9
```

```
/*
This example is like the previous one.  Instead of nosetvalue = -1, nosetvalue = NULL

The ST_SetValues() does the following...

+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 1 | 1 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |    =>    | 1 | 9 | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 9 | 9 |
+ - + - + - +          + - + - + - +
*/
SELECT
    (poly).x,
    (poly).y,
    (poly).val
FROM (
SELECT
    ST_PixelAsPolygons(
```

```
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                1, '8BUI', 1, 0
            ),
            1, 1, 1, ARRAY[[NULL, NULL, NULL], [NULL, 9, 9], [NULL, 9, 9]]::double ↩
                precision[][], NULL::double precision
        )
    ) AS poly
) foo
ORDER BY 1, 2;

 x | y | val
---+---+-----
 1 | 1 |   1
 1 | 2 |   1
 1 | 3 |   1
 2 | 1 |   1
 2 | 2 |   9
 2 | 3 |   9
 3 | 1 |   1
 3 | 2 |   9
 3 | 3 |   9
```

□□: □□ 3

```
/*
The ST_SetValues() does the following...

+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 1 | 1 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |    =>    | 1 | 9 | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 9 | 9 |
+ - + - + - +          + - + - + - +
*/
SELECT
    (poly).x,
    (poly).y,
    (poly).val
FROM (
SELECT
    ST_PixelAsPolygons(
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                1, '8BUI', 1, 0
            ),
            1, 2, 2, 2, 2, 9
        )
    ) AS poly
) foo
ORDER BY 1, 2;

 x | y | val
---+---+-----
 1 | 1 |   1
 1 | 2 |   1
 1 | 3 |   1
```

```
 2 | 1 |   1
 2 | 2 |   9
 2 | 3 |   9
 3 | 1 |   1
 3 | 2 |   9
 3 | 3 |   9
```

```
/*
The ST_SetValues() does the following...

+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 1 | 1 |
+ - + - + - +          + - + - + - +
| 1 |   | 1 |    =>    | 1 |   | 9 |
+ - + - + - +          + - + - + - +
| 1 | 1 | 1 |          | 1 | 9 | 9 |
+ - + - + - +          + - + - + - +
*/
SELECT
    (poly).x,
    (poly).y,
    (poly).val
FROM (
SELECT
    ST_PixelAsPolygons(
        ST_SetValues(
            ST_SetValue(
                ST_AddBand(
                    ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                    1, '8BUI', 1, 0
                ),
                1, 2, 2, NULL
            ),
            1, 2, 2, 2, 2, 9, TRUE
        )
    ) AS poly
) foo
ORDER BY 1, 2;

 x | y | val
---+---+-----
 1 | 1 |   1
 1 | 2 |   1
 1 | 3 |   1
 2 | 1 |   1
 2 | 2 |
 2 | 3 |   9
 3 | 1 |   1
 3 | 2 |   9
 3 | 3 |   9
```

□□: □□ 5

```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', 0, 0) AS rast
), bar AS (
    SELECT 1 AS gid, 'SRID=0;POINT(2.5 -2.5)'::geometry geom UNION ALL
    SELECT 2 AS gid, 'SRID=0;POLYGON((1 -1, 4 -1, 4 -4, 1 -4, 1 -1))'::geometry geom UNION ALL
```

```
    SELECT 3 AS gid, 'SRID=0;POLYGON((0 0, 5 0, 5 -1, 1 -1, 1 -4, 0 -4, 0 0))'::geometry geom UNION ALL
    SELECT 4 AS gid, 'SRID=0;MULTIPOINT(0 0, 4 4, 4 -4)'::geometry
)
SELECT
    rid, gid, ST_DumpValues(ST_SetValue(rast, 1, geom, gid))
FROM foo t1
CROSS JOIN bar t2
ORDER BY rid, gid;

 rid | gid |                                                                st_dumpvalues
-----+-----+---------------------------------------------------------------------------------------------------------------

   1 |   1 | (1,"{{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,1,NULL,NULL},{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,NULL}}")
   1 |   2 | (1,"{{NULL,NULL,NULL,NULL,NULL},{NULL,2,2,2,NULL},{NULL,2,2,2,NULL},{NULL,2,2,2,NULL},{NULL,NULL,NULL,NULL,NULL}}")
   1 |   3 | (1,"{{3,3,3,3,3},{3,NULL,NULL,NULL,NULL},{3,NULL,NULL,NULL,NULL},{3,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,NULL}}")
   1 |   4 | (1,"{{4,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,4}}")
(4 rows)
```

□□□□□□□□□□ geomvals □□□□ geomvals □□□□□□□□□□□□□□□□□□□□□.

```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', 0, 0) AS rast
), bar AS (
    SELECT 1 AS gid, 'SRID=0;POINT(2.5 -2.5)'::geometry geom UNION ALL
    SELECT 2 AS gid, 'SRID=0;POLYGON((1 -1, 4 -1, 4 -4, 1 -4, 1 -1))'::geometry geom UNION ALL
    SELECT 3 AS gid, 'SRID=0;POLYGON((0 0, 5 0, 5 -1, 1 -1, 1 -4, 0 -4, 0 0))'::geometry geom UNION ALL
    SELECT 4 AS gid, 'SRID=0;MULTIPOINT(0 0, 4 4, 4 -4)'::geometry
)
SELECT
    t1.rid, t2.gid, t3.gid, ST_DumpValues(ST_SetValues(rast, 1, ARRAY[ROW(t2.geom, t2.gid), ROW(t3.geom, t3.gid)]::geomval[]))
FROM foo t1
CROSS JOIN bar t2
CROSS JOIN bar t3
WHERE t2.gid = 1
    AND t3.gid = 2
ORDER BY t1.rid, t2.gid, t3.gid;

 rid | gid | gid |                                                    st_dumpvalues
-----+-----+-----+---------------------------------------------------------------------------------------------------------------

   1 |   1 |   2 | (1,"{{NULL,NULL,NULL,NULL,NULL},{NULL,2,2,2,NULL},{NULL,2,2,2,NULL},{NULL,2,2,2,NULL},{NULL,NULL,NULL,NULL,NULL}}")
(1 row)
```

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```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', 0, 0) AS rast
), bar AS (
    SELECT 1 AS gid, 'SRID=0;POINT(2.5 -2.5)'::geometry geom UNION ALL
    SELECT 2 AS gid, 'SRID=0;POLYGON((1 -1, 4 -1, 4 -4, 1 -4, 1 -1))'::geometry geom UNION ALL
```

```
    SELECT 3 AS gid, 'SRID=0;POLYGON((0 0, 5 0, 5 -1, 1 -1, 1 -4, 0 -4, 0 0))'::geometry ↩
        geom UNION ALL
    SELECT 4 AS gid, 'SRID=0;MULTIPOINT(0 0, 4 4, 4 -4)'::geometry
)
SELECT
    t1.rid, t2.gid, t3.gid, ST_DumpValues(ST_SetValues(rast, 1, ARRAY[ROW(t2.geom, t2.gid), ↩
         ROW(t3.geom, t3.gid)]::geomval[]))
FROM foo t1
CROSS JOIN bar t2
CROSS JOIN bar t3
WHERE t2.gid = 2
    AND t3.gid = 1
ORDER BY t1.rid, t2.gid, t3.gid;

 rid | gid | gid |                                                    st_dumpvalues
-----+-----+-----+-------------------------------------------------------------------------------

   1 |   2 |   1 | (1,"{{NULL,NULL,NULL,NULL,NULL},{NULL,2,2,2,NULL},{NULL,2,1,2,NULL},{ ↩
      NULL,2,2,2,NULL},{NULL,NULL,NULL,NULL,NULL}}")
(1 row)
```

□□

ST_Value, ST_SetValue, ST_PixelAsPolygons

11.6.14 ST_DumpValues

ST_DumpValues — □□□□□□□□□ 2 □□□□□□□□□□.

Synopsis

setof record **ST_DumpValues**(raster rast , integer[] nband=NULL , boolean exclude_nodata_value=true);
double precision[][] **ST_DumpValues**(raster rast , integer nband , boolean exclude_nodata_value=true);

□□

□□□□□□□□□ 2 □□□□□□□□□□ (□□□□□□□□, □□□□□□□□□□□). nband □ NULL □ □□□□□□□□□□, □□□□□□□□□□□□□□.

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□□

```
WITH foo AS (
    SELECT ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0), ↩
         1, '8BUI'::text, 1, 0), 2, '32BF'::text, 3, -9999), 3, '16BSI', 0, 0) AS rast
)
SELECT
    (ST_DumpValues(rast)).*
FROM foo;
```

```
 nband |                       valarray
-------+-----------------------------------------------------
     1 | {{1,1,1},{1,1,1},{1,1,1}}
     2 | {{3,3,3},{3,3,3},{3,3,3}}
     3 | {{NULL,NULL,NULL},{NULL,NULL,NULL},{NULL,NULL,NULL}}
(3 rows)
```

```
WITH foo AS (
    SELECT ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI'::text, 1, 0), 2, '32BF'::text, 3, -9999), 3, '16BSI', 0, 0) AS rast
)
SELECT
    (ST_DumpValues(rast, ARRAY[3, 1])).*
FROM foo;

 nband |                       valarray
-------+-----------------------------------------------------
     3 | {{NULL,NULL,NULL},{NULL,NULL,NULL},{NULL,NULL,NULL}}
     1 | {{1,1,1},{1,1,1},{1,1,1}}
(2 rows)
```

```
WITH foo AS (
    SELECT ST_SetValue(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', 1, 0), 1, 2, 5) AS rast
)
SELECT
    (ST_DumpValues(rast, 1))[2][1]
FROM foo;

 st_dumpvalues
---------------
             5
(1 row)
```

□□

ST_Value, ST_SetValue, ST_SetValues

11.6.15 ST_PixelOfValue

ST_PixelOfValue — □□□□□□□□□□□□□□□ columnx, rowy □□□□□□□□.

Synopsis

setof record **ST_PixelOfValue**(raster rast , integer nband , double precision[] search , boolean exclude_nodata_value=true);
setof record **ST_PixelOfValue**(raster rast , double precision[] search , boolean exclude_nodata_value=true);
setof record **ST_PixelOfValue**(raster rast , integer nband , double precision search , boolean exclude_nodata_value=true);
setof record **ST_PixelOfValue**(raster rast , double precision search , boolean exclude_nodata_value=true);

□□

□□□□□□□□□□□□□□□□□□ columnx, rowy □□□□□□□□□. □□□□□□□□□□□□□□, □□ 1 □□□□□□.

2.1.0 □□□□□□□□□□□□□□.

□□

```
SELECT
    (pixels).*
FROM (
    SELECT
        ST_PixelOfValue(
            ST_SetValue(
                ST_SetValue(
                    ST_SetValue(
                        ST_SetValue(
                            ST_SetValue(
                                ST_AddBand(
                                    ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
                                    '8BUI'::text, 1, 0
                                ),
                                1, 1, 0
                            ),
                            2, 3, 0
                        ),
                        3, 5, 0
                    ),
                    4, 2, 0
                ),
                5, 4, 255
            )
        , 1, ARRAY[1, 255]) AS pixels
) AS foo

 val | x | y
-----+---+---
   1 | 1 | 2
   1 | 1 | 3
   1 | 1 | 4
   1 | 1 | 5
   1 | 2 | 1
   1 | 2 | 2
   1 | 2 | 4
   1 | 2 | 5
   1 | 3 | 1
   1 | 3 | 2
   1 | 3 | 3
   1 | 3 | 4
   1 | 4 | 1
   1 | 4 | 3
   1 | 4 | 4
   1 | 4 | 5
   1 | 5 | 1
   1 | 5 | 2
   1 | 5 | 3
 255 | 5 | 4
   1 | 5 | 5
```

11.7 ⊠⊠⊠⊠⊠⊠⊠⊠

11.7.1 ST_SetGeoReference

ST_SetGeoReference — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 6 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL ⊠⊠ ESRI ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ GDAL ⊠⊠⊠.

Synopsis

raster **ST_SetGeoReference**(raster rast, text georefcoords, text format=GDAL);
raster **ST_SetGeoReference**(raster rast, double precision upperleftx, double precision upperlefty, double precision scalex, double precision scaley, double precision skewx, double precision skewy);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 6 ⊠⊠⊠⊠⊠⊠⊠. 'GDAL' ⊠⊠'ESRI' ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ GDAL ⊠⊠⊠. 6 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

GDAL:

```
scalex skewy skewx scaley upperleftx upperlefty
```

ESRI:

```
scalex skewy skewx scaley upperleftx + scalex*0.5 upperlefty + scaley*0.5
```

> **Note**
> ⊠⊠⊠⊠ DB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_SetGeoReference(raster, double precision, ...) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
WITH foo AS (
    SELECT ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0) AS rast
)
SELECT
    0 AS rid, (ST_Metadata(rast)).*
FROM foo
UNION ALL
SELECT
    1, (ST_Metadata(ST_SetGeoReference(rast, '10 0 0 -10 0.1 0.1', 'GDAL'))).*
FROM foo
UNION ALL
SELECT
    2, (ST_Metadata(ST_SetGeoReference(rast, '10 0 0 -10 5.1 -4.9', 'ESRI'))).*
FROM foo
UNION ALL
SELECT
```

```
    3, (ST_Metadata(ST_SetGeoReference(rast, 1, 1, 10, -10, 0.001, 0.001))).*
FROM foo

 rid |     upperleftx     |     upperlefty     | width | height | scalex | scaley | skewx | ↩
      skewy | srid | numbands
-----+--------------------+--------------------+-------+--------+--------+--------+-------+--

   0 |                  0 |                  0 |     5 |      5 |      1 |     -1 |     0 | ↩
          0 |    0 |        0
   1 |                0.1 |                0.1 |     5 |      5 |     10 |    -10 |     0 | ↩
          0 |    0 |        0
   2 | 0.0999999999999996 | 0.0999999999999996 |     5 |      5 |     10 |    -10 |     0 | ↩
          0 |    0 |        0
   3 |                  1 |                  1 |     5 |      5 |     10 |    -10 | 0.001 | ↩
        0.001 |    0 |        0
```

⊠⊠

ST_GeoReference, ST_ScaleX, ST_ScaleY, ST_UpperLeftX, ST_UpperLeftY

11.7.2 ST_SetRotation

ST_SetRotation — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_SetRotation**(raster rast, float8 rotation);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT
  ST_ScaleX(rast1), ST_ScaleY(rast1), ST_SkewX(rast1), ST_SkewY(rast1),
  ST_ScaleX(rast2), ST_ScaleY(rast2), ST_SkewX(rast2), ST_SkewY(rast2)
FROM (
  SELECT ST_SetRotation(rast, 15) AS rast1, rast as rast2 FROM dummy_rast
) AS foo;
      st_scalex      |      st_scaley      |      st_skewx      |      st_skewy      |  ↩
          st_scalex | st_scaley | st_skewx | st_skewy
---------------------+---------------------+--------------------+--------------------+-----------+--

   -1.51937582571764 |   -2.27906373857646 |   1.95086352047135 |   1.30057568031423 |  ↩
              2 |         3 |        0 |        0
 -0.0379843956429411 | -0.0379843956429411 | 0.0325143920078558 | 0.0325143920078558 |  ↩
          0.05 |     -0.05 |        0 |        0
```

⊠⊠

ST_Rotation, ST_ScaleX, ST_ScaleY, ST_SkewX, ST_SkewY

11.7.3 ST_SetScale

ST_SetScale — X □ Y □□□□□□□□□□□□□□□□□□□□□□□□□. □□/□□□□/□□□□□□□□□.

Synopsis

raster **ST_SetScale**(raster rast, float8 xy);
raster **ST_SetScale**(raster rast, float8 x, float8 y);

□□

X □ Y □□□□□□□□□□□□□□□□□□□□□□□□□. □□/□□□□/□□□□□□□□□□□□□□□□. □□□□□□□□□□, X □ Y □□□□□□□□□□□□□□.

> **Note**
> ST_SetScale □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ ST_Rescale □□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ (□□□□□□□) □□□□□□□□. ST_Rescale □□. ST_SetScale □□□□□□□□□□□□□□□□□□□□□□□□□□□.

□□□□: 2.0.0 □□ WKTRaster □□□□□ ST_SetPixelSize □□□□□□□□□□. 2.0.0 □□□□□□□□□□□□□□□□□□.

□□

```
UPDATE dummy_rast
    SET rast = ST_SetScale(rast, 1.5)
WHERE rid = 2;

SELECT ST_ScaleX(rast) As pixx, ST_ScaleY(rast) As pixy, Box3D(rast) As newbox
FROM dummy_rast
WHERE rid = 2;

 pixx | pixy |                    newbox
------+------+----------------------------------------------
  1.5 |  1.5 | BOX(3427927.75 5793244 0, 3427935.25 5793251.5 0)
```

```
UPDATE dummy_rast
    SET rast = ST_SetScale(rast, 1.5, 0.55)
WHERE rid = 2;

SELECT ST_ScaleX(rast) As pixx, ST_ScaleY(rast) As pixy, Box3D(rast) As newbox
FROM dummy_rast
WHERE rid = 2;

 pixx | pixy |                   newbox
------+------+--------------------------------------------
  1.5 | 0.55 | BOX(3427927.75 5793244 0,3427935.25 5793247 0)
```

□□

ST_ScaleX, ST_ScaleY, Box3D

11.7.4 ST_SetSkew

ST_SetSkew — □□□□ X □ Y □□□ (skew)(□□□□□□□□□) □□□□□□. □□□□□□□□□, X □ Y □□□□□□□□□□□□.

Synopsis

raster **ST_SetSkew**(raster rast, float8 skewxy);
raster **ST_SetSkew**(raster rast, float8 skewx, float8 skewy);

□□

□□□□ X □ Y □□□ (□□□□□□□□□) □□□□□□. □□□□□□□□□, X □ Y □□□□□□□□□□□□. □□□□□□ □□□□ □□□□□□□.

□□

```
-- Example 1
UPDATE dummy_rast SET rast = ST_SetSkew(rast,1,2) WHERE rid = 1;
SELECT rid, ST_SkewX(rast) As skewx, ST_SkewY(rast) As skewy,
    ST_GeoReference(rast) as georef
FROM dummy_rast WHERE rid = 1;

rid | skewx | skewy |    georef
----+-------+-------+--------------
  1 |     1 |     2 | 2.0000000000
                    : 2.0000000000
                    : 1.0000000000
                    : 3.0000000000
                    : 0.5000000000
                    : 0.5000000000
```

```
-- Example 2 set both to same number:
UPDATE dummy_rast SET rast = ST_SetSkew(rast,0) WHERE rid = 1;
SELECT rid, ST_SkewX(rast) As skewx, ST_SkewY(rast) As skewy,
    ST_GeoReference(rast) as georef
FROM dummy_rast WHERE rid = 1;

 rid | skewx | skewy |    georef
-----+-------+-------+--------------
   1 |     0 |     0 | 2.0000000000
                     : 0.0000000000
                     : 0.0000000000
                     : 3.0000000000
                     : 0.5000000000
                     : 0.5000000000
```

□□

ST_GeoReference, ST_SetGeoReference, ST_SkewX, ST_SkewY

11.7.5 ST_SetSRID

ST_SetSRID — ⊠⊠⊠⊠ SRID ⊠ spatial_ref_sys ⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_SetSRID**(raster rast, integer srid);

⊠⊠

⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

Section 4.5, ST_SRID

11.7.6 ST_SetUpperLeft

ST_SetUpperLeft — Sets the value of the upper left corner of the pixel of the raster to projected X and Y coordinates.

Synopsis

raster **ST_SetUpperLeft**(raster rast, double precision x, double precision y);

⊠⊠

Set the value of the upper left corner of raster to the projected X and Y coordinates

⊠⊠

```
SELECT ST_SetUpperLeft(rast,-71.01,42.37)
FROM dummy_rast
WHERE rid = 2;
```

⊠⊠

ST_UpperLeftX, ST_UpperLeftY

11.7.7 ST_Resample

ST_Resample — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_Resample**(raster rast, integer width, integer height, double precision gridx=NULL, double precision gridy=NULL, double precision skewx=0, double precision skewy=0, text algorithm=NearestNeigh double precision maxerr=0.125);
raster **ST_Resample**(raster rast, double precision scalex=0, double precision scaley=0, double precision gridx=NULL, double precision gridy=NULL, double precision skewx=0, double precision skewy=0, text algorithm=NearestNeighbor, double precision maxerr=0.125);
raster **ST_Resample**(raster rast, raster ref, text algorithm=NearestNeighbor, double precision maxerr=0.125, boolean usescale=true);
raster **ST_Resample**(raster rast, raster ref, boolean usescale, text algorithm=NearestNeighbor, double precision maxerr=0.125);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (width & height), ⊠⊠⊠⊠⊠⊠⊠ (gridx & gridy), ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (scalex, scaley, skewx & skewy) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

New pixel values are computed using one of the following resampling algorithms:

- NearestNeighbor (english or american spelling)
- Bilinear
- Cubic
- CubicSpline
- Lanczos
- Max
- Min

The default is NearestNeighbor which is the fastest but results in the worst interpolation.

`maxerr` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0.125 ⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠ GDAL Warp resampling methods ⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 3.4.0 max and min resampling options added

□□

```
SELECT
    ST_Width(orig) AS orig_width,
    ST_Width(reduce_100) AS new_width
FROM (
    SELECT
        rast AS orig,
        ST_Resample(rast,100,100) AS reduce_100
    FROM aerials.boston
    WHERE ST_Intersects(rast,
        ST_Transform(
            ST_MakeEnvelope(-71.128, 42.2392,-71.1277, 42.2397, 4326),26986)
    )
    LIMIT 1
) AS foo;

 orig_width | new_width
------------+-------------
        200 |         100
```

□□

ST_Rescale, ST_Resize, ST_Transform

11.7.8 ST_Rescale

ST_Rescale — Resample a raster by adjusting only its scale (or pixel size). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline, Lanczos, Max or Min resampling algorithm. Default is NearestNeighbor.

Synopsis

raster **ST_Rescale**(raster rast, double precision scalexy, text algorithm=NearestNeighbor, double precision maxerr=0.125);
raster **ST_Rescale**(raster rast, double precision scalex, double precision scaley, text algorithm=NearestNei
double precision maxerr=0.125);

□□

Resample a raster by adjusting only its scale (or pixel size). New pixel values are computed using one of the following resampling algorithms:

- NearestNeighbor (english or american spelling)
- Bilinear
- Cubic
- CubicSpline
- Lanczos
- Max

- Min

The default is NearestNeighbor which is the fastest but results in the worst interpolation.

`scalex` and `scaley` define the new pixel size. scaley must often be negative to get well oriented raster.

⊠ scalex ⊠⊠ scaley ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Resize ⊠⊠⊠⊠⊠⊠⊠⊠.

`maxerr` is the threshold for transformation approximation by the resampling algorithm (in pixel units). A default of 0.125 is used if no `maxerr` is specified, which is the same value used in GDAL gdalwarp utility. If set to zero, no approximation takes place.

Note
⊠⊠⊠⊠⊠⊠ GDAL Warp resampling methods ⊠⊠⊠⊠⊠⊠⊠.

Note
ST_Rescale ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_SetScale ⊠⊠⊠⊠⊠⊠⊠. ST_SetScale ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠. ST_Rescale ⊠⊠. ST_SetScale ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 3.4.0 max and min resampling options added

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠ 0.001 ⊠⊠⊠⊠⊠⊠⊠⊠ 0.0015 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
-- the original raster pixel size
SELECT ST_PixelWidth(ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 0.001, -0.001, 0, 0, ↩
    4269), '8BUI'::text, 1, 0)) width

   width
----------
0.001

-- the rescaled raster raster pixel size
SELECT ST_PixelWidth(ST_Rescale(ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 0.001, ↩
    -0.001, 0, 0, 4269), '8BUI'::text, 1, 0), 0.0015)) width

   width
----------
0.0015
```

⊠⊠

ST_Resize, ST_Resample, ST_SetScale, ST_ScaleX, ST_ScaleY, ST_Transform

11.7.9 ST_Reskew

ST_Reskew — ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NearestNeighbor(⊠⊠⊠⊠⊠⊠⊠⊠), Bilinear, Cubic, CubicSpline ⊠⊠ Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.

Synopsis

raster **ST_Reskew**(raster rast, double precision skewxy, text algorithm=NearestNeighbor, double precision maxerr=0.125);
raster **ST_Reskew**(raster rast, double precision skewx, double precision skewy, text algorithm=NearestNeig double precision maxerr=0.125);

⊠⊠

⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NearestNeighbor(⊠⊠⊠⊠⊠⊠⊠⊠⊠), Bilinear, Cubic, CubicSpline ⊠⊠ Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.

skewx ⊠ skewy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

maxerr ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0.125 ⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠ GDAL Warp resampling methods ⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ST_Reskew ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_SetSkew ⊠⊠⊠⊠⊠⊠⊠. ST_SetSkew ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_Reskew ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_SetSkew ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠ 0.0 ⊠⊠⊠⊠⊠ 0.0015 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
-- the original raster non-rotated
SELECT ST_Rotation(ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 0.001, -0.001, 0, 0, 4269) ↩
    , '8BUI'::text, 1, 0));

-- result
0

-- the reskewed raster raster rotation
SELECT ST_Rotation(ST_Reskew(ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 0.001, -0.001, ↩
    0, 0, 4269), '8BUI'::text, 1, 0), 0.0015));

-- result
-0.982793723247329
```

⊠⊠

ST_Resample, ST_Rescale, ST_SetSkew, ST_SetRotation, ST_SkewX, ST_SkewY, ST_Transform

11.7.10 ST_SnapToGrid

ST_SnapToGrid — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NearestNeighbor(⊠⊠⊠⊠⊠⊠⊠⊠), Bilinear, Cubic, CubicSpline ⊠⊠ Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.

Synopsis

raster **ST_SnapToGrid**(raster rast, double precision gridx, double precision gridy, text algorithm=NearestN double precision maxerr=0.125, double precision scalex=DEFAULT 0, double precision scaley=DEFAULT 0);
raster **ST_SnapToGrid**(raster rast, double precision gridx, double precision gridy, double precision scalex, double precision scaley, text algorithm=NearestNeighbor, double precision maxerr=0.125);
raster **ST_SnapToGrid**(raster rast, double precision gridx, double precision gridy, double precision scalexy, text algorithm=NearestNeighbor, double precision maxerr=0.125);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ (gridx & gridy) ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (scalex & scaley) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NearestNeighbor(⊠⊠⊠⊠⊠⊠⊠⊠), Bilinear, Cubic, CubicSpline ⊠⊠ Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.

`gridx` ⊠ `gridy` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

You can optionally define the pixel size of the new grid with `scalex` and `scaley`.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`maxerr` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0.125 ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠ GDAL Warp resampling methods ⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Resample ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
-- the original raster upper left X
SELECT ST_UpperLeftX(ST_AddBand(ST_MakeEmptyRaster(10, 10, 0, 0, 0.001, -0.001, 0, 0, 4269) ↵
    , '8BUI'::text, 1, 0));
-- result
0

-- the upper left of raster after snapping
SELECT ST_UpperLeftX(ST_SnapToGrid(ST_AddBand(ST_MakeEmptyRaster(10, 10, 0, 0, 0.001,  ↵
    -0.001, 0, 0, 4269), '8BUI'::text, 1, 0), 0.0002, 0.0002));

--result
-0.0008
```

⊠⊠

ST_Resample, ST_Rescale, ST_UpperLeftX, ST_UpperLeftY

11.7.11 ST_Resize

ST_Resize — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_Resize**(raster rast, integer width, integer height, text algorithm=NearestNeighbor, double precision maxerr=0.125);
raster **ST_Resize**(raster rast, double precision percentwidth, double precision percentheight, text algorithm=NearestNeighbor, double precision maxerr=0.125);
raster **ST_Resize**(raster rast, text width, text height, text algorithm=NearestNeighbor, double precision maxerr=0.125);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

NearestNeighbor(⊠⊠⊠⊠⊠⊠⊠⊠), Bilinear, Cubic, CubicSpline ⊠⊠ Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.

⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (”20%”) ⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
WITH foo AS(
SELECT
    1 AS rid,
    ST_Resize(
        ST_AddBand(
            ST_MakeEmptyRaster(1000, 1000, 0, 0, 1, -1, 0, 0, 0)
            , 1, '8BUI', 255, 0
        )
    , '50%', '500') AS rast
UNION ALL
SELECT
    2 AS rid,
    ST_Resize(
        ST_AddBand(
            ST_MakeEmptyRaster(1000, 1000, 0, 0, 1, -1, 0, 0, 0)
            , 1, '8BUI', 255, 0
        )
    , 500, 100) AS rast
UNION ALL
SELECT
    3 AS rid,
    ST_Resize(
        ST_AddBand(
            ST_MakeEmptyRaster(1000, 1000, 0, 0, 1, -1, 0, 0, 0)
            , 1, '8BUI', 255, 0
        )
    , 0.25, 0.9) AS rast
), bar AS (
    SELECT rid, ST_Metadata(rast) AS meta, rast FROM foo
)
SELECT rid, (meta).* FROM bar

 rid | upperleftx | upperlefty | width | height | scalex | scaley | skewx | skewy | srid | ↩
     numbands
-----+------------+------------+-------+--------+--------+--------+-------+-------+------+----------

   1 |          0 |          0 |   500 |    500 |      1 |     -1 |     0 |     0 |    0 | ↩
            1
   2 |          0 |          0 |   500 |    100 |      1 |     -1 |     0 |     0 |    0 | ↩
            1
   3 |          0 |          0 |   250 |    900 |      1 |     -1 |     0 |     0 |    0 | ↩
            1
(3 rows)
```

⊠⊠

ST_Resample, ST_Rescale, ST_Reskew, ST_SnapToGrid

11.7.12 ST_Transform

ST_Transform — ⊠⊠. NearestNeighbor, Bilinear, Cubic, CubicSpline, Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.

Synopsis

raster **ST_Transform**(raster rast, integer srid, text algorithm=NearestNeighbor, double precision maxerr=0.125, double precision scalex, double precision scaley);
raster **ST_Transform**(raster rast, integer srid, double precision scalex, double precision scaley, text algorithm=NearestNeighbor, double precision maxerr=0.125);
raster **ST_Transform**(raster rast, raster alignto, text algorithm=NearestNeighbor, double precision maxerr=0.125);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (pixel warp) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NearestNeighbor ⊠⊠, maxerror ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0.125 ⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠’NearestNeighbor’, ’Bilinear’, ’Cubic’, ’CubicSpline’, ⊠⊠⊠’Lanczos’ ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ GDAL Warp resampling methods ⊠⊠⊠⊠⊠⊠⊠⊠.

ST_Transform ⊠⊠⊠⊠⊠⊠ ST_SetSRID() ⊠⊠⊠⊠⊠⊠⊠⊠. ST_Transform ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠, ST_SetSRID() ⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 3 ⊠ alignto ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRID) ⊠⊠⊠⊠⊠⊠⊠⊠⊠, (ST_SameAlignment = TRUE ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
If you find your transformation support is not working right, you may need to set the environment variable PROJSO to the .so or .dll projection library your PostGIS is using. This just needs to have the name of the file. So for example on windows, you would in Control Panel -> System -> Environment Variables add a system variable called PROJSO and set it to `libproj.dll` (if you are using proj 4.6.1). You'll have to restart your PostgreSQL service/daemon after this change.

Warning
When transforming a coverage of tiles, you almost always want to use a reference raster to insure same alignment and no gaps in your tiles as demonstrated in example: Variant 3.

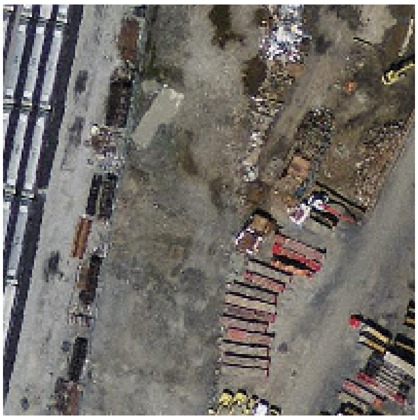
2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_Transform(rast, alignto) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT ST_Width(mass_stm) As w_before, ST_Width(wgs_84) As w_after,
  ST_Height(mass_stm) As h_before, ST_Height(wgs_84) As h_after
    FROM
    ( SELECT rast As mass_stm, ST_Transform(rast,4326) As wgs_84
  ,  ST_Transform(rast,4326, 'Bilinear') AS wgs_84_bilin
        FROM aerials.o_2_boston
            WHERE ST_Intersects(rast,
                ST_Transform(ST_MakeEnvelope(-71.128, 42.2392,-71.1277, 42.2397, 4326) ↩
                    ,26986) )
        LIMIT 1) As foo;
```

```
 w_before | w_after | h_before | h_after
----------+---------+----------+---------
      200 |     228 |      200 |     170
```

 *□□□□□□□□□□□□□□□ (mass_stm)*	 *WGS84 □□□ (wgs_84) □□□ □□*	 *□□□ NN □□ Bilinear □□□ □□□□ WGS84 □□□ (wgs_84_bilin) □□□□□*

□□: □□ 3

□□□ ST_Transform(raster, srid) □ ST_Transform(raster, alignto) □□□□□□□□□□□□□□□.

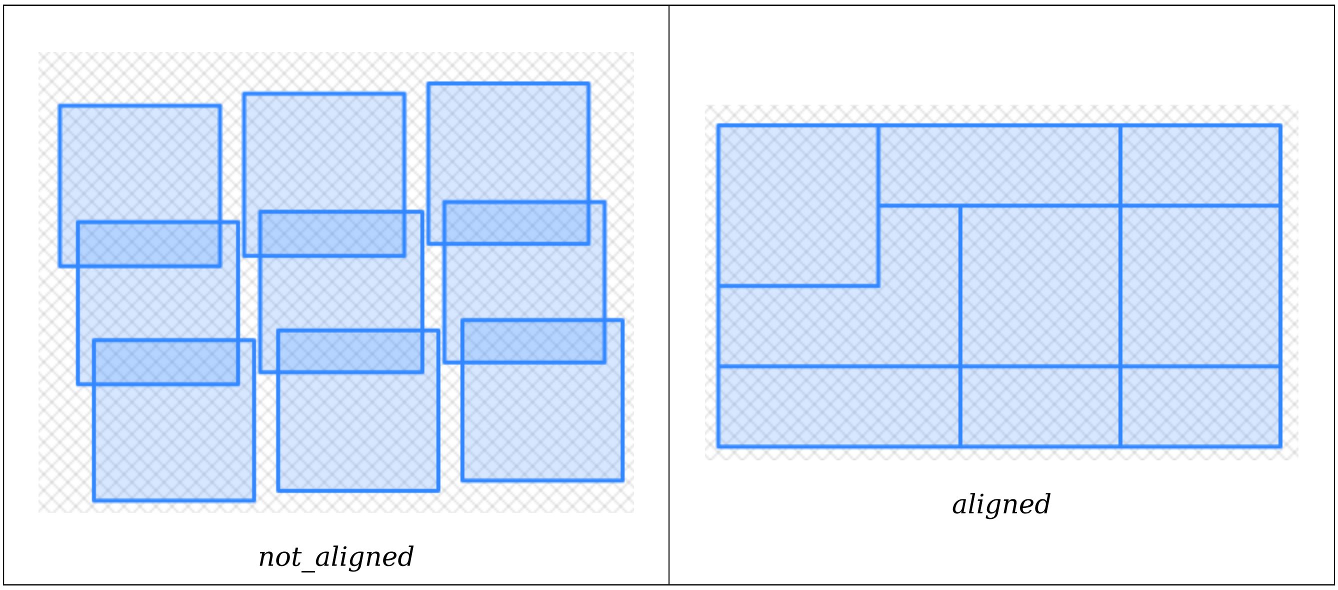
```
WITH foo AS (
    SELECT 0 AS rid, ST_AddBand(ST_MakeEmptyRaster(2, 2, -500000, 600000, 100, -100, 0, 0, 2163), 1, '16BUI', 1, 0) AS rast UNION ALL
    SELECT 1, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499800, 600000, 100, -100, 0, 0, 2163), 1, '16BUI', 2, 0) AS rast UNION ALL
    SELECT 2, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499600, 600000, 100, -100, 0, 0, 2163), 1, '16BUI', 3, 0) AS rast UNION ALL

    SELECT 3, ST_AddBand(ST_MakeEmptyRaster(2, 2, -500000, 599800, 100, -100, 0, 0, 2163), 1, '16BUI', 10, 0) AS rast UNION ALL
    SELECT 4, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499800, 599800, 100, -100, 0, 0, 2163), 1, '16BUI', 20, 0) AS rast UNION ALL
    SELECT 5, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499600, 599800, 100, -100, 0, 0, 2163), 1, '16BUI', 30, 0) AS rast UNION ALL

    SELECT 6, ST_AddBand(ST_MakeEmptyRaster(2, 2, -500000, 599600, 100, -100, 0, 0, 2163), 1, '16BUI', 100, 0) AS rast UNION ALL
    SELECT 7, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499800, 599600, 100, -100, 0, 0, 2163), 1, '16BUI', 200, 0) AS rast UNION ALL
    SELECT 8, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499600, 599600, 100, -100, 0, 0, 2163), 1, '16BUI', 300, 0) AS rast
), bar AS (
    SELECT
        ST_Transform(rast, 4269) AS alignto
    FROM foo
    LIMIT 1
), baz AS (
    SELECT
        rid,
        rast,
        ST_Transform(rast, 4269) AS not_aligned,
```

```
        ST_Transform(rast, alignto) AS aligned
    FROM foo
    CROSS JOIN bar
)
SELECT
    ST_SameAlignment(rast) AS rast,
    ST_SameAlignment(not_aligned) AS not_aligned,
    ST_SameAlignment(aligned) AS aligned
FROM baz

 rast | not_aligned | aligned
------+-------------+---------
 t    | f           | t
```



not_aligned *aligned*

⊠⊠

ST_Transform, ST_SetSRID

11.8 ⊠⊠⊠⊠⊠⊠⊠⊠

11.8.1 ST_SetBandNoDataValue

ST_SetBandNoDataValue — NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠, nodata value = NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_SetBandNoDataValue**(raster rast, double precision nodatavalue);
raster **ST_SetBandNoDataValue**(raster rast, integer band, double precision nodatavalue, boolean forcechecking=false);

⊠⊠

⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_Polygon, ST_DumpAsPolygons, ⊠⊠⊠ ST_PixelAs...() ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- change just first band no data value
UPDATE dummy_rast
    SET rast = ST_SetBandNoDataValue(rast,1, 254)
WHERE rid = 2;

-- change no data band value of bands 1,2,3
UPDATE dummy_rast
    SET rast =
        ST_SetBandNoDataValue(
            ST_SetBandNoDataValue(
                ST_SetBandNoDataValue(
                    rast,1, 254)
                ,2,99),
                3,108)
        WHERE rid = 2;

-- wipe out the nodata value this will ensure all pixels are considered for all processing functions
UPDATE dummy_rast
    SET rast = ST_SetBandNoDataValue(rast,1, NULL)
WHERE rid = 2;
```

⊠⊠

ST_BandNoDataValue, ST_NumBands

11.8.2 ST_SetBandIsNoData

ST_SetBandIsNoData — ⊠⊠⊠ isnodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_SetBandIsNoData**(raster rast, integer band=1);

⊠⊠

⊠⊠⊠ isnodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_BandIsNoData ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□

```
-- Create dummy table with one raster column
create table dummy_rast (rid integer, rast raster);

-- Add raster with two bands, one pixel/band. In the first band, nodatavalue = pixel value = 3.
-- In the second band, nodatavalue = 13, pixel value = 4
insert into dummy_rast values(1,
(
'01' -- little endian (uint8 ndr)
||
'0000' -- version (uint16 0)
||
'0200' -- nBands (uint16 0)
||
'17263529ED684A3F' -- scaleX (float64 0.000805965234044584)
||
'F9253529ED684ABF' -- scaleY (float64 -0.00080596523404458)
||
'1C9F33CE69E352C0' -- ipX (float64 -75.5533328537098)
||
'718F0E9A27A44840' -- ipY (float64 49.2824585505576)
||
'ED50EB853EC32B3F' -- skewX (float64 0.000211812383858707)
||
'7550EB853EC32B3F' -- skewY (float64 0.000211812383858704)
||
'E6100000' -- SRID (int32 4326)
||
'0100' -- width (uint16 1)
||
'0100' -- height (uint16 1)
||
'4' -- hasnodatavalue set to true, isnodata value set to false (when it should be true)
||
'2' -- first band type (4BUI)
||
'03' -- novalue==3
||
'03' -- pixel(0,0)==3 (same that nodata)
||
'0' -- hasnodatavalue set to false
||
'5' -- second band type (16BSI)
||
'0D00' -- novalue==13
||
'0400' -- pixel(0,0)==4
)::raster
);

select st_bandisnodata(rast, 1) from dummy_rast where rid = 1; -- Expected false
select st_bandisnodata(rast, 1, TRUE) from dummy_rast where rid = 1; -- Expected true

-- The isnodata flag is dirty. We are going to set it to true
update dummy_rast set rast = st_setbandisnodata(rast, 1) where rid = 1;


select st_bandisnodata(rast, 1) from dummy_rast where rid = 1; -- Expected true
```

⊠⊠

ST_BandNoDataValue, ST_NumBands, ST_SetBandNoDataValue, ST_BandIsNoData

11.8.3 ST_SetBandPath

ST_SetBandPath — Update the external path and band number of an out-db band

Synopsis

raster **ST_SetBandPath**(raster rast, integer band, text outdbpath, integer outdbindex, boolean force=false);

⊠⊠

Updates an out-db band's external raster file path and external band number.

> **Note**
> If `force` is set to true, no tests are done to ensure compatibility (e.g. alignment, pixel support) between the external raster file and the PostGIS raster. This mode is intended for file system changes where the external raster resides.

Availability: 2.5.0

⊠⊠

```
WITH foo AS (
    SELECT
        ST_AddBand(NULL::raster, '/home/pele/devel/geo/postgis-git/raster/test/regress/loader/Projected.tif', NULL::int[]) AS rast
)
SELECT
    1 AS query,
    *
FROM ST_BandMetadata(
    (SELECT rast FROM foo),
    ARRAY[1,3,2]::int[]
)
UNION ALL
SELECT
    2,
    *
FROM ST_BandMetadata(
    (
        SELECT
            ST_SetBandPath(
                rast,
                2,
                '/home/pele/devel/geo/postgis-git/raster/test/regress/loader/Projected2.tif',
                1
            ) AS rast
        FROM foo
    ),
```

```
    ARRAY[1,3,2]::int[]
)
ORDER BY 1, 2;

 query | bandnum | pixeltype | nodatavalue | isoutdb |  ↩
                                          path                                            | ↩
     outdbbandnum
-------+---------+-----------+-------------+---------+---------------------------------------------

     1 |       1 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            1
     1 |       2 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            2
     1 |       3 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            3
     2 |       1 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            1
     2 |       2 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
    raster/test/regress/loader/Projected2.tif      |            1
     2 |       3 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            3
```

☒☒

ST_BandMetaData, ST_SetBandIndex

11.8.4 ST_SetBandIndex

ST_SetBandIndex — Update the external band number of an out-db band

Synopsis

raster **ST_SetBandIndex**(raster rast, integer band, integer outdbindex, boolean force=false);

☒☒

Updates an out-db band's external band number. This does not touch the external raster file associated with the out-db band

> **Note**
> If `force` is set to true, no tests are done to ensure compatibility (e.g. alignment, pixel support) between the external raster file and the PostGIS raster. This mode is intended for where bands are moved around in the external raster file.

> **Note**
> Internally, this method replaces the PostGIS raster's band at index band with a new band instead of updating the existing path information.

Availability: 2.5.0

☒☒

```
WITH foo AS (
    SELECT
        ST_AddBand(NULL::raster, '/home/pele/devel/geo/postgis-git/raster/test/regress/ ↩
            loader/Projected.tif', NULL::int[]) AS rast
)
SELECT
    1 AS query,
    *
FROM ST_BandMetadata(
    (SELECT rast FROM foo),
    ARRAY[1,3,2]::int[]
)
UNION ALL
SELECT
    2,
    *
FROM ST_BandMetadata(
    (
        SELECT
            ST_SetBandIndex(
                rast,
                2,
                1
            ) AS rast
        FROM foo
    ),
    ARRAY[1,3,2]::int[]
)
ORDER BY 1, 2;

 query | bandnum | pixeltype | nodatavalue | isoutdb |  ↩
                                          path                                          |  ↩
     outdbbandnum
-------+---------+-----------+-------------+---------+------------------------------------------

     1 |       1 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            1
     1 |       2 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            2
     1 |       3 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            3
     2 |       1 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            1
     2 |       2 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
    raster/test/regress/loader/Projected.tif       |            1
     2 |       3 | 8BUI      |             | t       | /home/pele/devel/geo/postgis-git/ ↩
         raster/test/regress/loader/Projected.tif       |            3
```

☒☒

ST_BandMetaData, ST_SetBandPath

11.9 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

11.9.1 ST_Count

ST_Count — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠, NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

bigint **ST_Count**(raster rast, integer nband=1, boolean exclude_nodata_value=true);
bigint **ST_Count**(raster rast, boolean exclude_nodata_value);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ nband ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠.

> **Note**
> exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ nodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠ ST_Count(rastertable, rastercolumn, ...) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ST_CountAgg ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
--example will count all pixels not 249 and one will count all pixels.  --
SELECT rid, ST_Count(ST_SetBandNoDataValue(rast,249)) As exclude_nodata,
        ST_Count(ST_SetBandNoDataValue(rast,249),false) As include_nodata
    FROM dummy_rast WHERE rid=2;

rid | exclude_nodata | include_nodata
-----+----------------+----------------
   2 |             23 |             25
```

⊠⊠

ST_CountAgg, ST_SummaryStats, ST_SetBandNoDataValue

11.9.2 ST_CountAgg

ST_CountAgg — ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠, NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

bigint **ST_CountAgg**(raster rast, integer nband, boolean exclude_nodata_value, double precision sample_percent);
bigint **ST_CountAgg**(raster rast, integer nband, boolean exclude_nodata_value);
bigint **ST_CountAgg**(raster rast, boolean exclude_nodata_value);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ nband ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠.

exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ nodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, sample_percent ⊠ 0 ⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
WITH foo AS (
    SELECT
        rast.rast
    FROM (
        SELECT ST_SetValue(
            ST_SetValue(
                ST_SetValue(
                    ST_AddBand(
                        ST_MakeEmptyRaster(10, 10, 10, 10, 2, 2, 0, 0,0)
                        , 1, '64BF', 0, 0
                    )
                    , 1, 1, 1, -10
                )
                , 1, 5, 4, 0
            )
            , 1, 5, 5, 3.14159
        ) AS rast
    ) AS rast
    FULL JOIN (
        SELECT generate_series(1, 10) AS id
    ) AS id
        ON 1 = 1
)
SELECT
    ST_CountAgg(rast, 1, TRUE)
FROM foo;

 st_countagg
-------------
          20
(1 row)
```

⊠⊠

ST_Count, ST_SummaryStats, ST_SetBandNoDataValue

11.9.3 ST_Histogram

ST_Histogram — ⊠ (bin; ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

SETOF record **ST_Histogram**(raster rast, integer nband=1, boolean exclude_nodata_value=true, integer bins=autocomputed, double precision[] width=NULL, boolean right=false);
SETOF record **ST_Histogram**(raster rast, integer nband, integer bins, double precision[] width=NULL, boolean right=false);
SETOF record **ST_Histogram**(raster rast, integer nband, boolean exclude_nodata_value, integer bins, boolean right);
SETOF record **ST_Histogram**(raster rast, integer nband, integer bins, boolean right);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ min, max, count, percent ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠ `nband` ⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ `nodata` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `exclude_nodata_value` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`width` width: ⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ width ⊠⊠⊠⊠⊠⊠⊠, width ⊠⊠⊠⊠⊠ ⊠.

⊠⊠: ⊠ 9 ⊠, width [a, b, c] ⊠ [a, b, c, a, b, c, a, b, c] ⊠⊠⊠⊠⊠⊠⊠⊠.

`bins` ⊠⊠⊠⊠ (breakout) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`right` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠⊠. X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ [a, b) ⊠⊠ (a, b] ⊠ ⊠⊠⊠⊠⊠.

Changed: 3.1.0 Removed ST_Histogram(table_name, column_name) variant.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠ - ⊠⊠ 1, 2, 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT band, (stats).*
FROM (SELECT rid, band, ST_Histogram(rast, band) As stats
    FROM dummy_rast CROSS JOIN generate_series(1,3) As band
     WHERE rid=2) As foo;

 band |  min  |  max  | count | percent
------+-------+-------+-------+---------
    1 |   249 |   250 |     2 |    0.08
    1 |   250 |   251 |     2 |    0.08
    1 |   251 |   252 |     1 |    0.04
    1 |   252 |   253 |     2 |    0.08
    1 |   253 |   254 |    18 |    0.72
```

```
    2 |    78 | 113.2 |    11 |    0.44
    2 | 113.2 | 148.4 |     4 |    0.16
    2 | 148.4 | 183.6 |     4 |    0.16
    2 | 183.6 | 218.8 |     1 |    0.04
    2 | 218.8 |   254 |     5 |     0.2
    3 |    62 | 100.4 |    11 |    0.44
    3 | 100.4 | 138.8 |     5 |     0.2
    3 | 138.8 | 177.2 |     4 |    0.16
    3 | 177.2 | 215.6 |     1 |    0.04
    3 | 215.6 |   254 |     4 |    0.16
```

⊠⊠: ⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 6 ⊠⊠⊠⊠⊠⊠⊠.

```
SELECT (stats).*
FROM (SELECT rid, ST_Histogram(rast, 2,6) As stats
    FROM dummy_rast
     WHERE rid=2) As foo;

    min     |    max     | count | percent
------------+------------+-------+---------
         78 | 107.333333 |     9 |    0.36
 107.333333 | 136.666667 |     6 |    0.24
 136.666667 |        166 |     0 |       0
        166 | 195.333333 |     4 |    0.16
 195.333333 | 224.666667 |     1 |    0.04
 224.666667 |        254 |     5 |     0.2
(6 rows)

-- Same as previous but we explicitly control the pixel value range of each bin.
SELECT (stats).*
FROM (SELECT rid, ST_Histogram(rast, 2,6,ARRAY[0.5,1,4,100,5]) As stats
    FROM dummy_rast
     WHERE rid=2) As foo;

  min  |  max  | count | percent
-------+-------+-------+----------
    78 |  78.5 |     1 |     0.08
  78.5 |  79.5 |     1 |     0.04
  79.5 |  83.5 |     0 |        0
  83.5 | 183.5 |    17 |   0.0068
 183.5 | 188.5 |     0 |        0
 188.5 |   254 |     6 | 0.003664
(6 rows)
```

⊠⊠

ST_Count, ST_SummaryStats, ST_SummaryStatsAgg

11.9.4 ST_Quantile

ST_Quantile — ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (population) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (quantile) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠, ⊠⊠⊠⊠ 25%, 50%, 75% ⊠⊠⊠ (percentile) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

SETOF record **ST_Quantile**(raster rast, integer nband=1, boolean exclude_nodata_value=true, double precision[] quantiles=NULL);
SETOF record **ST_Quantile**(raster rast, double precision[] quantiles);
SETOF record **ST_Quantile**(raster rast, integer nband, double precision[] quantiles);
double precision **ST_Quantile**(raster rast, double precision quantile);
double precision **ST_Quantile**(raster rast, boolean exclude_nodata_value, double precision quantile=NULL);
double precision **ST_Quantile**(raster rast, integer nband, double precision quantile);
double precision **ST_Quantile**(raster rast, integer nband, boolean exclude_nodata_value, double precision quantile);
double precision **ST_Quantile**(raster rast, integer nband, double precision quantile);

□□

□□□□□□□□ (population) □□□□□□□□□□□□□□□□□□□□□□□□□□□□ (quantile) □□□□□□. □□□, □□□□□ 25%, 50%, 75% □□□ (percentile) □□□□□□□□□□□□□□.

> **Note**
> exclude_nodata_value □□□□□□□□□□, NODATA □□□□□□□□□□□□□.

Changed: 3.1.0 Removed ST_Quantile(table_name, column_name) variant.

2.0.0 □□□□□□□□□□□□□.

□□

```
UPDATE dummy_rast SET rast = ST_SetBandNoDataValue(rast,249) WHERE rid=2;
--Example will consider only pixels of band 1 that are not 249 and in named quantiles --

SELECT (pvq).*
FROM (SELECT ST_Quantile(rast, ARRAY[0.25,0.75]) As pvq
    FROM dummy_rast WHERE rid=2) As foo
    ORDER BY (pvq).quantile;

 quantile | value
----------+-------
     0.25 |   253
     0.75 |   254

SELECT ST_Quantile(rast, 0.75) As value
    FROM dummy_rast WHERE rid=2;

value
------
  254
```

```
--real live example.  Quantile of all pixels in band 2 intersecting a geometry
SELECT rid, (ST_Quantile(rast,2)).* As pvc
    FROM o_4_boston
        WHERE ST_Intersects(rast,
            ST_GeomFromText('POLYGON((224486 892151,224486 892200,224706 892200,224706 ↩
                892151,224486 892151))',26986)
```

```
            )
ORDER BY value, quantile,rid
;


 rid | quantile | value
-----+----------+-------
   1 |        0 |     0
   2 |        0 |     0
  14 |        0 |     1
  15 |        0 |     2
  14 |     0.25 |    37
   1 |     0.25 |    42
  15 |     0.25 |    47
   2 |     0.25 |    50
  14 |      0.5 |    56
   1 |      0.5 |    64
  15 |      0.5 |    66
   2 |      0.5 |    77
  14 |     0.75 |    81
  15 |     0.75 |    87
   1 |     0.75 |    94
   2 |     0.75 |   106
  14 |        1 |   199
   1 |        1 |   244
   2 |        1 |   255
  15 |        1 |   255
```

⊠⊠

ST_Count, ST_SummaryStats, ST_SummaryStatsAgg, ST_SetBandNoDataValue

11.9.5 ST_SummaryStats

ST_SummaryStats — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ count, sum, mean, stddev, min, max ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

summarystats **ST_SummaryStats**(raster rast, boolean exclude_nodata_value);
summarystats **ST_SummaryStats**(raster rast, integer nband, boolean exclude_nodata_value);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ count, sum, mean, stddev, min, max ⊠⊠⊠⊠⊠⊠ summarystats ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ nband ⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠.

Note
⊠⊠⊠⊠⊠ nodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□, sample_percent □ 1 □□□□□□□ □□□□□□□□.

2.2.0 □□□□□□□□ ST_SummaryStats(rastertable, rastercolumn, ...) □□□□□□□□□□□□□□□. □□ ST_SummaryStatsAgg □□□□□□□□□□.

2.0.0 □□□□□□□□□□□□□□.

□□: □□□□□□□□

```
SELECT rid, band, (stats).*
FROM (SELECT rid, band, ST_SummaryStats(rast, band) As stats
    FROM dummy_rast CROSS JOIN generate_series(1,3) As band
     WHERE rid=2) As foo;

 rid | band | count | sum  |    mean     |  stddev   | min | max
-----+------+-------+------+------------+-----------+-----+-----
   2 |    1 |    23 | 5821 | 253.086957 |  1.248061 | 250 | 254
   2 |    2 |    25 | 3682 |     147.28 | 59.862188 |  78 | 254
   2 |    3 |    25 | 3290 |      131.6 | 61.647384 |  62 | 254
```

□□: □□□□□□□□□□□□□□□□□

PostGIS □□□ 64 □□□□□□□□□□□□□□□□□□□□□□□□□ (□□□□□□□ 102,000 □, 150x150 □ □□□□□□□ 134,000 □) □□□□□□□□□□ 574 □□□□□□□□□.

```
WITH
-- our features of interest
   feat AS (SELECT gid As building_id, geom_26986 As geom FROM buildings AS b
    WHERE gid IN(100, 103,150)
   ),
-- clip band 2 of raster tiles to boundaries of builds
-- then get stats for these clipped regions
   b_stats AS
    (SELECT  building_id, (stats).*
FROM (SELECT building_id, ST_SummaryStats(ST_Clip(rast,2,geom)) As stats
    FROM aerials.boston
        INNER JOIN feat
    ON ST_Intersects(feat.geom,rast)
 ) As foo
 )
-- finally summarize stats
SELECT building_id, SUM(count) As num_pixels
  , MIN(min) As min_pval
  ,  MAX(max) As max_pval
  , SUM(mean*count)/SUM(count) As avg_pval
    FROM b_stats
 WHERE count
> 0
    GROUP BY building_id
    ORDER BY building_id;
 building_id | num_pixels | min_pval | max_pval |     avg_pval
-------------+------------+----------+----------+------------------
         100 |       1090 |        1 |      255 | 61.0697247706422
         103 |        655 |        7 |      182 | 70.5038167938931
         150 |        895 |        2 |      252 | 185.642458100559
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠

```
-- stats for each band --
SELECT band, (stats).*
FROM (SELECT band, ST_SummaryStats('o_4_boston','rast', band) As stats
    FROM generate_series(1,3) As band) As foo;

 band |  count  |  sum   |       mean       |      stddev      | min | max
------+---------+--------+------------------+------------------+-----+-----
    1 | 8450000 | 725799 | 82.7064349112426 | 45.6800222638537 |   0 | 255
    2 | 8450000 | 700487 | 81.4197705325444 | 44.2161184161765 |   0 | 255
    3 | 8450000 | 575943 |  74.682739408284 | 44.2143885481407 |   0 | 255

-- For a table -- will get better speed if set sampling to less than 100%
-- Here we set to 25% and get a much faster answer
SELECT band, (stats).*
FROM (SELECT band, ST_SummaryStats('o_4_boston','rast', band,true,0.25) As stats
    FROM generate_series(1,3) As band) As foo;

 band |  count  |  sum   |       mean       |      stddev      | min | max
------+---------+--------+------------------+------------------+-----+-----
    1 | 2112500 | 180686 | 82.6890480473373 | 45.6961043857248 |   0 | 255
    2 | 2112500 | 174571 |  81.448503668639 | 44.2252623171821 |   0 | 255
    3 | 2112500 | 144364 | 74.6765884023669 | 44.2014869384578 |   0 | 255
```

⊠⊠

summarystats, ST_SummaryStatsAgg, ST_Count, ST_Clip

11.9.6 ST_SummaryStatsAgg

ST_SummaryStatsAgg — ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ count, sum, mean, stddev, min, max ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

summarystats **ST_SummaryStatsAgg**(raster rast, integer nband, boolean exclude_nodata_value, double precision sample_percent);
summarystats **ST_SummaryStatsAgg**(raster rast, boolean exclude_nodata_value, double precision sample_percent);
summarystats **ST_SummaryStatsAgg**(raster rast, integer nband, boolean exclude_nodata_value);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ count, sum, mean, stddev, min, max ⊠⊠⊠⊠⊠⊠ summarystats ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ nband ⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠.

> **Note**
> ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ nodata ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠. ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ ⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, sample_percent ⊠ 0 ⊠ 1 ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
WITH foo AS (
    SELECT
        rast.rast
    FROM (
        SELECT ST_SetValue(
            ST_SetValue(
                ST_SetValue(
                    ST_AddBand(
                        ST_MakeEmptyRaster(10, 10, 10, 10, 2, 2, 0, 0,0)
                        , 1, '64BF', 0, 0
                    )
                    , 1, 1, 1, -10
                )
                , 1, 5, 4, 0
            )
            , 1, 5, 5, 3.14159
        ) AS rast
    ) AS rast
    FULL JOIN (
        SELECT generate_series(1, 10) AS id
    ) AS id
        ON 1 = 1
)
SELECT
    (stats).count,
    round((stats).sum::numeric, 3),
    round((stats).mean::numeric, 3),
    round((stats).stddev::numeric, 3),
    round((stats).min::numeric, 3),
    round((stats).max::numeric, 3)
FROM (
    SELECT
        ST_SummaryStatsAgg(rast, 1, TRUE, 1) AS stats
    FROM foo
) bar;

 count |  round   | round  | round |  round   | round
-------+---------+--------+-------+---------+-------
    20 | -68.584 | -3.429 | 6.571 | -10.000 | 3.142
(1 row)
```

⊠⊠

summarystats, ST_SummaryStats, ST_Count, ST_Clip

11.9.7 ST_ValueCount

ST_ValueCount — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠. ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠.

Synopsis

SETOF record **ST_ValueCount**(raster rast, integer nband=1, boolean exclude_nodata_value=true, double precision[] searchvalues=NULL, double precision roundto=0, double precision OUT value, integer OUT count);
SETOF record **ST_ValueCount**(raster rast, integer nband, double precision[] searchvalues, double precision roundto=0, double precision OUT value, integer OUT count);
SETOF record **ST_ValueCount**(raster rast, double precision[] searchvalues, double precision roundto=0, double precision OUT value, integer OUT count);
bigint **ST_ValueCount**(raster rast, double precision searchvalue, double precision roundto=0);
bigint **ST_ValueCount**(raster rast, integer nband, boolean exclude_nodata_value, double precision searchvalue, double precision roundto=0);
bigint **ST_ValueCount**(raster rast, integer nband, double precision searchvalue, double precision roundto=0);
SETOF record **ST_ValueCount**(text rastertable, text rastercolumn, integer nband=1, boolean exclude_nodata_value=true, double precision[] searchvalues=NULL, double precision roundto=0, double precision OUT value, integer OUT count);
SETOF record **ST_ValueCount**(text rastertable, text rastercolumn, double precision[] searchvalues, double precision roundto=0, double precision OUT value, integer OUT count);
SETOF record **ST_ValueCount**(text rastertable, text rastercolumn, integer nband, double precision[] searchvalues, double precision roundto=0, double precision OUT value, integer OUT count);
bigint**ST_ValueCount**(text rastertable, text rastercolumn, integer nband, boolean exclude_nodata_value, double precision searchvalue, double precision roundto=0);
bigint **ST_ValueCount**(text rastertable, text rastercolumn, double precision searchvalue, double precision roundto=0);
bigint **ST_ValueCount**(text rastertable, text rastercolumn, integer nband, double precision searchvalue, double precision roundto=0);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `value`, `count` ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `nband` ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠. `searchvalues` ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `searchvalues` ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
`exclude_nodata_value` ⊠⊠⊠⊠⊠⊠⊠⊠⊠, NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
UPDATE dummy_rast SET rast = ST_SetBandNoDataValue(rast,249) WHERE rid=2;
--Example will count only pixels of band 1 that are not 249. --

SELECT (pvc).*
FROM (SELECT ST_ValueCount(rast) As pvc
    FROM dummy_rast WHERE rid=2) As foo
    ORDER BY (pvc).value;

 value | count
-------+-------
   250 |     2
   251 |     1
   252 |     2
   253 |     6
   254 |    12

-- Example will coount all pixels of band 1 including 249 --
SELECT (pvc).*
FROM (SELECT ST_ValueCount(rast,1,false) As pvc
    FROM dummy_rast WHERE rid=2) As foo
    ORDER BY (pvc).value;

 value | count
-------+-------
   249 |     2
   250 |     2
   251 |     1
   252 |     2
   253 |     6
   254 |    12

-- Example will count only non-nodata value pixels of band 2
SELECT (pvc).*
FROM (SELECT ST_ValueCount(rast,2) As pvc
    FROM dummy_rast WHERE rid=2) As foo
    ORDER BY (pvc).value;
 value | count
-------+-------
    78 |     1
    79 |     1
    88 |     1
    89 |     1
    96 |     1
    97 |     1
    98 |     1
    99 |     2
   112 |     2
:
```

```
--real live example.  Count all the pixels in an aerial raster tile band 2 intersecting a ↩
    geometry
-- and return only the pixel band values that have a count > 500
SELECT (pvc).value, SUM((pvc).count) As total
FROM (SELECT ST_ValueCount(rast,2) As pvc
    FROM o_4_boston
        WHERE ST_Intersects(rast,
            ST_GeomFromText('POLYGON((224486 892151,224486 892200,224706 892200,224706 ↩
                892151,224486 892151))',26986)
            )
        ) As foo
```

```
    GROUP BY (pvc).value
    HAVING SUM((pvc).count) > 500
    ORDER BY (pvc).value;

 value | total
-------+-----
    51 | 502
    54 | 521
```

```
-- Just return count of pixels in each raster tile that have value of 100 of tiles that ↩
    intersect  a specific geometry --
SELECT rid, ST_ValueCount(rast,2,100) As count
    FROM o_4_boston
        WHERE ST_Intersects(rast,
            ST_GeomFromText('POLYGON((224486 892151,224486 892200,224706 892200,224706 ↩
                892151,224486 892151))',26986)
             ) ;

 rid | count
-----+-------
   1 |    56
   2 |    95
  14 |    37
  15 |    64
```

⊠⊠

ST_Count, ST_SetBandNoDataValue

11.10 Raster Inputs

11.10.1 ST_RastFromWKB

ST_RastFromWKB — Return a raster value from a Well-Known Binary (WKB) raster.

Synopsis

raster **ST_RastFromWKB**(bytea wkb);

⊠⊠

Given a Well-Known Binary (WKB) raster, return a raster.

Availability: 2.5.0

⊠⊠

```
SELECT (ST_Metadata(
    ST_RastFromWKB(
        '\001\000\000\000\000\000\000\000\000\000\000\000@\000\000\000\000\000\000\010@ ↩
            \000\000\000\000\000\000\340?\000\000\000\000\000\000\340?\000\000\000\000\000\000\00
            bytea
```

```
    )
)).* AS metadata;

 upperleftx | upperlefty | width | height | scalex | scaley | skewx | skewy | srid | ↩
    numbands
------------+------------+-------+--------+--------+--------+-------+-------+------+---------- ↩

        0.5 |        0.5 |    10 |     20 |      2 |      3 |     0 |     0 |   10 | ↩
          0
```

⊠⊠

ST_MetaData, ST_RastFromHexWKB, ST_AsBinary/ST_AsWKB, ST_AsHexWKB

11.10.2 ST_RastFromHexWKB

ST_RastFromHexWKB — Return a raster value from a Hex representation of Well-Known Binary (WKB) raster.

Synopsis

raster **ST_RastFromHexWKB**(text wkb);

⊠⊠

Given a Well-Known Binary (WKB) raster in Hex representation, return a raster.

Availability: 2.5.0

⊠⊠

```
SELECT (ST_Metadata(
    ST_RastFromHexWKB(
        '010000000000000000000000400000000000000840000000000000 ↩
            E03F000000000000E03F000000000000000000000000000000000A0000000A001400'
    )
)).* AS metadata;

 upperleftx | upperlefty | width | height | scalex | scaley | skewx | skewy | srid | ↩
    numbands
------------+------------+-------+--------+--------+--------+-------+-------+------+---------- ↩

        0.5 |        0.5 |    10 |     20 |      2 |      3 |     0 |     0 |   10 | ↩
          0
```

⊠⊠

ST_MetaData, ST_RastFromWKB, ST_AsBinary/ST_AsWKB, ST_AsHexWKB

11.11 ⊠⊠⊠⊠⊠⊠

11.11.1 ST_AsBinary/ST_AsWKB

ST_AsBinary/ST_AsWKB — Return the Well-Known Binary (WKB) representation of the raster.

Synopsis

bytea **ST_AsBinary**(raster rast, boolean outasin=FALSE);
bytea **ST_AsWKB**(raster rast, boolean outasin=FALSE);

⊠⊠

Returns the Binary representation of the raster. If `outasin` is TRUE, out-db bands are treated as in-db. Refer to raster/doc/RFC2-WellKnownBinaryFormat located in the PostGIS source folder for details of the representation.

⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠, WKB ⊠⊠⊠⊠ DB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ DB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, `outasin` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ `outasin` ⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 2.5.0 Addition of `ST_AsWKB`

⊠⊠

```
SELECT ST_AsBinary(rast) As rastbin FROM dummy_rast WHERE rid=1;

                     rastbin
---------------------------------------------------------------------------------
\001\000\000\000\000\000\000\000\000\000\000\000@\000\000\000\000\000\000\010@ ↩
   \000\000\000\000\000\000\340?\000\000\000\000\000\000\340?\000\000\000\000\000\000\000\000\000\00
```

⊠⊠

ST_RastFromWKB, ST_AsHexWKB

11.11.2 ST_AsHexWKB

ST_AsHexWKB — Return the Well-Known Binary (WKB) in Hex representation of the raster.

Synopsis

bytea **ST_AsHexWKB**(raster rast, boolean outasin=FALSE);

⊠⊠

Returns the Binary representation in Hex representation of the raster. If `outasin` is TRUE, out-db bands are treated as in-db. Refer to raster/doc/RFC2-WellKnownBinaryFormat located in the PostGIS source folder for details of the representation.

> **Note**
> By default, Hex WKB output contains the external file path for out-db bands. If the client does not have access to the raster file underlying an out-db band, set `outasin` to TRUE.

Availability: 2.5.0

⊠⊠

```
SELECT ST_AsHexWKB(rast) As rastbin FROM dummy_rast WHERE rid=1;

                                                            st_ashexwkb
----------------------------------------------------------------------------------------------------

 0100000000000000000000004000000000000000840000000000000 ↩
     E03F000000000000E03F000000000000000000000000000000000A0000000A001400
```

⊠⊠

ST_RastFromHexWKB, ST_AsBinary/ST_AsWKB

11.11.3 ST_AsGDALRaster

ST_AsGDALRaster — Return the raster tile in the designated GDAL Raster format. Raster formats are one of those supported by your compiled library. Use ST_GDALDrivers() to get a list of formats supported by your library.

Synopsis

bytea **ST_AsGDALRaster**(raster rast, text format, text[] options=NULL, integer srid=sameassource);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- `format` - ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ LibGDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠'JPEG', 'GTiff', 'PNG' ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠ ST_GDALDrivers ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `options` - GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.
- `srs` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ proj4text ⊠⊠ (spatial_ref_sys ⊠⊠⊠⊠⊠) srtext ⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

JPEG Output Example, multiple tiles as single raster

```
SELECT ST_AsGDALRaster(ST_Union(rast), 'JPEG', ARRAY['QUALITY=50']) As rastjpg
FROM dummy_rast
WHERE rast && ST_MakeEnvelope(10, 10, 11, 11);
```

Using PostgreSQL Large Object Support to export raster

One way to export raster into another format is using PostgreSQL large object export functions. We'lll repeat the prior example but also exporting. Note for this you'll need to have super user access to db since it uses server side lo functions. It will also export to path on server network. If you need export locally, use the psql equivalent lo_ functions which export to the local file system instead of the server file system.

```
DROP TABLE IF EXISTS tmp_out ;

CREATE TABLE tmp_out AS
SELECT lo_from_bytea(0,
       ST_AsGDALRaster(ST_Union(rast), 'JPEG', ARRAY['QUALITY=50'])
        ) AS loid
  FROM dummy_rast
WHERE rast && ST_MakeEnvelope(10, 10, 11, 11);

SELECT lo_export(loid, '/tmp/dummy.jpg')
   FROM tmp_out;

SELECT lo_unlink(loid)
  FROM tmp_out;
```

GeoTiff ⊠⊠⊠⊠

```
SELECT ST_AsGDALRaster(rast, 'GTiff') As rastjpg
FROM dummy_rast WHERE rid=2;

-- Out GeoTiff with jpeg compression, 90% quality
SELECT ST_AsGDALRaster(rast, 'GTiff',
  ARRAY['COMPRESS=JPEG', 'JPEG_QUALITY=90'],
  4269) As rasttiff
FROM dummy_rast WHERE rid=2;
```

⊠⊠

Section 10.3, ST_GDALDrivers, ST_SRID

11.11.4 ST_AsJPEG

ST_AsJPEG — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ JPEG(Joint Photographic Exports Group) ⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠ RGB ⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

bytea **ST_AsJPEG**(raster rast, text[] options=NULL);
bytea **ST_AsJPEG**(raster rast, integer nband, integer quality);
bytea **ST_AsJPEG**(raster rast, integer nband, text[] options=NULL);
bytea **ST_AsJPEG**(raster rast, integer[] nbands, text[] options=NULL);
bytea **ST_AsJPEG**(raster rast, integer[] nbands, integer quality);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ JPEG(Joint Photographic Exports Group) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_AsGDALRaster ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ 1 ⊠⊠⊠ ⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- `nband` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `nbands` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (JPEG ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠). ⊠⊠⊠⊠⊠⊠ RGB ⊠⊠⊠. ⊠⊠⊠⊠ ARRAY[3,2,1] ⊠⊠⊠ 3 ⊠⊠⊠⊠, ⊠⊠ 2 ⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `quality` - 1 ⊠⊠ 100 ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `options` - JPEG ⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (ST_GDALDrivers⊠⊠ JPEG ⊠⊠⊠ create_options ⊠⊠⊠⊠⊠⊠⊠). JPEG ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ `PROGRESSIVE` ON/OFF ⊠⊠⊠⊠⊠ 75 ⊠⊠ 0 ⊠⊠ 100 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `QUALITY` ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠

```
-- output first 3 bands 75% quality
SELECT ST_AsJPEG(rast) As rastjpg
    FROM dummy_rast WHERE rid=2;

-- output only first band as 90% quality
SELECT ST_AsJPEG(rast,1,90) As rastjpg
    FROM dummy_rast WHERE rid=2;

-- output first 3 bands (but make band 2 Red, band 1 green, and band 3 blue, progressive ↩
    and 90% quality
SELECT ST_AsJPEG(rast,ARRAY[2,1,3],ARRAY['QUALITY=90','PROGRESSIVE=ON']) As rastjpg
    FROM dummy_rast WHERE rid=2;
```

⊠⊠

Section 10.3, ST_GDALDrivers, ST_AsGDALRaster, ST_AsPNG, ST_AsTIFF

11.11.5 ST_AsPNG

ST_AsPNG — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PNG(Portable Network Graphics) ⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠ ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠, 3 ⊠, ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ 2 ⊠⊠ ⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠. ⊠⊠⊠ RGB ⊠⊠ RGBA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

bytea **ST_AsPNG**(raster rast, text[] options=NULL);
bytea **ST_AsPNG**(raster rast, integer nband, integer compression);
bytea **ST_AsPNG**(raster rast, integer nband, text[] options=NULL);
bytea **ST_AsPNG**(raster rast, integer[] nbands, integer compression);
bytea **ST_AsPNG**(raster rast, integer[] nbands, text[] options=NULL);

□□

□□□□□□□□□□□□□□□ PNG(Portable Network Graphics) □□□□□□□□□□. □□□□□□□□□□□□□□□□□□□ ST_AsGDALRaster □□□□□□□□□□. □□□□□□□□□□□□□□□, □□ 3 □□□□□□□□□□□. srid □□□□□□□□□□□□□□□□ SRID □□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□:

- nband - □□□□□□□□□□□□□□□□□□.
- nbands - □□□□□□□□□□□□□ (PNG □□□ 4 □□□□□□□□). □□□□□□□ RGBA □□□. □□□□ ARRAY[3,2,1] □□□ 3 □□□□, □□ 2 □□□□, □□ 1 □□□□□□□□□□□□□□□□.
- compression - 1 □□ 9 □□□□□□□□□. □□□□□□□□□□□□□□□□□□.
- options - PNG □□□□□□□ GDAL □□□□□□□□□□□□□ (ST_GDALDrivers□□ PNG □□□ create_options □□□□□□□□). PNG □□□, □□□□□□□ ZLEVEL(□□□□□□□□□ - □□□□ 6) □□□, □□□□ ARRAY['ZLEVEL=9'] □□□□□□□. □□□□□□□□ 2 □□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□ GDAL □□□□□□□□ □□□□□□□□.

2.0.0 □□□□□□□□□□□□□. GDAL 1.6.0 □□□□□□□□□□□.

□□

```
SELECT ST_AsPNG(rast) As rastpng
FROM dummy_rast WHERE rid=2;

-- export the first 3 bands and map band 3 to Red, band 1 to Green, band 2 to blue
SELECT ST_AsPNG(rast, ARRAY[3,1,2]) As rastpng
FROM dummy_rast WHERE rid=2;
```

□□

ST_AsGDALRaster, ST_ColorMap, ST_GDALDrivers, Section 10.3

11.11.6 ST_AsTIFF

ST_AsTIFF — Return the raster selected bands as a single TIFF image (byte array). If no band is specified or any of specified bands does not exist in the raster, then will try to use all bands.

Synopsis

bytea **ST_AsTIFF**(raster rast, text[] options='', integer srid=sameassource);
bytea **ST_AsTIFF**(raster rast, text compression='', integer srid=sameassource);
bytea **ST_AsTIFF**(raster rast, integer[] nbands, text compression='', integer srid=sameassource);
bytea **ST_AsTIFF**(raster rast, integer[] nbands, text[] options, integer srid=sameassource);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIFF(Tagged Image File Format) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_AsGDALRaster ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_AsGDALRaster ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ SRS ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

- `nbands` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (PNG ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠). ⊠⊠⊠⊠⊠⊠ RGB ⊠⊠⊠. ⊠⊠⊠⊠ ARRAY[3,2,1] ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠, ⊠⊠ 2 ⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `compression` - ⊠⊠⊠⊠⊠: JPEG90(⊠⊠⊠⊠⊠⊠⊠), LZW, JPEG, DEFLATE9
- `options` - GTiff ⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (ST_GDALDrivers⊠⊠ GTiff ⊠⊠⊠ create_options ⊠⊠⊠⊠⊠⊠⊠). ⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.
- `srid` - ⊠⊠⊠⊠ spatial_ref_sys ⊠ SRID ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: JPEG ⊠⊠ 90%

```
SELECT ST_AsTIFF(rast, 'JPEG90') As rasttiff
FROM dummy_rast WHERE rid=2;
```

⊠⊠

ST_GDALDrivers, ST_AsGDALRaster, ST_SRID

11.12 ⊠⊠⊠⊠⊠⊠⊠

11.12.1 ST_Clip

ST_Clip — Returns the raster clipped by the input geometry. If band number is not specified, all bands are processed. If `crop` is not specified or TRUE, the output raster is cropped. If `touched` is set to TRUE, then touched pixels are included, otherwise only if the center of the pixel is in the geometry it is included.

Synopsis

raster **ST_Clip**(raster rast, integer[] nband, geometry geom, double precision[] nodataval=NULL, boolean crop=TRUE, boolean touched=FALSE);
raster **ST_Clip**(raster rast, integer nband, geometry geom, double precision nodataval, boolean crop=TRUE, boolean touched=FALSE);
raster **ST_Clip**(raster rast, integer nband, geometry geom, boolean crop, boolean touched=FALSE);
raster **ST_Clip**(raster rast, geometry geom, double precision[] nodataval=NULL, boolean crop=TRUE, boolean touched=FALSE);
raster **ST_Clip**(raster rast, geometry geom, double precision nodataval, boolean crop=TRUE, boolean touched=FALSE);
raster **ST_Clip**(raster rast, geometry geom, boolean crop, boolean touched=FALSE);

⊠⊠

⊠⊠⊠⊠ geom ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

ST_Clip ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NODATA ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠ ST_MinPossibleValue(ST_Band band)) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠ ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠. NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠. NODATA ⊠⊠⊠.

If `crop` is not specified, true is assumed meaning the output raster is cropped to the intersection of the `geom`and `rast` extents. If `crop` is set to false, the new raster gets the same extent as `rast`. If `touched` is set to true, then all pixels in the `rast` that intersect the geometry are selected.

> **Note**
> The default behavior is touched=false, which will only select pixels where the center of the pixel is covered by the geometry.

Enhanced: 3.5.0 - touched argument added.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Examples here use Massachusetts aerial data available on MassGIS site MassGIS Aerial Orthos.

Examples: Comparing selecting all touched vs. not all touched

```
SELECT ST_Count(rast) AS count_pixels_in_orig, ST_Count(rast_touched) AS all_touched_pixels
    , ST_Count(rast_not_touched) AS default_clip
FROM ST_AsRaster(ST_Letters('R'), scalex =
> 1.0, scaley =
> -1.0) AS r(rast)
    INNER JOIN ST_GeomFromText('LINESTRING(0 1, 5 6, 10 10)') AS g(geom)
 ON ST_Intersects(r.rast,g.geom)
 , ST_Clip(r.rast, g.geom, touched =
> true) AS rast_touched
 , ST_Clip(r.rast, g.geom, touched =
> false) AS rast_not_touched;

 count_pixels_in_orig | all_touched_pixels | default_clip
----------------------+--------------------+--------------
                 2605 |                 16 |           10
(1 row)
```

Examples: 1 band clipping (not touched)

```
-- Clip the first band of an aerial tile by a 20 meter buffer.
SELECT ST_Clip(rast, 1,
        ST_Buffer(ST_Centroid(ST_Envelope(rast)),20)
    ) from aerials.boston
WHERE rid = 4;
```

```
-- Demonstrate effect of crop on final dimensions of raster
-- Note how final extent is clipped to that of the geometry
-- if crop = true
SELECT ST_XMax(ST_Envelope(ST_Clip(rast, 1, clipper, true))) As xmax_w_trim,
    ST_XMax(clipper) As xmax_clipper,
    ST_XMax(ST_Envelope(ST_Clip(rast, 1, clipper, false))) As xmax_wo_trim,
    ST_XMax(ST_Envelope(rast)) As xmax_rast_orig
FROM (SELECT rast, ST_Buffer(ST_Centroid(ST_Envelope(rast)),6) As clipper
    FROM aerials.boston
WHERE rid = 6) As foo;

   xmax_w_trim    |   xmax_clipper   |   xmax_wo_trim   |  xmax_rast_orig
------------------+------------------+------------------+------------------
 230657.436173996 | 230657.436173996 | 230666.436173996 | 230666.436173996
```

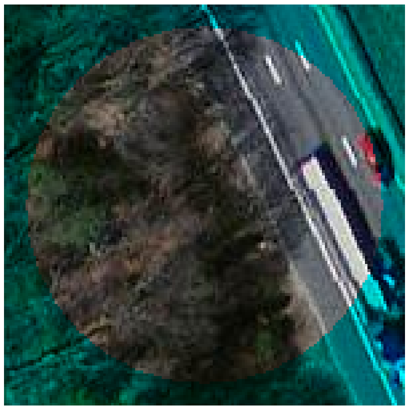
□□□□□□□□□□□□□□

□□□□

□□: crop □□□□ 1 □□□□□□□□□□□□□□□□□□□□□□□□□

```
-- Same example as before, but we need to set crop to false to be able to use ST_AddBand
-- because ST_AddBand requires all bands be the same Width and height
SELECT ST_AddBand(ST_Clip(rast, 1,
        ST_Buffer(ST_Centroid(ST_Envelope(rast)),20),false
    ), ARRAY[ST_Band(rast,2),ST_Band(rast,3)] ) from aerials.boston
WHERE rid = 6;
```

□□□□□□□□□□□□□



□□□□ - □□□□

□□: □□□□□□□□

```
-- Clip all bands of an aerial tile by a 20 meter buffer.
-- Only difference is we don't specify a specific band to clip
-- so all bands are clipped
SELECT ST_Clip(rast,
      ST_Buffer(ST_Centroid(ST_Envelope(rast)), 20),
      false
    ) from aerials.boston
WHERE rid = 4;
```

□□□□□□□□□□□□□

□□□□

□□

ST_AddBand, ST_Count, ST_MapAlgebra (callback function version), ST_Intersection

11.12.2 ST_ColorMap

ST_ColorMap — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 8BUI ⊠⊠ (grayscale, RGB, RGBA) ⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_ColorMap**(raster rast, integer nband=1, text colormap=grayscale, text method=INTERPOLATE);

raster **ST_ColorMap**(raster rast, text colormap, text method=INTERPOLATE);

⊠⊠

`rast` ⊠ `nband` ⊠⊠⊠⊠⊠⊠⊠ `colormap` ⊠⊠⊠⊠⊠⊠ 8BUI ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `colormap` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 8BUI ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`nband` ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `colormap` ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠ `colormap` ⊠⊠⊠:

- `grayscale` ⊠⊠ `greyscale` - 8BUI ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (shades of gray) ⊠⊠⊠
- `pseudocolor` - 8BUI(RGBA) ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠
- `fire` - 8BUI(RGBA) ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠
- `bluered` - 8BUI(RGBA) ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `colormap` ⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠ (RGBA) ⊠ ⊠⊠ (⊠⊠⊠⊠⊠⊠⊠ 0 ⊠⊠ 255 ⊠⊠⊠⊠⊠⊠⊠⊠). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠ 0/100% ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠, ⊠, ⊠⊠, ⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ NODATA ⊠⊠⊠ ⊠, *nv*, *null* ⊠⊠ *nodata* ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
5 0 0 0 255
4 100:50 55 255
1 150,100 150 255
0% 255 255 255 255
nv 0 0 0 0
```

`colormap` ⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠ (color-relief) ⊠⊠ gdaldem ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠ `method` ⊠⊠⊠:

- `INTERPOLATE` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `EXACT` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0 0 0 0(RGBA) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- `NEAREST` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠ ColorBrewer ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Warning
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NODATA ⊠⊠⊠⊠⊠⊠⊠ ST_SetBandNoDataValue ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
-- setup test raster table --
DROP TABLE IF EXISTS funky_shapes;
CREATE TABLE funky_shapes(rast raster);

INSERT INTO funky_shapes(rast)
WITH ref AS (
    SELECT ST_MakeEmptyRaster( 200, 200, 0, 200, 1, -1, 0, 0) AS rast
)
SELECT
    ST_Union(rast)
FROM (
    SELECT
        ST_AsRaster(
            ST_Rotate(
                ST_Buffer(
                    ST_GeomFromText('LINESTRING(0 2,50 50,150 150,125 50)'),
                    i*2
                ),
                pi() * i * 0.125, ST_Point(50,50)
            ),
            ref.rast, '8BUI'::text, i * 5
        ) AS rast
    FROM ref
    CROSS JOIN generate_series(1, 10, 3) AS i
) AS shapes;
```

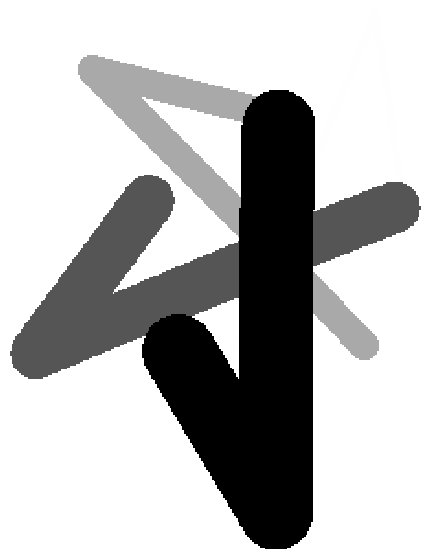
```
SELECT
    ST_NumBands(rast) As n_orig,
    ST_NumBands(ST_ColorMap(rast,1, 'greyscale')) As ngrey,
    ST_NumBands(ST_ColorMap(rast,1, 'pseudocolor')) As npseudo,
    ST_NumBands(ST_ColorMap(rast,1, 'fire')) As nfire,
    ST_NumBands(ST_ColorMap(rast,1, 'bluered')) As nbluered,
    ST_NumBands(ST_ColorMap(rast,1, '
100% 255   0   0
 80% 160   0   0
 50% 130   0   0
 30%  30   0   0
 20%  60   0   0
  0%   0   0   0
  nv 255 255 255
    ')) As nred
FROM funky_shapes;
```

```
n_orig | ngrey | npseudo | nfire | nbluered | nred
--------+-------+---------+-------+----------+------
      1 |     1 |       4 |     4 |        4 |    3
```

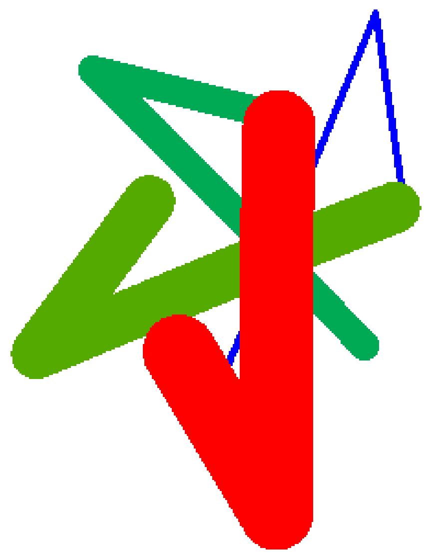
☒☒: ST_AsPNG ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒

```
SELECT
    ST_AsPNG(rast) As orig_png,
    ST_AsPNG(ST_ColorMap(rast,1,'greyscale')) As grey_png,
    ST_AsPNG(ST_ColorMap(rast,1, 'pseudocolor')) As pseudo_png,
    ST_AsPNG(ST_ColorMap(rast,1, 'nfire')) As fire_png,
    ST_AsPNG(ST_ColorMap(rast,1, 'bluered')) As bluered_png,
    ST_AsPNG(ST_ColorMap(rast,1, '
100% 255   0   0
 80% 160   0   0
 50% 130   0   0
 30%  30   0   0
 20%  60   0   0
  0%   0   0   0
  nv 255 255 255
    ')) As red_png
FROM funky_shapes;
```

orig_png

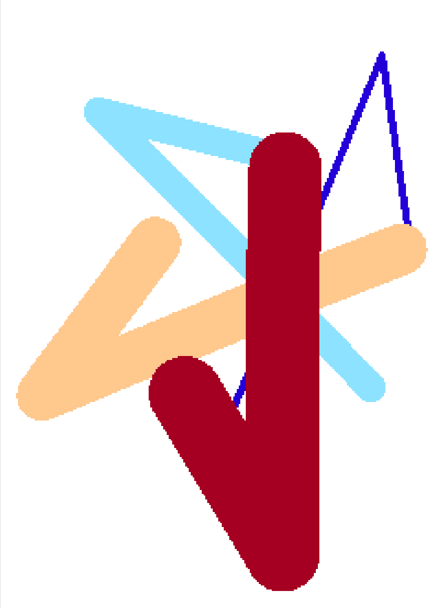


grey_png

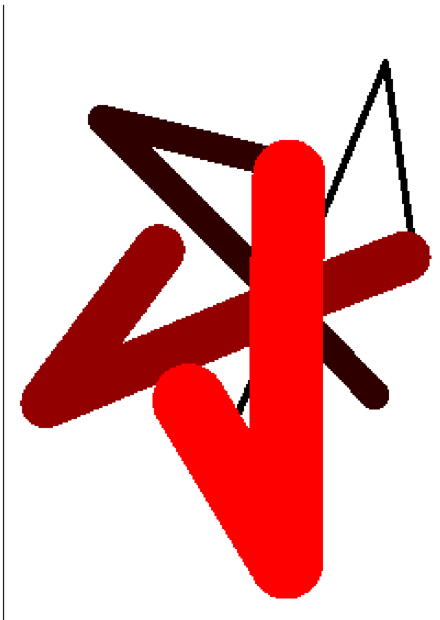


pseudo_png

fire_png



bluered_png



red_png

⊠⊠

ST_AsPNG, ST_AsRaster ST_MapAlgebra (callback function version), ST_Grayscale ST_NumBands, ST_Reclass, ST_SetBandNoDataValue, ST_Union

11.12.3 ST_Grayscale

ST_Grayscale — Creates a new one-8BUI band raster from the source raster and specified bands representing Red, Green and Blue

Synopsis

(1) raster **ST_Grayscale**(raster rast, integer redband=1, integer greenband=2, integer blueband=3, text extenttype=INTERSECTION);

(2) raster **ST_Grayscale**(rastbandarg[] rastbandargset, text extenttype=INTERSECTION);

⊠⊠

Create a raster with one 8BUI band given three input bands (from one or more rasters). Any input band whose pixel type is not 8BUI will be reclassified using ST_Reclass.

> **Note**
> This function is not like ST_ColorMap with the `grayscale` keyword as ST_ColorMap operates on only one band while this function expects three bands for RGB. This function applies the following equation for converting RGB to Grayscale: 0.2989 * RED + 0.5870 * GREEN + 0.1140 * BLUE

Availability: 2.5.0

□□: □□ 1

```
SET postgis.gdal_enabled_drivers = 'ENABLE_ALL';
SET postgis.enable_outdb_rasters = True;

WITH apple AS (
    SELECT ST_AddBand(
        ST_MakeEmptyRaster(350, 246, 0, 0, 1, -1, 0, 0, 0),
        '/tmp/apple.png'::text,
        NULL::int[]
    ) AS rast
)
SELECT
    ST_AsPNG(rast) AS original_png,
    ST_AsPNG(ST_Grayscale(rast)) AS grayscale_png
FROM apple;
```

original_png

grayscale_png

□□: □□ 2

```
SET postgis.gdal_enabled_drivers = 'ENABLE_ALL';
SET postgis.enable_outdb_rasters = True;

WITH apple AS (
    SELECT ST_AddBand(
        ST_MakeEmptyRaster(350, 246, 0, 0, 1, -1, 0, 0, 0),
        '/tmp/apple.png'::text,
        NULL::int[]
    ) AS rast
)
SELECT
    ST_AsPNG(rast) AS original_png,
    ST_AsPNG(ST_Grayscale(
        ARRAY[
            ROW(rast, 1)::rastbandarg, -- red
            ROW(rast, 2)::rastbandarg, -- green
            ROW(rast, 3)::rastbandarg, -- blue
        ]::rastbandarg[]
    )) AS grayscale_png
```

```
FROM apple;
```

⊠⊠

ST_AsPNG, ST_Reclass, ST_ColorMap

11.12.4 ST_Intersection

ST_Intersection — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠-⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

setof geomval **ST_Intersection**(geometry geom, raster rast, integer band_num=1);
setof geomval **ST_Intersection**(raster rast, geometry geom);
setof geomval **ST_Intersection**(raster rast, integer band, geometry geomin);
raster **ST_Intersection**(raster rast1, raster rast2, double precision[] nodataval);
raster **ST_Intersection**(raster rast1, raster rast2, text returnband, double precision[] nodataval);
raster **ST_Intersection**(raster rast1, integer band1, raster rast2, integer band2, double precision[] nodataval);
raster **ST_Intersection**(raster rast1, integer band1, raster rast2, integer band2, text returnband, double precision[] nodataval);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠-⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.

geomval ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ (ST_DumpAsPolygon ⊠⊠⊠) ⊠ ⊠⊠⊠ geomval ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ ST_Intersection(geometry, geometry) PostGIS ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. WHERE ⊠⊠ ST_Intersect ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠ geomval ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠’.geom’ ⊠⊠’.val’ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠. ⊠: (ST_Intersection(rast, geom)).geom

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_MapAlgebraExpr ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ `returnband` ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠’BAND1’, ’BAND2’ ⊠⊠’BOTH’ ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠, NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

ST_Intersection ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ ⊠’BAND1’, ’BAND2’ ⊠⊠’BOTH’ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠ 2 ⊠⊠ NODATA ⊠⊠⊠⊠ `nodataval[]` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠, ST_MinPossibleValue ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠. NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Clip ⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> □□□□□□ NODATA □□□□□□□□□□□□□□□□□□□□□□□□□□□□□, ST_MapAlgebraExpr □□□□□□□□□□□□□□□□□□□□□□□□□□.

> **Note**
> □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, ST_Clip □□□□□□□. ST_Clip □□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

> **Note**
> ST_Intersects □□□□□□□□□□□□□□/□□□□□□□□□□□ ST_Intersection □□□□□□□□□□□□.

□□□□: 2.0.0 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□. 2.0.0 □□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□.

□□: □□, □□□ -- □□-□□□□□□

```
SELECT
    foo.rid,
    foo.gid,
    ST_AsText((foo.geomval).geom) As geomwkt,
    (foo.geomval).val
FROM (
    SELECT
        A.rid,
        g.gid,
        ST_Intersection(A.rast, g.geom) As geomval
    FROM dummy_rast AS A
    CROSS JOIN (
        VALUES
            (1, ST_Point(3427928, 5793243.85) ),
            (2, ST_GeomFromText('LINESTRING(3427927.85 5793243.75,3427927.8 ↩
                5793243.75,3427927.8 5793243.8)')),
            (3, ST_GeomFromText('LINESTRING(1 2, 3 4)'))
    ) As g(gid,geom)
    WHERE A.rid = 2
) As foo;

 rid | gid |      geomwkt                                                | val
-----+-----+---------------------------------------------------------------------------------------------

   2 |   1 | POINT(3427928 5793243.85)                                   | 249
   2 |   1 | POINT(3427928 5793243.85)                                   | 253
   2 |   2 | POINT(3427927.85 5793243.75)                                | 254
   2 |   2 | POINT(3427927.8 5793243.8)                                  | 251
   2 |   2 | POINT(3427927.8 5793243.8)                                  | 253
   2 |   2 | LINESTRING(3427927.8 5793243.75,3427927.8 5793243.8)    | 252
   2 |   2 | MULTILINESTRING((3427927.8 5793243.8,3427927.8 5793243.75),...) | 250
   2 |   3 | GEOMETRYCOLLECTION EMPTY
```

□□

geomval, ST_Intersects, ST_MapAlgebraExpr, ST_Clip, ST_AsText

11.12.5 ST_MapAlgebra (callback function version)

ST_MapAlgebra (callback function version) — ⌧⌧⌧⌧⌧⌧⌧ - ⌧⌧⌧ 1 ⌧⌧⌧, ⌧⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧ ⌧⌧⌧⌧⌧ 1 ⌧⌧⌧⌧⌧⌧⌧⌧ 1 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

Synopsis

raster **ST_MapAlgebra**(rastbandarg[] rastbandargset, regprocedure callbackfunc, text pixeltype=NULL, text extenttype=INTERSECTION, raster customextent=NULL, integer distancex=0, integer distancey=0, text[] VARIADIC userargs=NULL);
raster **ST_MapAlgebra**(raster rast, integer[] nband, regprocedure callbackfunc, text pixeltype=NULL, text extenttype=FIRST, raster customextent=NULL, integer distancex=0, integer distancey=0, text[] VARIADIC userargs=NULL);
raster **ST_MapAlgebra**(raster rast, integer nband, regprocedure callbackfunc, text pixeltype=NULL, text extenttype=FIRST, raster customextent=NULL, integer distancex=0, integer distancey=0, text[] VARIADIC userargs=NULL);
raster **ST_MapAlgebra**(raster rast1, integer nband1, raster rast2, integer nband2, regprocedure callbackfunc, text pixeltype=NULL, text extenttype=INTERSECTION, raster customextent=NULL, integer distancex=0, integer distancey=0, text[] VARIADIC userargs=NULL);
raster **ST_MapAlgebra**(raster rast, integer nband, regprocedure callbackfunc, float8[] mask, boolean weighted, text pixeltype=NULL, text extenttype=INTERSECTION, raster customextent=NULL, text[] VARIADIC userargs=NULL);

⌧⌧

⌧⌧⌧ 1 ⌧⌧⌧, ⌧⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ 1 ⌧⌧⌧⌧⌧⌧⌧⌧ 1 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

`rast,rast1,rast2, rastbandargset` ⌧⌧⌧ (代數) ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧

`rastbandargset` ⌧⌧⌧⌧⌧⌧⌧⌧⌧/⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧ 1 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

`nband, nband1, nband2` ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. nband ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. nband1 ⌧ rast1 ⌧⌧⌧⌧⌧⌧⌧⌧ nband2 ⌧⌧⌧⌧ 2 ⌧/⌧⌧ 2 ⌧⌧⌧⌧ rast2 ⌧⌧⌧⌧⌧⌧⌧⌧.

`callbackfunc` The `callbackfunc` parameter must be the name and signature of an SQL or PL/pgSQL function, cast to a regprocedure. An example PL/pgSQL function example is:

```
CREATE OR REPLACE FUNCTION sample_callbackfunc(value double precision[][][], position
    integer[][], VARIADIC userargs text[])
    RETURNS double precision
    AS $$
    BEGIN
        RETURN 0;
    END;
    $$ LANGUAGE 'plpgsql' IMMUTABLE;
```

The `callbackfunc` must have three arguments: a 3-dimension double precision array, a 2-dimension integer array and a variadic 1-dimension text array. The first argument `value` is the set of values (as double precision) from all input rasters. The three dimensions (where indexes are 1-based) are: raster #, row y, column x. The second argument `position` is the set of pixel positions from the output raster and input rasters. The outer dimension (where indexes are 0-based) is the raster #. The position at outer dimension index 0 is the output raster's pixel position. For each outer dimension, there are two elements in the inner dimension for X and Y. The third argument `userargs` is for passing through any user-specified arguments.

Passing a regprocedure argument to a SQL function requires the full function signature to be passed, then cast to a regprocedure type. To pass the above example PL/pgSQL function as an argument, the SQL for the argument is:

```
'sample_callbackfunc(double precision[], integer[], text[])'::regprocedure
```

Note that the argument contains the name of the function, the types of the function arguments, quotes around the name and argument types, and a cast to a regprocedure.

mask An n-dimensional array (matrix) of numbers used to filter what cells get passed to map algebra call-back function. 0 means a neighbor cell value should be treated as no-data and 1 means value should be treated as data. If weight is set to true, then the values, are used as multipliers to multiple the pixel value of that value in the neighborhood position.

weighted mask ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠ (mask ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠/⊠⊠) ⊠⊠⊠.

pixeltype pixeltype ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. pixeltype ⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠: INTERSECTION, UNION, FIRST, CUSTOM), ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠: SECOND, LAST) ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ pixeltype ⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_BandPixelType ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, NULL ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

extenttype ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ INTERSECTION(⊠⊠⊠), UNION, FIRST(⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠), SECOND, LAST, CUSTOM ⊠⊠⊠.

customextent extentype ⊠ CUSTOM ⊠⊠⊠, ⊠⊠⊠⊠⊠ customextent ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 1 ⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

distancex The distance in pixels from the reference cell in x direction. So width of resulting matrix would be 2*distancex + 1.If not specified only the reference cell is considered (neighborhood of 0).

distancey ⊠⊠⊠⊠⊠⊠⊠⊠⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2*distancey + 1 ⊠⊠⊠⊠ ⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0) ⊠⊠⊠⊠⊠⊠.

userargs callbackfunc ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ variadic text ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠ callbackfunc ⊠⊠⊠⊠⊠⊠, userargs ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note

(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) VARIADIC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, PostgreSQL ⊠⊠⊠ ⊠⊠ Query Language (SQL) Functions ⊠"SQL Functions with Variable Numbers of Arguments" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note

⊠⊠, callbackfunc ⊠⊠⊠⊠ ⊠ text[] ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastbandarg ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠. ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 2 ⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 2 ⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.2.0 ⊠⊠⊠⊠⊠ mask ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

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```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, 0, 0, 0), 1, '16BUI', 1, 0) AS rast
)
SELECT
    ST_MapAlgebra(
        ARRAY[ROW(rast, 1)]::rastbandarg[],
        'sample_callbackfunc(double precision[], int[], text[])'::regprocedure
    ) AS rast
FROM foo
```

□□□ 1 □, □□□□

```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, 0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI', 100, 0) AS rast
)
SELECT
    ST_MapAlgebra(
        ARRAY[ROW(rast, 3), ROW(rast, 1), ROW(rast, 3), ROW(rast, 2)]::rastbandarg[],
        'sample_callbackfunc(double precision[], int[], text[])'::regprocedure
    ) AS rast
FROM foo
```

□□□□□, □□□□

```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, 0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI', 100, 0) AS rast UNION ALL
    SELECT 2 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 1, 1, -1, 0, 0, 0), 1, '16BUI', 2, 0), 2, '8BUI', 20, 0), 3, '32BUI', 300, 0) AS rast
)
SELECT
    ST_MapAlgebra(
        ARRAY[ROW(t1.rast, 3), ROW(t2.rast, 1), ROW(t2.rast, 3), ROW(t1.rast, 2)]::rastbandarg[],
        'sample_callbackfunc(double precision[], int[], text[])'::regprocedure
    ) AS rast
FROM foo t1
CROSS JOIN foo t2
WHERE t1.rid = 1
    AND t2.rid = 2
```

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```
WITH foo AS (
    SELECT 0 AS rid, ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, 0, 0, 0), 1, '16BUI', 1, 0) AS rast UNION ALL
    SELECT 1, ST_AddBand(ST_MakeEmptyRaster(2, 2, 2, 0, 1, -1, 0, 0, 0), 1, '16BUI', 2, 0) AS rast UNION ALL
    SELECT 2, ST_AddBand(ST_MakeEmptyRaster(2, 2, 4, 0, 1, -1, 0, 0, 0), 1, '16BUI', 3, 0) AS rast UNION ALL

    SELECT 3, ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, -2, 1, -1, 0, 0, 0), 1, '16BUI', 10, 0) AS rast UNION ALL
    SELECT 4, ST_AddBand(ST_MakeEmptyRaster(2, 2, 2, -2, 1, -1, 0, 0, 0), 1, '16BUI', 20, 0) AS rast UNION ALL
```

```
    SELECT 5, ST_AddBand(ST_MakeEmptyRaster(2, 2, 4, -2, 1, -1, 0, 0, 0), 1, '16BUI', 30, 0) AS rast UNION ALL

    SELECT 6, ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, -4, 1, -1, 0, 0, 0), 1, '16BUI', 100, 0) AS rast UNION ALL
    SELECT 7, ST_AddBand(ST_MakeEmptyRaster(2, 2, 2, -4, 1, -1, 0, 0, 0), 1, '16BUI', 200, 0) AS rast UNION ALL
    SELECT 8, ST_AddBand(ST_MakeEmptyRaster(2, 2, 4, -4, 1, -1, 0, 0, 0), 1, '16BUI', 300, 0) AS rast
)
SELECT
    t1.rid,
    ST_MapAlgebra(
        ARRAY[ROW(ST_Union(t2.rast), 1)]::rastbandarg[],
        'sample_callbackfunc(double precision[], int[], text[])'::regprocedure,
        '32BUI',
        'CUSTOM', t1.rast,
        1, 1
    ) AS rast
FROM foo t1
CROSS JOIN foo t2
WHERE t1.rid = 4
    AND t2.rid BETWEEN 0 AND 8
    AND ST_Intersects(t1.rast, t2.rast)
GROUP BY t1.rid, t1.rast
```

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```
WITH src AS (
    SELECT 0 AS rid, ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, 0, 0, 0), 1, '16BUI', 1, 0) AS rast UNION ALL
    SELECT 1, ST_AddBand(ST_MakeEmptyRaster(2, 2, 2, 0, 1, -1, 0, 0, 0), 1, '16BUI', 2, 0) AS rast UNION ALL
    SELECT 2, ST_AddBand(ST_MakeEmptyRaster(2, 2, 4, 0, 1, -1, 0, 0, 0), 1, '16BUI', 3, 0) AS rast UNION ALL

    SELECT 3, ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, -2, 1, -1, 0, 0, 0), 1, '16BUI', 10, 0) AS rast UNION ALL
    SELECT 4, ST_AddBand(ST_MakeEmptyRaster(2, 2, 2, -2, 1, -1, 0, 0, 0), 1, '16BUI', 20, 0) AS rast UNION ALL
    SELECT 5, ST_AddBand(ST_MakeEmptyRaster(2, 2, 4, -2, 1, -1, 0, 0, 0), 1, '16BUI', 30, 0) AS rast UNION ALL

    SELECT 6, ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, -4, 1, -1, 0, 0, 0), 1, '16BUI', 100, 0) AS rast UNION ALL
    SELECT 7, ST_AddBand(ST_MakeEmptyRaster(2, 2, 2, -4, 1, -1, 0, 0, 0), 1, '16BUI', 200, 0) AS rast UNION ALL
    SELECT 8, ST_AddBand(ST_MakeEmptyRaster(2, 2, 4, -4, 1, -1, 0, 0, 0), 1, '16BUI', 300, 0) AS rast
)
WITH foo AS (
    SELECT
        t1.rid,
        ST_Union(t2.rast) AS rast
    FROM src t1
    JOIN src t2
        ON ST_Intersects(t1.rast, t2.rast)
        AND t2.rid BETWEEN 0 AND 8
    WHERE t1.rid = 4
    GROUP BY t1.rid
), bar AS (
    SELECT
```

```
        t1.rid,
        ST_MapAlgebra(
            ARRAY[ROW(t2.rast, 1)]::rastbandarg[],
            'raster_nmapalgebra_test(double precision[], int[], text[])'::regprocedure,
            '32BUI',
            'CUSTOM', t1.rast,
            1, 1
        ) AS rast
    FROM src t1
    JOIN foo t2
        ON t1.rid = t2.rid
)
SELECT
    rid,
    (ST_Metadata(rast)),
    (ST_BandMetadata(rast, 1)),
    ST_Value(rast, 1, 1, 1)
FROM bar;
```

□□: □□ 2 □ 3

□□□ 1 □, □□□□

```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, 0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI', 100, 0) AS rast
)
SELECT
    ST_MapAlgebra(
        rast, ARRAY[3, 1, 3, 2]::integer[],
        'sample_callbackfunc(double precision[], int[], text[])'::regprocedure
    ) AS rast
FROM foo
```

□□□ 1 □, □□ 1 □

```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, 0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI', 100, 0) AS rast
)
SELECT
    ST_MapAlgebra(
        rast, 2,
        'sample_callbackfunc(double precision[], int[], text[])'::regprocedure
    ) AS rast
FROM foo
```

□□: □□ 4

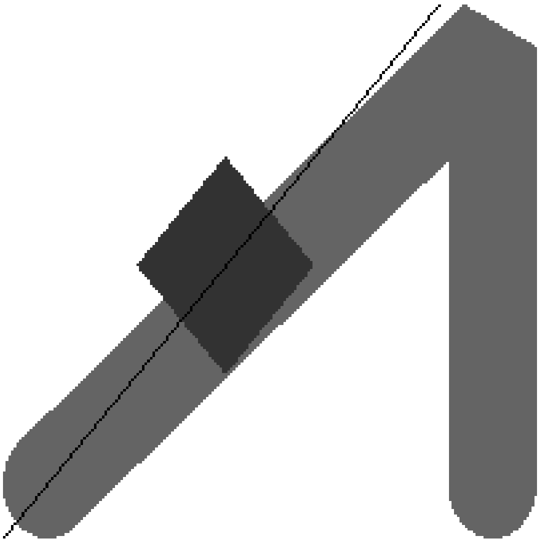
□□□ 2 □, □□ 2 □

```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, 0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI', 100, 0) AS rast UNION ALL
    SELECT 2 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 1, 1, -1, 0, 0, 0), 1, '16BUI', 2, 0), 2, '8BUI', 20, 0), 3, '32BUI', 300, 0) AS rast
)
```

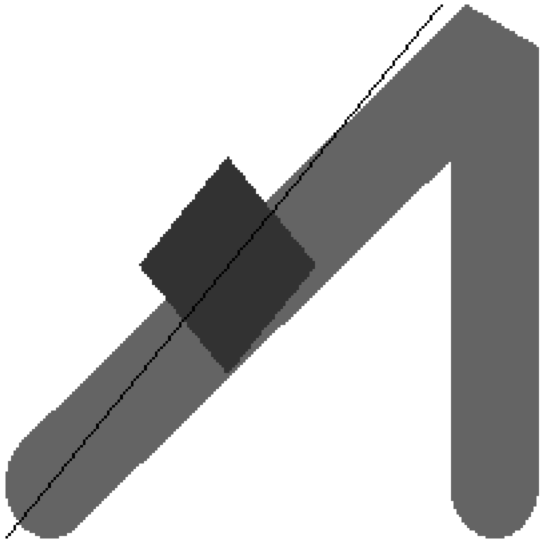
```
SELECT
    ST_MapAlgebra(
        t1.rast, 2,
        t2.rast, 1,
        'sample_callbackfunc(double precision[], int[], text[])'::regprocedure
    ) AS rast
FROM foo t1
CROSS JOIN foo t2
WHERE t1.rid = 1
    AND t2.rid = 2
```

□□: mask □□□□

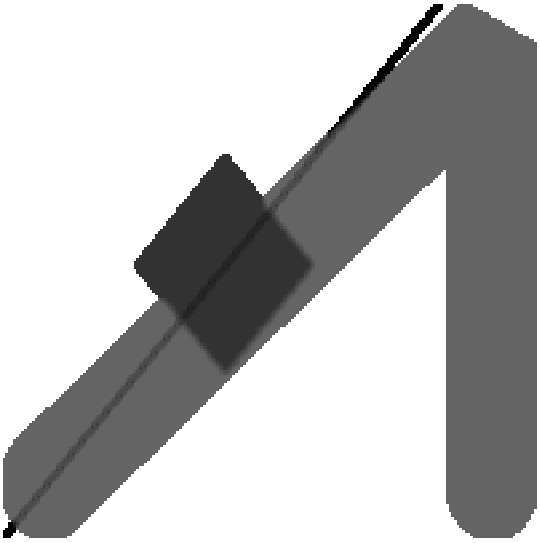
```
WITH foo AS (SELECT
   ST_SetBandNoDataValue(
ST_SetValue(ST_SetValue(ST_AsRaster(
        ST_Buffer(
            ST_GeomFromText('LINESTRING(50 50,100 90,100 50)'), 5,'join=bevel'),
            200,200,ARRAY['8BUI'], ARRAY[100], ARRAY[0]), ST_Buffer('POINT(70 70)'::geometry,10,'quad_segs=1') ,50),
  'LINESTRING(20 20, 100 100, 150 98)'::geometry,1),0)  AS rast )
SELECT 'original' AS title, rast
FROM foo
UNION ALL
SELECT 'no mask mean value' AS title, ST_MapAlgebra(rast,1,'ST_mean4ma(double precision[], int[], text[])'::regprocedure) AS rast
FROM foo
UNION ALL
SELECT 'mask only consider neighbors, exclude center' AS title, ST_MapAlgebra(rast,1,'ST_mean4ma(double precision[], int[], text[])'::regprocedure,
    '{{1,1,1}, {1,0,1}, {1,1,1}}'::double precision[], false) As rast
FROM foo

UNION ALL
SELECT 'mask weighted only consider neighbors, exclude center multi other pixel values by 2' AS title, ST_MapAlgebra(rast,1,'ST_mean4ma(double precision[], int[], text[])'::regprocedure,
    '{{2,2,2}, {2,0,2}, {2,2,2}}'::double precision[], true) As rast
FROM foo;
```



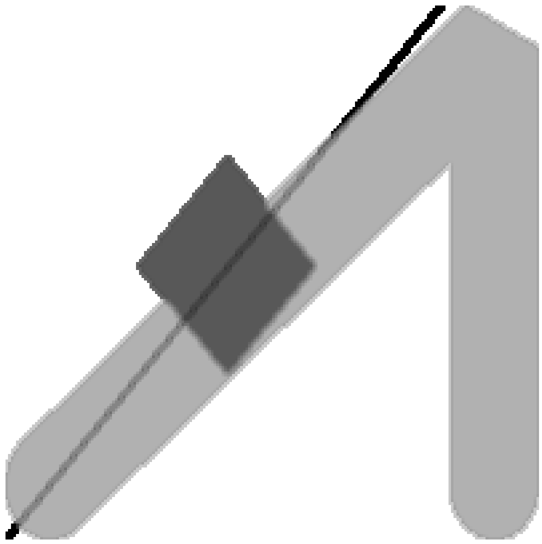
⊠⊠



mask ⊠⊠⊠⊠⊠ (mask ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠)



mask ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠



mask ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠

⊠⊠

rastbandarg, ST_Union, ST_MapAlgebra (expression version)

11.12.6 ST_MapAlgebra (expression version)

ST_MapAlgebra (expression version) — ⊠⊠⊠⊠⊠ - ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠ 2 ⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ ⊠ SQL ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_MapAlgebra**(raster rast, integer nband, text pixeltype, text expression, double precision nodataval=NULL);
raster **ST_MapAlgebra**(raster rast, text pixeltype, text expression, double precision nodataval=NULL);
raster **ST_MapAlgebra**(raster rast1, integer nband1, raster rast2, integer nband2, text expression, text pixeltype=NULL, text extenttype=INTERSECTION, text nodata1expr=NULL, text nodata2expr=NULL, double precision nodatanodataval=NULL);
raster **ST_MapAlgebra**(raster rast1, raster rast2, text expression, text pixeltype=NULL, text extenttype=INTERSECTION, text nodata1expr=NULL, text nodata2expr=NULL, double precision nodatanodataval=NULL);

⊠⊠

⊠⊠⊠⊠⊠ - ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠ 2 ⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠ 1, 2 (⊠⊠⊠ 1 ⊠)

⊠⊠⊠⊠⊠ (rast) ⊠⊠⊠ `expression` ⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `nband` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`pixeltype` ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `pixeltype` ⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ `rast` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- `expression` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
  1. `[rast]` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠
  2. `[rast.val]` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠
  3. `[rast.x]` - ⊠⊠⊠⊠⊠⊠ 1-⊠⊠⊠⊠⊠⊠
  4. `[rast.y]` - ⊠⊠⊠⊠⊠⊠ 1-⊠⊠⊠⊠⊠⊠

⊠⊠: ⊠⊠ 3, 4 (⊠⊠⊠ 2 ⊠)

⊠⊠⊠⊠⊠⊠⊠⊠ `rast1`, (`rast2`) ⊠⊠⊠ `expression` ⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠, ⊠⊠⊠ PostgreSQL ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `band1`, `band2` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠ ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠. `extenttype` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`expression` ⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠. ⊠: (([rast1] + [rast2])/2.0)::integer

`pixeltype` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_BandPixelType ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`extenttype` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

1. `INTERSECTION` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠.
2. `UNION` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
3. `FIRST` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

4. SECOND - □□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

nodata1expr rast1 □□□□□□ NODATA □□□□□□□□□□□□□□□ rast2 □□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□, □□ rast2 □□□□□□□□□□□□□□□□.

nodata2expr rast2 □□□□□□ NODATA □□□□□□□□□□□□□□□ rast1 □□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□, □□ rast1 □□□□□□□□□□□□□□□□.

nodatanodataval □□□□□□□□□□□ rast1 □ rast2 □□□□□□□□□ NODATA □□□□□□□□□□□□□□□ □□□□.

- expression, nodata1expr □ nodata2expr □□□□□□□□□□□□□.

1. [rast1] - rast1 □□□□□□□□□□□□□□
2. [rast1.val] - rast1 □□□□□□□□□□□□□□
3. [rast1.x] - rast1 □□□□□□□□□□ 1-□□□□□□
4. [rast1.y] - rast1 □□□□□□□□□□ 1-□□□□□□
5. [rast2] - rast2 □□□□□□□□□□□□□□
6. [rast2.val] - rast2 □□□□□□□□□□□□□□
7. [rast2.x] - rast2 □□□□□□□□□□ 1-□□□□□□
8. [rast2.y] - rast2 □□□□□□□□□□ 1-□□□□□□

□□: □□ 1 □ 2

```
WITH foo AS (
    SELECT ST_AddBand(ST_MakeEmptyRaster(10, 10, 0, 0, 1, 1, 0, 0, 0), '32BF'::text, 1, -1) ←
         AS rast
)
SELECT
    ST_MapAlgebra(rast, 1, NULL, 'ceil([rast]*[rast.x]/[rast.y]+[rast.val])')
FROM foo;
```

□□: □□ 3 □ 4

```
WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, ←
         0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI'::text, 100, 0) AS rast ←
        UNION ALL
    SELECT 2 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 1, 1, -1, ←
         0, 0, 0), 1, '16BUI', 2, 0), 2, '8BUI', 20, 0), 3, '32BUI'::text, 300, 0) AS rast
)
SELECT
    ST_MapAlgebra(
        t1.rast, 2,
        t2.rast, 1,
        '([rast2] + [rast1.val]) / 2'
    ) AS rast
FROM foo t1
CROSS JOIN foo t2
WHERE t1.rid = 1
    AND t2.rid = 2;
```

□□

rastbandarg, ST_Union, ST_MapAlgebra (callback function version)

11.12.7 ST_MapAlgebraExpr

ST_MapAlgebraExpr — ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_MapAlgebraExpr**(raster rast, integer band, text pixeltype, text expression, double precision nodataval=NULL);
raster **ST_MapAlgebraExpr**(raster rast, text pixeltype, text expression, double precision nodataval=NULL);

⊠⊠

> **Warning**
> ST_MapAlgebraExpr 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ST_MapAlgebra (expression version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠ (rast) ⊠⊠⊠ expression ⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. nband ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠.

pixeltype ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. pixeltype ⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rast ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ [rast], 1-⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ [rast.x], 1-⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ [rast.y] ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

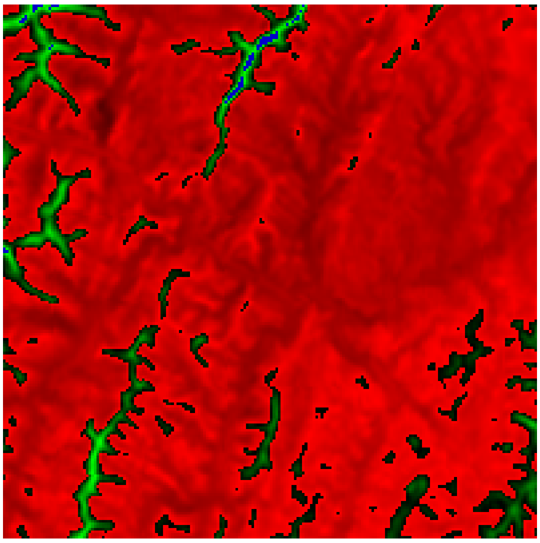
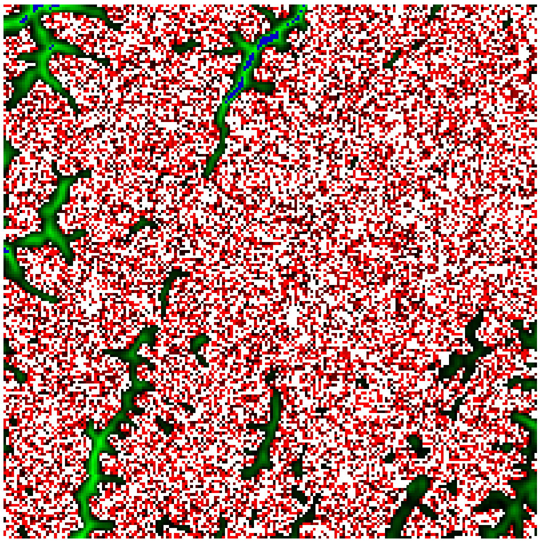
⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (modulo) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
ALTER TABLE dummy_rast ADD COLUMN map_rast raster;
UPDATE dummy_rast SET map_rast = ST_MapAlgebraExpr(rast,NULL,'mod([rast]::numeric,2)') ↩
    WHERE rid = 2;

SELECT
    ST_Value(rast,1,i,j) As origval,
    ST_Value(map_rast, 1, i, j) As mapval
FROM dummy_rast
CROSS JOIN generate_series(1, 3) AS i
CROSS JOIN generate_series(1,3) AS j
WHERE rid = 2;

 origval | mapval
---------+--------
     253 |      1
     254 |      0
     253 |      1
     253 |      1
     254 |      0
     254 |      0
```

```
     250 |      0
     254 |      0
     254 |      0
```

□□□□□□□ NODATA □□ 0 □□□□□□□□□□□□□□□□ 2BUI □, □□ 1 □□□□□□□□□□□□□□.

```
ALTER TABLE dummy_rast ADD COLUMN map_rast2 raster;
UPDATE dummy_rast SET
    map_rast2 = ST_MapAlgebraExpr(rast,'2BUI'::text,'CASE WHEN [rast] BETWEEN 100 and 250 THEN 1 WHEN [rast] = 252 THEN 2 WHEN [rast] BETWEEN 253 and 254 THEN 3 ELSE 0 END'::text, '0')
WHERE rid = 2;

SELECT DISTINCT
    ST_Value(rast,1,i,j) As origval,
    ST_Value(map_rast2, 1, i, j) As mapval
FROM dummy_rast
CROSS JOIN generate_series(1, 5) AS i
CROSS JOIN generate_series(1,5) AS j
WHERE rid = 2;

 origval | mapval
---------+--------
     249 |      1
     250 |      1
     251 |
     252 |      2
     253 |      3
     254 |      3

SELECT
    ST_BandPixelType(map_rast2) As b1pixtyp
FROM dummy_rast
WHERE rid = 2;

 b1pixtyp
----------
 2BUI
```

	
original (column rast_view)	*rast_view_ma*

⊠⊠ 3 ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT
    ST_AddBand(
        ST_AddBand(
            ST_AddBand(
                ST_MakeEmptyRaster(rast_view),
                ST_MapAlgebraExpr(rast_view,1,NULL,'tan([rast])*[rast]')
            ),
            ST_Band(rast_view,2)
        ),
        ST_Band(rast_view, 3)
    )  As rast_view_ma
FROM wind
WHERE rid=167;
```

⊠⊠

ST_MapAlgebraExpr, ST_MapAlgebraFct, ST_BandPixelType, ST_GeoReference, ST_Value

11.12.8 ST_MapAlgebraExpr

ST_MapAlgebraExpr — ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠: ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. extenttype ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. extenttype ⊠⊠⊠ INTERSECTION, UNION, FIRST, SECOND ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_MapAlgebraExpr**(raster rast1, raster rast2, text expression, text pixeltype=same_as_rast1_band
text extenttype=INTERSECTION, text nodata1expr=NULL, text nodata2expr=NULL, double preci-

sion nodatanodataval=NULL);
raster **ST_MapAlgebraExpr**(raster rast1, integer band1, raster rast2, integer band2, text expression, text pixeltype=same_as_rast1_band, text extenttype=INTERSECTION, text nodata1expr=NULL, text nodata2expr=NULL, double precision nodatanodataval=NULL);

⊠⊠

> **Warning**
> ST_MapAlgebraExpr 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ST_MapAlgebra (expression version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠ rast1, (rast2) ⊠⊠⊠ expression ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠, ⊠⊠⊠ PostgreSQL ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. band1, band2 ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠ ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. extenttype ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

expression ⊠⊠⊠ 2 ⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠. ⊠: (([rast1] + [rast2])/2.0)::integer

pixeltype ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_BandPixelType ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠, NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

extenttype ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

1. INTERSECTION - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠.
2. UNION - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
3. FIRST - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
4. SECOND - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

nodata1expr rast1 ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rast2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ rast2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

nodata2expr rast2 ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rast1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ rast1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

nodatanodataval ⊠⊠⊠⊠⊠⊠⊠⊠⊠ rast1 ⊠ rast2 ⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠.

pixeltype ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. pixeltype ⊠ NULL ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rast1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

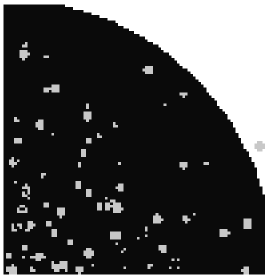
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ [rast1.val], [rast2.val], ⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ [rast1.x], [rast1.y] ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

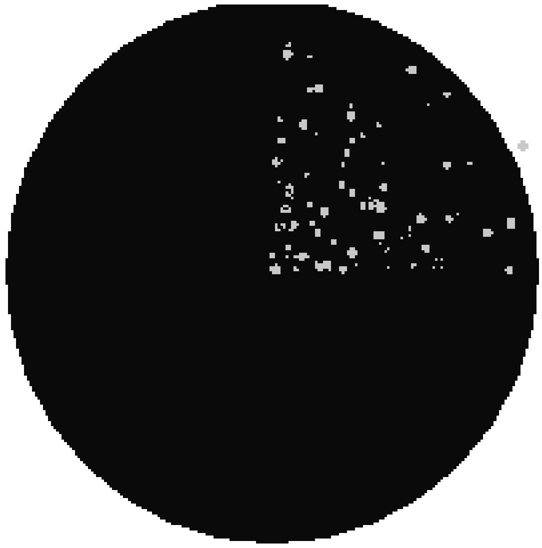
⊠⊠: ⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (modulo) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
--Create a cool set of rasters --
DROP TABLE IF EXISTS fun_shapes;
CREATE TABLE fun_shapes(rid serial PRIMARY KEY, fun_name text, rast raster);

-- Insert some cool shapes around Boston in Massachusetts state plane meters --
INSERT INTO fun_shapes(fun_name, rast)
VALUES ('ref', ST_AsRaster(ST_MakeEnvelope(235229, 899970, 237229, 901930,26986),200,200,'8 ←
    BUI',0,0));

INSERT INTO fun_shapes(fun_name,rast)
WITH ref(rast) AS (SELECT rast FROM fun_shapes WHERE fun_name = 'ref' )
SELECT 'area' AS fun_name, ST_AsRaster(ST_Buffer(ST_SetSRID(ST_Point(236229, 900930),26986) ←
    , 1000),
            ref.rast,'8BUI', 10, 0) As rast
FROM ref
UNION ALL
SELECT 'rand bubbles',
            ST_AsRaster(
            (SELECT ST_Collect(geom)
    FROM (SELECT ST_Buffer(ST_SetSRID(ST_Point(236229 + i*random()*100, 900930 + j*random() ←
        *100),26986), random()*20) As geom
            FROM generate_series(1,10) As i, generate_series(1,10) As j
            ) As foo ), ref.rast,'8BUI', 200, 0)
FROM ref;

--map them -
SELECT  ST_MapAlgebraExpr(
        area.rast, bub.rast, '[rast2.val]', '8BUI', 'INTERSECTION', '[rast2.val]', '[rast1. ←
            val]') As interrast,
        ST_MapAlgebraExpr(
            area.rast, bub.rast, '[rast2.val]', '8BUI', 'UNION', '[rast2.val]', '[rast1.val ←
                ]') As unionrast
FROM
  (SELECT rast FROM fun_shapes WHERE
 fun_name = 'area') As area
CROSS JOIN  (SELECT rast
FROM fun_shapes WHERE
 fun_name = 'rand bubbles') As bub
```



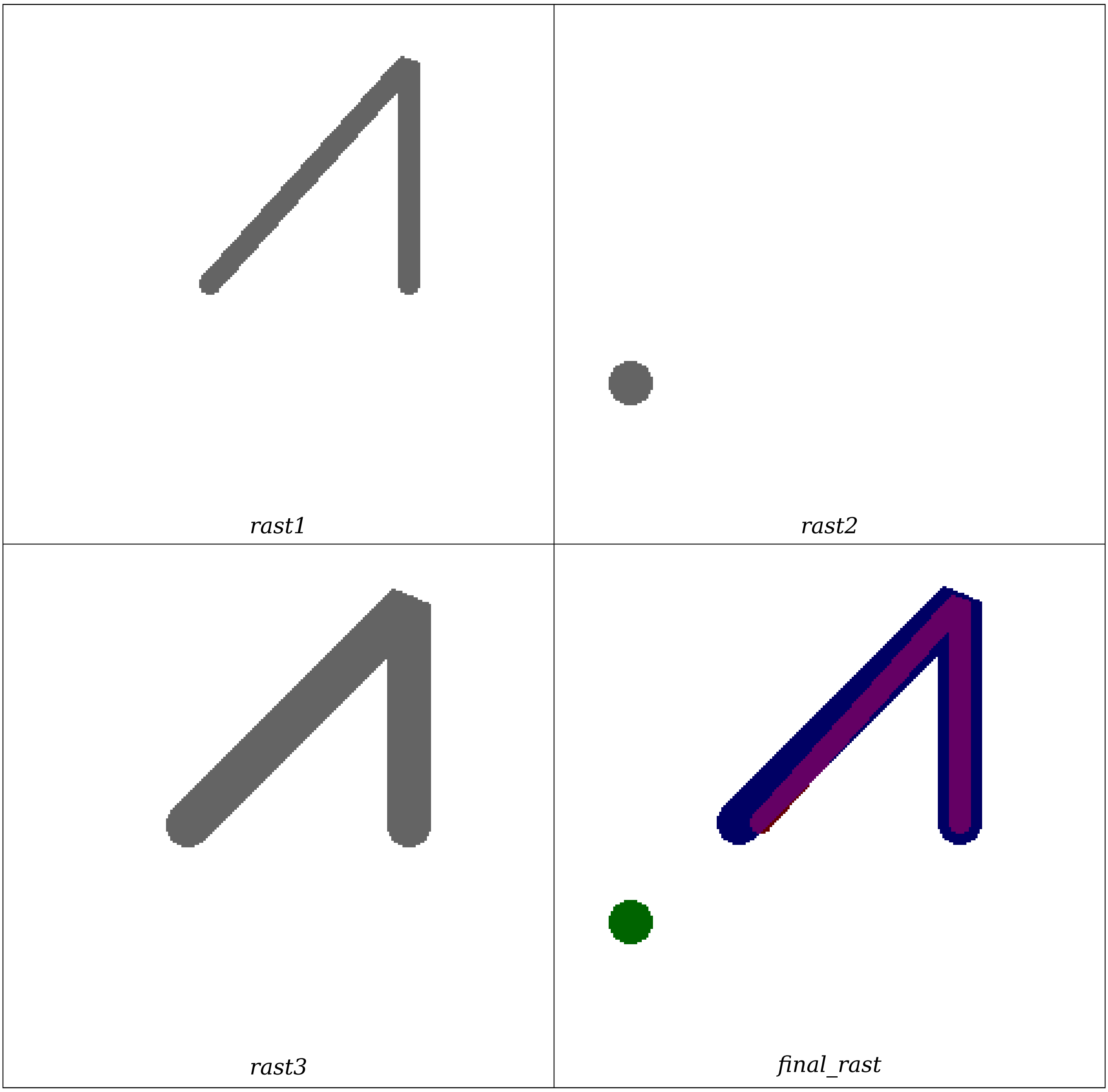
□□□□□ (intersection)



□□□□□ (union)

□□: □□□□□□□□□□□□□□□□□□□□□

```
-- we use ST_AsPNG to render the image so all single band ones look grey --
WITH mygeoms
    AS ( SELECT 2 As bnum, ST_Buffer(ST_Point(1,5),10) As geom
            UNION ALL
            SELECT 3 AS bnum,
                ST_Buffer(ST_GeomFromText('LINESTRING(50 50,150 150,150 50)'), 10,'join= ↩
                    bevel') As geom
            UNION ALL
            SELECT 1 As bnum,
                ST_Buffer(ST_GeomFromText('LINESTRING(60 50,150 150,150 50)'), 5,'join= ↩
                    bevel') As geom
            ),
   -- define our canvas to be 1 to 1 pixel to geometry
   canvas
    AS (SELECT ST_AddBand(ST_MakeEmptyRaster(200,
        200,
        ST_XMin(e)::integer, ST_YMax(e)::integer, 1, -1, 0, 0) , '8BUI'::text,0) As rast
        FROM (SELECT ST_Extent(geom) As e,
                    Max(ST_SRID(geom)) As srid
                    from mygeoms
                    ) As foo
            ),
   rbands AS (SELECT ARRAY(SELECT ST_MapAlgebraExpr(canvas.rast, ST_AsRaster(m.geom, canvas ↩
       .rast, '8BUI', 100),
                 '[rast2.val]', '8BUI', 'FIRST', '[rast2.val]', '[rast1.val]') As rast
                FROM mygeoms AS m CROSS JOIN canvas
                ORDER BY m.bnum) As rasts
                )
          SELECT rasts[1] As rast1 , rasts[2] As rast2, rasts[3] As rast3, ST_AddBand(
                    ST_AddBand(rasts[1],rasts[2]), rasts[3]) As final_rast
            FROM rbands;
```

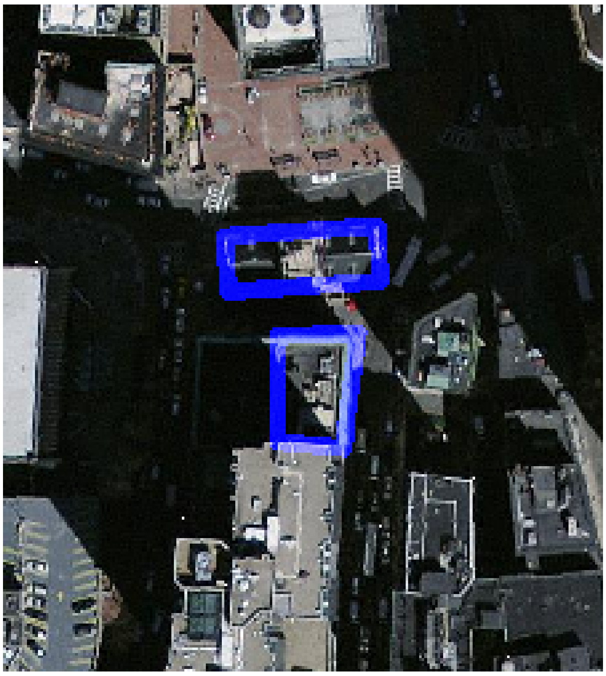


rast1 *rast2* *rast3* *final_rast*

□□: □□□□□□□□□□□□□□□□ 2 □□□□□□□□□□□□

```
-- Create new 3 band raster composed of first 2 clipped bands, and overlay of 3rd band with ↩
     our geometry
-- This query took 3.6 seconds on PostGIS windows 64-bit install
WITH pr AS
-- Note the order of operation: we clip all the rasters to dimensions of our region
(SELECT ST_Clip(rast,ST_Expand(geom,50) ) As rast, g.geom
    FROM aerials.o_2_boston AS r INNER JOIN
-- union our parcels of interest so they form a single geometry we can later intersect with
        (SELECT ST_Union(ST_Transform(geom,26986)) AS geom
          FROM landparcels WHERE pid IN('0303890000', '0303900000')) As g
        ON ST_Intersects(rast::geometry, ST_Expand(g.geom,50))
),
```

```
-- we then union the raster shards together
-- ST_Union on raster is kinda of slow but much faster the smaller you can get the rasters
-- therefore we want to clip first and then union
prunion AS
(SELECT ST_AddBand(NULL, ARRAY[ST_Union(rast,1),ST_Union(rast,2),ST_Union(rast,3)] ) As ↩
    clipped,geom
FROM pr
GROUP BY geom)
-- return our final raster which is the unioned shard with
-- with the overlay of our parcel boundaries
-- add first 2 bands, then mapalgebra of 3rd band + geometry
SELECT ST_AddBand(ST_Band(clipped,ARRAY[1,2])
    , ST_MapAlgebraExpr(ST_Band(clipped,3), ST_AsRaster(ST_Buffer(ST_Boundary(geom),2), ↩
        clipped, '8BUI',250),
     '[rast2.val]', '8BUI', 'FIRST', '[rast2.val]', '[rast1.val]') ) As rast
FROM prunion;
```



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ST_MapAlgebraExpr, ST_AddBand, ST_AsPNG, ST_AsRaster, ST_MapAlgebraFct, ST_BandPixelType, ST_GeoReference, ST_Value, ST_Union, ST_Union

11.12.9 ST_MapAlgebraFct

ST_MapAlgebraFct — ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_MapAlgebraFct**(raster rast, regprocedure onerasteruserfunc);
raster **ST_MapAlgebraFct**(raster rast, regprocedure onerasteruserfunc, text[] VARIADIC args);
raster **ST_MapAlgebraFct**(raster rast, text pixeltype, regprocedure onerasteruserfunc);
raster **ST_MapAlgebraFct**(raster rast, text pixeltype, regprocedure onerasteruserfunc, text[] VARIADIC args);
raster **ST_MapAlgebraFct**(raster rast, integer band, regprocedure onerasteruserfunc);
raster **ST_MapAlgebraFct**(raster rast, integer band, regprocedure onerasteruserfunc, text[] VARIADIC args);
raster **ST_MapAlgebraFct**(raster rast, integer band, text pixeltype, regprocedure onerasteruserfunc);
raster **ST_MapAlgebraFct**(raster rast, integer band, text pixeltype, regprocedure onerasteruserfunc, text[] VARIADIC args);

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> **Warning**
> ST_MapAlgebraFct 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠ (rast) ⊠⊠⊠ onerasteruserfunc ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. band ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

pixeltype ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. pixeltype ⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rast ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

The `onerasteruserfunc` parameter must be the name and signature of a SQL or PL/pgSQL function, cast to a regprocedure. A very simple and quite useless PL/pgSQL function example is:

```
CREATE OR REPLACE FUNCTION simple_function(pixel FLOAT, pos INTEGER[], VARIADIC args TEXT []) 
    RETURNS FLOAT
    AS $$ BEGIN
        RETURN 0.0;
    END; $$
    LANGUAGE 'plpgsql' IMMUTABLE;
```

The `userfunction` may accept two or three arguments: a float value, an optional integer array, and a variadic text array. The first argument is the value of an individual raster cell (regardless of the raster datatype). The second argument is the position of the current processing cell in the form '{x,y}'. The third argument indicates that all remaining parameters to ST_MapAlgebraFct shall be passed through to the `userfunction`.

Passing a regprodedure argument to a SQL function requires the full function signature to be passed, then cast to a regprocedure type. To pass the above example PL/pgSQL function as an argument, the SQL for the argument is:

```
'simple_function(float,integer[],text[])'::regprocedure
```

Note that the argument contains the name of the function, the types of the function arguments, quotes around the name and argument types, and a cast to a regprocedure.

`userfunction` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ variadic text ⊠⊠⊠⊠⊠. ⊠⊠ ST_MapAlgebraFct ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `userfunction` ⊠⊠⊠⊠⊠, `args` ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
(⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) VARIADIC ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, PostgreSQL ⊠⊠⊠⊠⊠ Query Language (SQL) Functions ⊠"SQL Functions with Variable Numbers of Arguments" ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, userfunction ⊠⊠⊠⊠⊠ text[] ⊠⊠⊠⊠⊠⊠⊠⊠.

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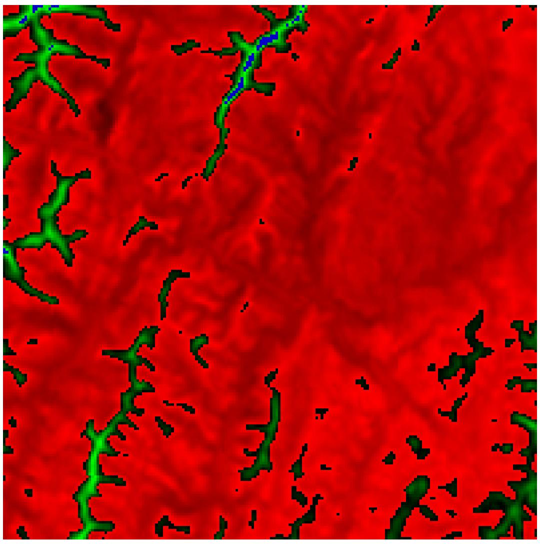
⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (modulo) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
ALTER TABLE dummy_rast ADD COLUMN map_rast raster;
CREATE FUNCTION mod_fct(pixel float, pos integer[], variadic args text[])
RETURNS float
AS $$
BEGIN
    RETURN pixel::integer % 2;
END;
$$
LANGUAGE 'plpgsql' IMMUTABLE;

UPDATE dummy_rast SET map_rast = ST_MapAlgebraFct(rast,NULL,'mod_fct(float,integer[],text ↩
    [])'::regprocedure) WHERE rid = 2;

SELECT ST_Value(rast,1,i,j) As origval, ST_Value(map_rast, 1, i, j) As mapval
FROM dummy_rast CROSS JOIN generate_series(1, 3) AS i CROSS JOIN generate_series(1,3) AS j
WHERE rid = 2;

 origval | mapval
---------+--------
     253 |      1
     254 |      0
     253 |      1
     253 |      1
     254 |      0
     254 |      0
     250 |      0
     254 |      0
     254 |      0
```

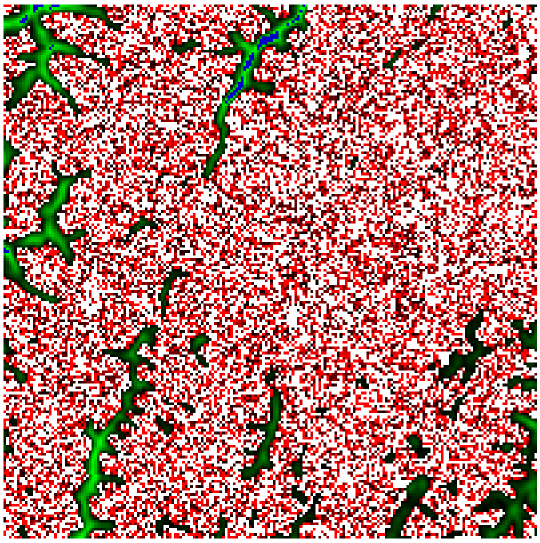
⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠ (0) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2BUI ⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
ALTER TABLE dummy_rast ADD COLUMN map_rast2 raster;
CREATE FUNCTION classify_fct(pixel float, pos integer[], variadic args text[])
RETURNS float
AS
$$
DECLARE
    nodata float := 0;
BEGIN
    IF NOT args[1] IS NULL THEN
```

```
        nodata := args[1];
    END IF;
    IF pixel < 251 THEN
        RETURN 1;
    ELSIF pixel = 252 THEN
        RETURN 2;
    ELSIF pixel
> 252 THEN
        RETURN 3;
    ELSE
        RETURN nodata;
    END IF;
END;
$$
LANGUAGE 'plpgsql';
UPDATE dummy_rast SET map_rast2 = ST_MapAlgebraFct(rast,'2BUI','classify_fct(float,integer[],text[])'::regprocedure, '0') WHERE rid = 2;

SELECT DISTINCT ST_Value(rast,1,i,j) As origval, ST_Value(map_rast2, 1, i, j) As mapval
FROM dummy_rast CROSS JOIN generate_series(1, 5) AS i CROSS JOIN generate_series(1,5) AS j
WHERE rid = 2;

 origval | mapval
---------+--------
     249 |      1
     250 |      1
     251 |
     252 |      2
     253 |      3
     254 |      3

SELECT ST_BandPixelType(map_rast2) As b1pixtyp
FROM dummy_rast WHERE rid = 2;

 b1pixtyp
----------
 2BUI
```



□□ *(rast-view □)*



rast_view_ma

⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
CREATE FUNCTION rast_plus_tan(pixel float, pos integer[], variadic args text[])
RETURNS float
AS
$$
BEGIN
    RETURN tan(pixel) * pixel;
END;
$$
LANGUAGE 'plpgsql';

SELECT ST_AddBand(
    ST_AddBand(
        ST_AddBand(
            ST_MakeEmptyRaster(rast_view),
            ST_MapAlgebraFct(rast_view,1,NULL,'rast_plus_tan(float,integer[],text[])':: ↩
                regprocedure)
        ),
        ST_Band(rast_view,2)
    ),
    ST_Band(rast_view, 3) As rast_view_ma
)
FROM wind
WHERE rid=167;
```

⊠⊠

ST_MapAlgebraExpr, ST_BandPixelType, ST_GeoReference, ST_SetValue

11.12.10 ST_MapAlgebraFct

ST_MapAlgebraFct — ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠: ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ INTERSECTION ⊠⊠⊠.

Synopsis

raster **ST_MapAlgebraFct**(raster rast1, raster rast2, regprocedure tworastuserfunc, text pixeltype=same_a
text extenttype=INTERSECTION, text[] VARIADIC userargs);
raster **ST_MapAlgebraFct**(raster rast1, integer band1, raster rast2, integer band2, regprocedure tworastuserfunc, text pixeltype=same_as_rast1, text extenttype=INTERSECTION, text[] VARIADIC userargs);

⊠⊠

Warning
ST_MapAlgebraFct 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□□□□ rast1, rast2 □□□ tworastuserfunc □□□□□ PostgreSQL □□□□□□□□□□□, □□ 1 □□□□□□□□□□□□□□□□. band1 □□ band2 □□□□□□□□□□, □□ 1 □□□□□□. □□□□□□□□ □□□□□□□□□□□□□, □□□□□□□□□, □□□ 1 □□□□□□□□□.

pixeltype □□□□□□, □□□□□□□□□□□□□□□□□□□□□□. pixeltype □ NULL □□□□□□□ □□□□□□, □□□□□□□□□□□ rast1 □□□□□□□□□□□□□□□□□□□.

The tworastuserfunc parameter must be the name and signature of an SQL or PL/pgSQL function, cast to a regprocedure. An example PL/pgSQL function example is:

```
CREATE OR REPLACE FUNCTION simple_function_for_two_rasters(pixel1 FLOAT, pixel2 FLOAT, pos ←
    INTEGER[], VARIADIC args TEXT[])
    RETURNS FLOAT
    AS $$ BEGIN
        RETURN 0.0;
    END; $$
    LANGUAGE 'plpgsql' IMMUTABLE;
```

The tworastuserfunc may accept three or four arguments: a double precision value, a double precision value, an optional integer array, and a variadic text array. The first argument is the value of an individual raster cell in rast1 (regardless of the raster datatype). The second argument is an individual raster cell value in rast2. The third argument is the position of the current processing cell in the form '{x,y}'. The fourth argument indicates that all remaining parameters to ST_MapAlgebraFct shall be passed through to the tworastuserfunc.

Passing a regprodedure argument to a SQL function requires the full function signature to be passed, then cast to a regprocedure type. To pass the above example PL/pgSQL function as an argument, the SQL for the argument is:

```
'simple_function(double precision, double precision, integer[], text[])'::regprocedure
```

Note that the argument contains the name of the function, the types of the function arguments, quotes around the name and argument types, and a cast to a regprocedure.

The fourth argument to the tworastuserfunc is a variadic text array. All trailing text arguments to any ST_MapAlgebraFct call are passed through to the specified tworastuserfunc, and are contained in the userargs argument.

Note
(□□□□□□□□□□□□□□) VARIADIC □□□□□□□□□□□□□□□□□□□□, PostgreSQL □□□ □□ Query Language (SQL) Functions □"SQL Functions with Variable Numbers of Arguments" □□□□□□□□□□.

Note
□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, tworastuserfunc □□□□□ text[] □□□□□□□□□.

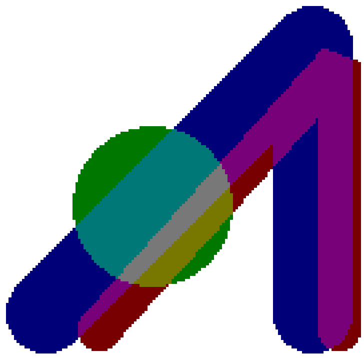
2.0.0 □□□□□□□□□□□□□.

□□: □□□□□□□□□□□□□□□□□□□□□□□

```
-- define our user defined function --
CREATE OR REPLACE FUNCTION raster_mapalgebra_union(
    rast1 double precision,
```

```
    rast2 double precision,
    pos integer[],
    VARIADIC userargs text[]
)
    RETURNS double precision
    AS $$
    DECLARE
    BEGIN
        CASE
            WHEN rast1 IS NOT NULL AND rast2 IS NOT NULL THEN
                RETURN ((rast1 + rast2)/2.);
            WHEN rast1 IS NULL AND rast2 IS NULL THEN
                RETURN NULL;
            WHEN rast1 IS NULL THEN
                RETURN rast2;
            ELSE
                RETURN rast1;
        END CASE;

        RETURN NULL;
    END;
    $$ LANGUAGE 'plpgsql' IMMUTABLE COST 1000;

-- prep our test table of rasters
DROP TABLE IF EXISTS map_shapes;
CREATE TABLE map_shapes(rid serial PRIMARY KEY, rast raster, bnum integer, descrip text);
INSERT INTO map_shapes(rast,bnum, descrip)
WITH mygeoms
    AS ( SELECT 2 As bnum, ST_Buffer(ST_Point(90,90),30) As geom, 'circle' As descrip
            UNION ALL
            SELECT 3 AS bnum,
                ST_Buffer(ST_GeomFromText('LINESTRING(50 50,150 150,150 50)'), 15) As geom, ←
                     'big road' As descrip
            UNION ALL
            SELECT 1 As bnum,
                ST_Translate(ST_Buffer(ST_GeomFromText('LINESTRING(60 50,150 150,150 50)'), ←
                     8,'join=bevel'), 10,-6) As geom, 'small road' As descrip
            ),
   -- define our canvas to be 1 to 1 pixel to geometry
   canvas
    AS ( SELECT ST_AddBand(ST_MakeEmptyRaster(250,
        250,
        ST_XMin(e)::integer, ST_YMax(e)::integer, 1, -1, 0, 0 ) , '8BUI'::text,0) As rast
        FROM (SELECT ST_Extent(geom) As e,
                    Max(ST_SRID(geom)) As srid
                    from mygeoms
                    ) As foo
            )
-- return our rasters aligned with our canvas
SELECT ST_AsRaster(m.geom, canvas.rast, '8BUI', 240) As rast, bnum, descrip
                FROM mygeoms AS m CROSS JOIN canvas
UNION ALL
SELECT canvas.rast, 4, 'canvas'
FROM canvas;

-- Map algebra on single band rasters and then collect with ST_AddBand
INSERT INTO map_shapes(rast,bnum,descrip)
SELECT ST_AddBand(ST_AddBand(rasts[1], rasts[2]),rasts[3]), 4, 'map bands overlay fct union ←
     (canvas)'
    FROM (SELECT ARRAY(SELECT ST_MapAlgebraFct(m1.rast, m2.rast,
            'raster_mapalgebra_union(double precision, double precision, integer[], text[]) ←
                '::regprocedure, '8BUI', 'FIRST')
```

```
                FROM map_shapes As m1 CROSS JOIN map_shapes As m2
    WHERE m1.descrip = 'canvas' AND m2.descrip <
> 'canvas' ORDER BY m2.bnum) As rasts) As foo;
```

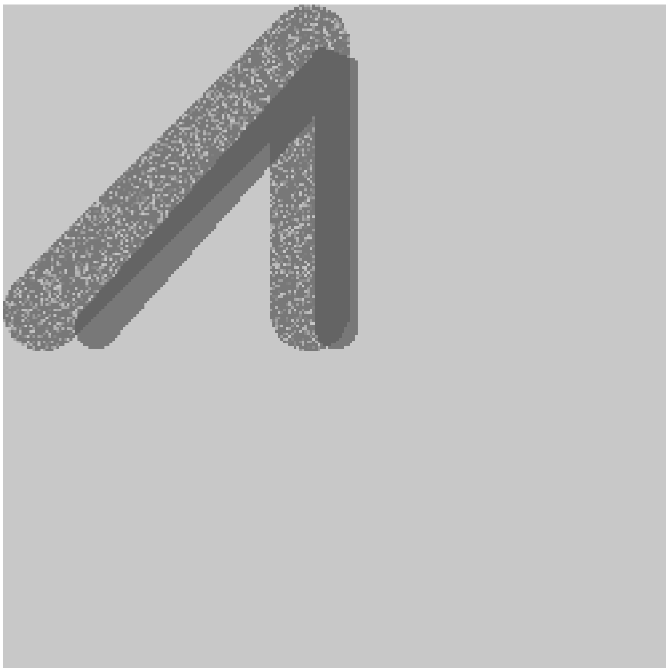


⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) (R: small road, G: circle, B: big road)

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
CREATE OR REPLACE FUNCTION raster_mapalgebra_userargs(
    rast1 double precision,
    rast2 double precision,
    pos integer[],
    VARIADIC userargs text[]
)
    RETURNS double precision
    AS $$
    DECLARE
    BEGIN
        CASE
            WHEN rast1 IS NOT NULL AND rast2 IS NOT NULL THEN
                RETURN least(userargs[1]::integer,(rast1 + rast2)/2.);
            WHEN rast1 IS NULL AND rast2 IS NULL THEN
                RETURN userargs[2]::integer;
            WHEN rast1 IS NULL THEN
                RETURN greatest(rast2,random()*userargs[3]::integer)::integer;
            ELSE
                RETURN greatest(rast1, random()*userargs[4]::integer)::integer;
        END CASE;

        RETURN NULL;
    END;
    $$ LANGUAGE 'plpgsql' VOLATILE COST 1000;
```

```
SELECT ST_MapAlgebraFct(m1.rast, 1, m1.rast, 3,
            'raster_mapalgebra_userargs(double precision, double precision, integer[], text ↩
                []'::regprocedure,
                '8BUI', 'INTERSECT', '100','200','200','0')
                FROM map_shapes As m1
    WHERE m1.descrip = 'map bands overlay fct union (canvas)';
```



⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠

ST_MapAlgebraExpr, ST_BandPixelType, ST_GeoReference, ST_SetValue

11.12.11 ST_MapAlgebraFctNgb

ST_MapAlgebraFctNgb — ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠: ⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Map Algebra Nearest Neighbor) ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (neighborhood) ⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_MapAlgebraFctNgb**(raster rast, integer band, text pixeltype, integer ngbwidth, integer ngbheight, regprocedure onerastngbuserfunc, text nodatamode, text[] VARIADIC args);

⊠⊠

Warning
ST_MapAlgebraFctNgb 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⌧⌧⌧ 1 ⌧⌧⌧: ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (neighborhood) ⌧⌧⌧⌧ PostgreSQL ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ ⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

rast ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧

band ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (⌧⌧⌧⌧ 1)

pixeltype ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧ ST_BandPixelType ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧, ⌧⌧⌧⌧⌧, NULL ⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧ NULL ⌧⌧⌧⌧⌧⌧⌧⌧⌧, rast ⌧⌧⌧⌧⌧⌧ ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

ngbwidth ⌧⌧ (neighborhood) ⌧⌧⌧⌧⌧⌧

ngbheight ⌧⌧ (neighborhood) ⌧⌧⌧⌧⌧⌧

onerastngbuserfunc ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ PL/pgSQL ⌧⌧ psql ⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧ ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ 2 ⌧⌧⌧⌧⌧⌧⌧⌧⌧.

nodatamode NODATA ⌧⌧ NULL ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

’ignore’: ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ NODATA ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ ⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧ NODATA ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

’NULL’: ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ NODATA ⌧⌧⌧⌧⌧⌧⌧ NULL ⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ ⌧⌧⌧⌧⌧.

’value’: ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ NODATA ⌧⌧⌧⌧⌧⌧ (⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧) ⌧⌧⌧⌧⌧⌧. ⌧⌧⌧ NODATA ⌧⌧⌧, (⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧) ’NULL’ ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

args ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧

2.0.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

⌧⌧

⌧⌧⌧⌧⌧ http://trac.osgeo.org/gdal/wiki/frmts_wtkraster.html ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ ST_Rescale ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

```
--
-- A simple 'callback' user function that averages up all the values in a neighborhood.
--
CREATE OR REPLACE FUNCTION rast_avg(matrix float[][], nodatamode text, variadic args text ↩
    [])
    RETURNS float AS
    $$
    DECLARE
        _matrix float[][];
        x1 integer;
        x2 integer;
        y1 integer;
        y2 integer;
        sum float;
    BEGIN
        _matrix := matrix;
        sum := 0;
        FOR x in array_lower(matrix, 1)..array_upper(matrix, 1) LOOP
            FOR y in array_lower(matrix, 2)..array_upper(matrix, 2) LOOP
                sum := sum + _matrix[x][y];
            END LOOP;
        END LOOP;
        RETURN (sum*1.0/(array_upper(matrix,1)*array_upper(matrix,2) ))::integer ;
```

```
    END;
    $$
LANGUAGE 'plpgsql' IMMUTABLE COST 1000;

-- now we apply to our raster averaging pixels within 2 pixels of each other in X and Y ↩
   direction --
SELECT ST_MapAlgebraFctNgb(rast, 1,  '8BUI', 4,4,
        'rast_avg(float[][], text, text[])'::regprocedure, 'NULL', NULL) As nn_with_border
    FROM katrinas_rescaled
    limit 1;
```

 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠	 ⊠⊠⊠⊠⊠ *4x4* ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠

⊠⊠

ST_MapAlgebraFct, ST_MapAlgebraExpr, ST_Rescale

11.12.12 ST_Reclass

ST_Reclass — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. nband ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. nband ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 16BUI ⊠⊠⊠ 8BUI ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_Reclass**(raster rast, integer nband, text reclassexpr, text pixeltype, double precision nodataval=NULL);
raster **ST_Reclass**(raster rast, reclassarg[] VARIADIC reclassargset);
raster **ST_Reclass**(raster rast, text reclassexpr, text pixeltype);

⊠⊠

⊠⊠⊠⊠⊠ (rast) ⊠⊠⊠ reclassexpr ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. band ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠

□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□ □ reclassarg □□□□□□□.

□□□□□□□□□ pixeltype □□□□□□□□□□. reclassargset □□□□□□□, □ reclassarg(□□□ □□) □□□□□□□□□□□□□□□□□□.

2.0.0 □□□□□□□□□□□□□.

□□□□

□□□□□ 2 □ 8BUI □□ 4BUI □□□□□ 101 □□ 254 □□□□□□□ NODATA □□□□□□□□□□□ □□□□□.

```
ALTER TABLE dummy_rast ADD COLUMN reclass_rast raster;
UPDATE dummy_rast SET reclass_rast = ST_Reclass(rast,2,'0-87:1-10, 88-100:11-15, ←
    101-254:0-0', '4BUI',0) WHERE rid = 2;

SELECT i as col, j as row, ST_Value(rast,2,i,j) As origval,
    ST_Value(reclass_rast, 2, i, j) As reclassval,
    ST_Value(reclass_rast, 2, i, j, false) As reclassval_include_nodata
FROM dummy_rast CROSS JOIN generate_series(1, 3) AS i CROSS JOIN generate_series(1,3) AS j
WHERE rid = 2;

 col | row | origval | reclassval | reclassval_include_nodata
-----+-----+---------+------------+--------------------------
   1 |   1 |      78 |          9 |                         9
   2 |   1 |      98 |         14 |                        14
   3 |   1 |     122 |            |                         0
   1 |   2 |      96 |         14 |                        14
   2 |   2 |     118 |            |                         0
   3 |   2 |     180 |            |                         0
   1 |   3 |      99 |         15 |                        15
   2 |   3 |     112 |            |                         0
   3 |   3 |     169 |            |                         0
```

□□□□□□□□□□□□□□□□□□□

□□□□□□□□□ 1, 2, 3 □□□ 1BB, 4BUI, 4BUI □□□□□□□□□□□□□□□□□□□□. □□□□ (□ □□□□□□□□□□□□□□□□□□□) □□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□ reclassarg □□□□□□□□□□□□□□□□□.

```
UPDATE dummy_rast SET reclass_rast =
    ST_Reclass(rast,
        ROW(2,'0-87]:1-10, (87-100]:11-15, (101-254]:0-0', '4BUI',NULL)::reclassarg,
        ROW(1,'0-253]:1, 254:0', '1BB', NULL)::reclassarg,
        ROW(3,'0-70]:1, (70-86:2, [86-150):3, [150-255:4', '4BUI', NULL)::reclassarg
        ) WHERE rid = 2;

SELECT i as col, j as row,ST_Value(rast,1,i,j) As ov1,  ST_Value(reclass_rast, 1, i, j) As ←
    rv1,
    ST_Value(rast,2,i,j) As ov2, ST_Value(reclass_rast, 2, i, j) As rv2,
    ST_Value(rast,3,i,j) As ov3, ST_Value(reclass_rast, 3, i, j) As rv3
FROM dummy_rast CROSS JOIN generate_series(1, 3) AS i CROSS JOIN generate_series(1,3) AS j
WHERE rid = 2;

col | row | ov1 | rv1 | ov2 | rv2 | ov3 | rv3
----+-----+-----+-----+-----+-----+-----+-----
  1 |   1 | 253 |   1 |  78 |   9 |  70 |   1
  2 |   1 | 254 |   0 |  98 |  14 |  86 |   3
```

```
  3 |    1 | 253 |    1 | 122 |    0 | 100 |    3
  1 |    2 | 253 |    1 |  96 |   14 |  80 |    2
  2 |    2 | 254 |    0 | 118 |    0 | 108 |    3
  3 |    2 | 254 |    0 | 180 |    0 | 162 |    4
  1 |    3 | 250 |    1 |  99 |   15 |  90 |    3
  2 |    3 | 254 |    0 | 112 |    0 | 108 |    3
  3 |    3 | 254 |    0 | 169 |    0 | 175 |    4
```

⊠⊠ 32BF ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

32BF ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠ ((8BUI,8BUI,8BUI) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
ALTER TABLE wind ADD COLUMN rast_view raster;
UPDATE wind
    set rast_view = ST_AddBand( NULL,
        ARRAY[
    ST_Reclass(rast, 1,'0.1-10]:1-10,9-10]:11,(11-33:0'::text, '8BUI'::text,0),
    ST_Reclass(rast,1, '11-33):0-255,[0-32:0,(34-1000:0'::text, '8BUI'::text,0),
    ST_Reclass(rast,1,'0-32]:0,(32-100:100-255'::text, '8BUI'::text,0)
    ]
    );
```

⊠⊠

ST_AddBand, ST_Band, ST_BandPixelType, ST_MakeEmptyRaster, reclassarg, ST_Value

11.12.13 ST_Union

ST_Union — ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_Union**(setof raster rast);
raster **ST_Union**(setof raster rast, unionarg[] unionargset);
raster **ST_Union**(setof raster rast, integer nband);
raster **ST_Union**(setof raster rast, text uniontype);
raster **ST_Union**(setof raster rast, integer nband, text uniontype);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, uniontype ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. uniontype ⊠⊠⊠ LAST(⊠⊠⊠), FIRST, MIN, MAX, COUNT, SUM, MEAN, RANGE ⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> In order for rasters to be unioned, they must all have the same alignment. Use ST_SameAlignment and ST_NotSameAlignmentReason for more details and help. One way to fix alignment issues is to use ST_Resample and use the same reference raster for alignment.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠ C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠).

2.1.0 ⊠⊠⊠⊠ ST_Union(rast, unionarg) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_Union(rast) ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_Union(rast, uniontype) ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
-- this creates a single band from first band of raster tiles
-- that form the original file system tile
SELECT filename, ST_Union(rast,1) As file_rast
FROM sometable WHERE filename IN('dem01', 'dem02') GROUP BY filename;
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
-- this creates a multi band raster collecting all the tiles that intersect a line
-- Note: In 2.0, this would have just returned a single band raster
-- , new union works on all bands by default
-- this is equivalent to unionarg: ARRAY[ROW(1, 'LAST'), ROW(2, 'LAST'), ROW(3, 'LAST')]:: ↩
    unionarg[]
SELECT ST_Union(rast)
FROM aerials.boston
WHERE ST_Intersects(rast,  ST_GeomFromText('LINESTRING(230486 887771, 230500 88772)',26986) ↩
     );
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
-- this creates a multi band raster collecting all the tiles that intersect a line
SELECT ST_Union(rast,ARRAY[ROW(2, 'LAST'), ROW(1, 'LAST'), ROW(3, 'LAST')]::unionarg[])
FROM aerials.boston
WHERE ST_Intersects(rast,  ST_GeomFromText('LINESTRING(230486 887771, 230500 88772)',26986) ↩
     );
```

⊠⊠

unionarg, ST_Envelope, ST_ConvexHull, ST_Clip, ST_Union

11.13 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

11.13.1 ST_Distinct4ma

ST_Distinct4ma — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_Distinct4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Distinct4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ 1 ⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ 2 ⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Warning**
> 2.1.0 ⊠⊠⊠⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT
    rid,
    st_value(
        st_mapalgebrafctngb(rast, 1, NULL, 1, 1, 'st_distinct4ma(float[][],text,text[])':: ↩
            regprocedure, 'ignore', NULL), 2, 2
    )
FROM dummy_rast
WHERE rid = 2;
 rid | st_value
-----+----------
   2 |        3
(1 row)
```

⊠⊠

ST_MapAlgebraFctNgb, ST_MapAlgebra (callback function version), ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Distinct4ma, ST_StdDev4ma

11.13.2 ST_InvDistWeight4ma

ST_InvDistWeight4ma — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

double precision **ST_InvDistWeight4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠ (Inverse Distance Weighted method) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

userargs ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠ 1 ⊠⊠⊠⊠⊠ (力率) ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠ k ⊠⊠). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ 1 ⊠⊠⊠. ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

$$\hat{z}(x_o) = \frac{\sum_{j=1}^{m} z(x_j) d_{ij}^{-k}}{\sum_{j=1}^{m} d_{ij}^{-k}}$$

k = ⊠⊠ (power factor), 0 ⊠ 1 ⊠⊠⊠⊠⊠

> **Note**
> ⊠⊠⊠⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- NEEDS EXAMPLE
```

⊠⊠

ST_MapAlgebra (callback function version), ST_MinDist4ma

11.13.3 ST_Max4ma

ST_Max4ma — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_Max4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Max4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 2 ⊠⊠⊠, ⊠⊠⊠⊠ userargs ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠ 1 ⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠ 2 ⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Warning
2.1.0 ⊠⊠⊠⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT
    rid,
    st_value(
        st_mapalgebrafctngb(rast, 1, NULL, 1, 1, 'st_max4ma(float[][],text,text[])':: ↩
            regprocedure, 'ignore', NULL), 2, 2
    )
FROM dummy_rast
WHERE rid = 2;
 rid | st_value
-----+----------
   2 |      254
(1 row)
```

⊠⊠

ST_MapAlgebraFctNgb, ST_MapAlgebra (callback function version), ST_Min4ma, ST_Sum4ma, ST_Mean4ma, ST_Range4ma, ST_Distinct4ma, ST_StdDev4ma

11.13.4 ST_Mean4ma

ST_Mean4ma — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_Mean4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Mean4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 2 ⊠⊠⊠, ⊠⊠⊠⊠⊠ userargs ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠ 1 ⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠ 2 ⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Warning
2.1.0 ⊠⊠⊠⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠ 1

```
SELECT
    rid,
    st_value(
        st_mapalgebrafctngb(rast, 1, '32BF', 1, 1, 'st_mean4ma(float[][],text,text[])':: ↩
            regprocedure, 'ignore', NULL), 2, 2
    )
FROM dummy_rast
WHERE rid = 2;
 rid |     st_value
-----+------------------
   2 | 253.222229003906
(1 row)
```

⊠⊠: ⊠⊠ 2

```
SELECT
    rid,
    st_value(
              ST_MapAlgebra(rast, 1, 'st_mean4ma(double precision[][][], integer[][], text ↩
                  [])'::regprocedure,'32BF', 'FIRST', NULL, 1, 1)
       ,  2, 2)
  FROM dummy_rast
   WHERE rid = 2;
 rid |     st_value
-----+------------------
   2 | 253.222229003906
(1 row)
```

⊠⊠

ST_MapAlgebraFctNgb, ST_MapAlgebra (callback function version), ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Range4ma, ST_StdDev4ma

11.13.5 ST_Min4ma

ST_Min4ma — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_Min4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Min4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 2 ⊠⊠⊠, ⊠⊠⊠⊠⊠ userargs ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ 1 ⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ 2 ⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Warning**
> 2.1.0 ⊠⊠⊠⊠⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠.

☒☒

```
SELECT
    rid,
    st_value(
        st_mapalgebrafctngb(rast, 1, NULL, 1, 1, 'st_min4ma(float[][],text,text[])':: ↩
            regprocedure, 'ignore', NULL), 2, 2
    )
FROM dummy_rast
WHERE rid = 2;
 rid | st_value
-----+----------
   2 |      250
(1 row)
```

☒☒

ST_MapAlgebraFctNgb, ST_MapAlgebra (callback function version), ST_Max4ma, ST_Sum4ma, ST_Mean4m
ST_Range4ma, ST_Distinct4ma, ST_StdDev4ma

11.13.6 ST_MinDist4ma

ST_MinDist4ma — ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (☒☒☒☒☒) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

double precision **ST_MinDist4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

☒☒

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> **Note**
> ☒☒☒☒☒☒☒ ST_InvDistWeight4ma ☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

> **Note**
> ☒☒☒☒ ST_MapAlgebra (callback function version) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

2.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
-- NEEDS EXAMPLE
```

⊠⊠

ST_MapAlgebra (callback function version), ST_InvDistWeight4ma

11.13.7 ST_Range4ma

ST_Range4ma — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_Range4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Range4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠ 2 ⊠⊠⊠, ⊠⊠⊠⊠ userargs ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ 1 ⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ 2 ⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Warning**
> 2.1.0 ⊠⊠⊠⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT
    rid,
    st_value(
        st_mapalgebrafctngb(rast, 1, NULL, 1, 1, 'st_range4ma(float[][],text,text[])':: ↩
            regprocedure, 'ignore', NULL), 2, 2
    )
FROM dummy_rast
WHERE rid = 2;
 rid | st_value
-----+----------
   2 |        4
(1 row)
```

⌧⌧

ST_MapAlgebraFctNgb, ST_MapAlgebra (callback function version), ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Distinct4ma, ST_StdDev4ma

11.13.8 ST_StdDev4ma

ST_StdDev4ma — ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

Synopsis

float8 **ST_StdDev4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_StdDev4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

⌧⌧

⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

Note
⌧⌧ 1 ⌧ ST_MapAlgebraFctNgb ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

Note
⌧⌧ 2 ⌧ ST_MapAlgebra (callback function version) ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

Warning
2.1.0 ⌧⌧⌧⌧ ST_MapAlgebraFctNgb ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ 1 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

2.0.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧ 2 ⌧⌧⌧⌧⌧⌧⌧.

⌧⌧

```
SELECT
    rid,
    st_value(
        st_mapalgebrafctngb(rast, 1, '32BF', 1, 1, 'st_stddev4ma(float[][],text,text[])':: ↩
            regprocedure, 'ignore', NULL), 2, 2
    )
FROM dummy_rast
WHERE rid = 2;
 rid |     st_value
-----+------------------
   2 | 1.30170822143555
(1 row)
```

⊠⊠

ST_MapAlgebraFctNgb, ST_MapAlgebra (callback function version), ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Distinct4ma, ST_StdDev4ma

11.13.9 ST_Sum4ma

ST_Sum4ma — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

float8 **ST_Sum4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Sum4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
⊠⊠ 2 ⊠⊠⊠, ⊠⊠⊠⊠ userargs ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ 1 ⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ 2 ⊠ ST_MapAlgebra (callback function version) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Warning**
> 2.1.0 ⊠⊠⊠⊠ ST_MapAlgebraFctNgb ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT
    rid,
    st_value(
        st_mapalgebrafctngb(rast, 1, '32BF', 1, 1, 'st_sum4ma(float[][],text,text[])':: ↩
            regprocedure, 'ignore', NULL), 2, 2
    )
FROM dummy_rast
WHERE rid = 2;
 rid | st_value
-----+----------
   2 |     2279
(1 row)
```

⊠⊠

ST_MapAlgebraFctNgb, ST_MapAlgebra (callback function version), ST_Min4ma, ST_Max4ma, ST_Mean4ma, ST_Range4ma, ST_Distinct4ma, ST_StdDev4ma

11.14 ⊠⊠⊠⊠⊠⊠⊠

11.14.1 ST_Aspect

ST_Aspect — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_Aspect**(raster rast, integer band=1, text pixeltype=32BF, text units=DEGREES, boolean interpolate_nodata=FALSE);
raster **ST_Aspect**(raster rast, integer band, raster customextent, text pixeltype=32BF, text units=DEGREES, boolean interpolate_nodata=FALSE);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

units ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. RADIANS, DEGREES(⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.

units = RADIANS ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠ 2π ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

units = DEGREES ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠⊠ 360 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠ 0 ⊠⊠⊠, ⊠⊠⊠⊠⊠ -1 ⊠⊠⊠.

> **Note**
> ⊠⊠ (slope), ⊠ (aspect), ⊠⊠⊠⊠ (hillshade) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ESRI - How hillshade works ⊠ ERDAS Field Guide - Aspect Images ⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_MapAlgebra() ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ interpolate_nodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠ 1

```
WITH foo AS (
    SELECT ST_SetValues(
        ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '32BF', 0, -9999),
        1, 1, 1, ARRAY[
            [1, 1, 1, 1, 1],
            [1, 2, 2, 2, 1],
            [1, 2, 3, 2, 1],
            [1, 2, 2, 2, 1],
            [1, 1, 1, 1, 1]
```

```
        ]::double precision[][]
    ) AS rast
)
SELECT
    ST_DumpValues(ST_Aspect(rast, 1, '32BF'))
FROM foo




-----------------------------------------------------------------------------------------------------------------------

----------------------------------
 (1,"{{315,341.565063476562,0,18.4349479675293,45},{288.434936523438,315,0,45,71.5650482177734},{270

2227,180,161.565048217773,135}}")
(1 row)
```

□□: □□ 2

□□□□□□□□□□□□□□□□□□. □□□□ PostgreSQL 9.1 □□□□□□□□□□□□□□.

```
WITH foo AS (
    SELECT ST_Tile(
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(6, 6, 0, 0, 1, -1, 0, 0, 0),
                1, '32BF', 0, -9999
            ),
            1, 1, 1, ARRAY[
                [1, 1, 1, 1, 1, 1],
                [1, 1, 1, 1, 2, 1],
                [1, 2, 2, 3, 3, 1],
                [1, 1, 3, 2, 1, 1],
                [1, 2, 2, 1, 2, 1],
                [1, 1, 1, 1, 1, 1]
            ]::double precision[]
        ),
        2, 2
    ) AS rast
)
SELECT
    t1.rast,
    ST_Aspect(ST_Union(t2.rast), 1, t1.rast)
FROM foo t1
CROSS JOIN foo t2
WHERE ST_Intersects(t1.rast, t2.rast)
GROUP BY t1.rast;
```

□□

ST_MapAlgebra (callback function version), ST_TRI, ST_TPI, ST_Roughness, ST_HillShade, ST_Slope

11.14.2 ST_HillShade

ST_HillShade — □□□□□□□, □□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

Synopsis

raster **ST_HillShade**(raster rast, integer band=1, text pixeltype=32BF, double precision azimuth=315, double precision altitude=45, double precision max_bright=255, double precision scale=1.0, boolean interpolate_nodata=FALSE);
raster **ST_HillShade**(raster rast, integer band, raster customextent, text pixeltype=32BF, double precision azimuth=315, double precision altitude=45, double precision max_bright=255, double precision scale=1.0, boolean interpolate_nodata=FALSE);

⊠⊠

⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠ 255 ⊠⊠⊠⊠⊠.

`azimuth` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0 ⊠⊠ 360 ⊠⊠⊠⊠⊠⊠⊠⊠.

`altitude` ⊠ 0 ⊠⊠⊠⊠⊠, 90 ⊠⊠⊠⊠ (天頂) ⊠ 0 ⊠⊠ 90 ⊠⊠⊠⊠⊠⊠⊠⊠.

`max_bright` ⊠ 0 ⊠⊠⊠⊠⊠⊠, 255 ⊠⊠⊠⊠⊠⊠ 0 ⊠ 255 ⊠⊠⊠⊠⊠⊠⊠.

`scale` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠: ⊠⊠⊠⊠⊠⊠ scale=370400, ⊠⊠: ⊠⊠⊠⊠⊠⊠ scale=111120 ⊠⊠⊠⊠⊠⊠⊠.

`interpolate_nodata` ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_InvDistWeight4ma ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, How hillshade works ⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_MapAlgebra() ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ `interpolate_nodata` ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠ 1

```
WITH foo AS (
    SELECT ST_SetValues(
        ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '32BF', 0, -9999),
        1, 1, 1, ARRAY[
            [1, 1, 1, 1, 1],
            [1, 2, 2, 2, 1],
            [1, 2, 3, 2, 1],
            [1, 2, 2, 2, 1],
            [1, 1, 1, 1, 1]
        ]::double precision[][]
    ) AS rast
)
SELECT
    ST_DumpValues(ST_Hillshade(rast, 1, '32BF'))
FROM foo
```

```
-----------------------------------------------------------------------------------------------------

-----------------------------------------------------------------------
 (1,"{{NULL,NULL,NULL,NULL,NULL},{NULL,251.32763671875,220.749786376953,147.224319458008, ↩
    NULL},{NULL,220.749786376953,180.312225341797,67.7497863769531,NULL},{NULL ↩
     ,147.224319458008
,67.7497863769531,43.1210060119629,NULL},{NULL,NULL,NULL,NULL,NULL}}")
(1 row)
```

⊠⊠: ⊠⊠ 2

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ PostgreSQL 9.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
WITH foo AS (
    SELECT ST_Tile(
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(6, 6, 0, 0, 1, -1, 0, 0, 0),
                1, '32BF', 0, -9999
            ),
            1, 1, 1, ARRAY[
                [1, 1, 1, 1, 1, 1],
                [1, 1, 1, 1, 2, 1],
                [1, 2, 2, 3, 3, 1],
                [1, 1, 3, 2, 1, 1],
                [1, 2, 2, 1, 2, 1],
                [1, 1, 1, 1, 1, 1]
            ]::double precision[]
        ),
        2, 2
    ) AS rast
)
SELECT
    t1.rast,
    ST_Hillshade(ST_Union(t2.rast), 1, t1.rast)
FROM foo t1
CROSS JOIN foo t2
WHERE ST_Intersects(t1.rast, t2.rast)
GROUP BY t1.rast;
```

⊠⊠

ST_MapAlgebra (callback function version), ST_TRI, ST_TPI, ST_Roughness, ST_Aspect, ST_Slope

11.14.3 ST_Roughness

ST_Roughness — DEM ⊠⊠⊠⊠" ⊠⊠⊠ (roughness)" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_Roughness**(raster rast, integer nband, raster customextent, text pixeltype="32BF" , boolean interpolate_nodata=FALSE);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ DEM ⊠” ⊠⊠⊠” ⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- needs examples
```

⊠⊠

ST_MapAlgebra (callback function version), ST_TRI, ST_TPI, ST_Slope, ST_HillShade, ST_Aspect

11.14.4 ST_Slope

ST_Slope — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_Slope**(raster rast, integer nband=1, text pixeltype=32BF, text units=DEGREES, double precision scale=1.0, boolean interpolate_nodata=FALSE);
raster **ST_Slope**(raster rast, integer nband, raster customextent, text pixeltype=32BF, text units=DEGREES, double precision scale=1.0, boolean interpolate_nodata=FALSE);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

units ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. RADIANS, DEGREES(⊠⊠⊠), PERCENT ⊠⊠⊠⊠⊠⊠⊠.

scale ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠: ⊠⊠⊠⊠⊠⊠ scale=370400, ⊠⊠: ⊠⊠⊠⊠⊠⊠ scale=111120 ⊠⊠⊠⊠⊠⊠⊠.

interpolate_nodata ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_InvDistWeight4ma ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠ (slope), ⊠ (aspect), ⊠⊠⊠⊠ (hillshade) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ESRI - How hillshade works ⊠ ERDAS Field Guide - Slope Images ⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_MapAlgebra() ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ units, scale, interpolate_nodata ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

□□: □□ 1

```
WITH foo AS (
    SELECT ST_SetValues(
        ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '32BF', 0, -9999),
        1, 1, 1, ARRAY[
            [1, 1, 1, 1, 1],
            [1, 2, 2, 2, 1],
            [1, 2, 3, 2, 1],
            [1, 2, 2, 2, 1],
            [1, 1, 1, 1, 1]
        ]::double precision[][]
    ) AS rast
)
SELECT
    ST_DumpValues(ST_Slope(rast, 1, '32BF'))
FROM foo

                            st_dumpvalues

----------------------------------------------------------------------------------------------------

----------------------------------------------------------------------------------------------------

---------------------------------------------------------------------
 (1,"{{10.0249881744385,21.5681285858154,26.5650520324707,21.5681285858154,10.0249881744385},{21.568

{26.5650520324707,36.8698959350586,0,36.8698959350586,26.5650520324707},{21.5681285858154,35.2643890

5681285858154,26.5650520324707,21.5681285858154,10.0249881744385}}")
(1 row)
```

□□: □□ 2

□□□□□□□□□□□□□□□□□. □□□□ PostgreSQL 9.1 □□□□□□□□□□□□□.

```
WITH foo AS (
    SELECT ST_Tile(
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(6, 6, 0, 0, 1, -1, 0, 0, 0),
                1, '32BF', 0, -9999
            ),
            1, 1, 1, ARRAY[
                [1, 1, 1, 1, 1, 1],
                [1, 1, 1, 1, 2, 1],
                [1, 2, 2, 3, 3, 1],
                [1, 1, 3, 2, 1, 1],
                [1, 2, 2, 1, 2, 1],
                [1, 1, 1, 1, 1, 1]
            ]::double precision[]
        ),
        2, 2
    ) AS rast
)
SELECT
    t1.rast,
    ST_Slope(ST_Union(t2.rast), 1, t1.rast)
FROM foo t1
CROSS JOIN foo t2
```

```
WHERE ST_Intersects(t1.rast, t2.rast)
GROUP BY t1.rast;
```

⊠⊠

ST_MapAlgebra (callback function version), ST_TRI, ST_TPI, ST_Roughness, ST_HillShade, ST_Aspect

11.14.5 ST_TPI

ST_TPI — ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Topographic Position Index) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_TPI**(raster rast, integer nband, raster customextent, text pixeltype="32BF" , boolean interpolate_nodata=FALSE);

⊠⊠

Calculates the Topographic Position Index, which is defined as the focal mean with radius of one minus the center cell.

> **Note**
> ⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠ (focalmean radius of one) ⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- needs examples
```

⊠⊠

ST_MapAlgebra (callback function version), ST_TRI, ST_Roughness, ST_Slope, ST_HillShade, ST_Aspect

11.14.6 ST_TRI

ST_TRI — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Terrain Ruggedness Index) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

raster **ST_TRI**(raster rast, integer nband, raster customextent, text pixeltype="32BF" , boolean interpolate_nodata=FALSE);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Terrain Ruggedness Index) ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠ (focalmean radius of one) ⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- needs examples
```

⊠⊠

ST_MapAlgebra (callback function version), ST_Roughness, ST_TPI, ST_Slope, ST_HillShade, ST_Aspect

11.15 ⊠⊠⊠⊠⊠⊠⊠⊠

11.15.1 Box3D

Box3D — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ BOX3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

box3d **Box3D**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ((MINX, MINY), (MAXX, MAXY)) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ BOX3D ⊠⊠ BOX2D ⊠⊠⊠⊠⊠⊠⊠. BOX2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, 2.0.0 ⊠⊠⊠⊠ BOX3D ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT
    rid,
    Box3D(rast) AS rastbox
FROM dummy_rast;

rid |        rastbox
----+-------------------------------------------------
1   | BOX3D(0.5 0.5 0,20.5 60.5 0)
2   | BOX3D(3427927.75 5793243.5 0,3427928 5793244 0)
```

⊠⊠

ST_Envelope

11.15.2 ST_ConvexHull

ST_ConvexHull — BandNoDataValue ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Envelope ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_ConvexHull**(raster rast);

⊠⊠

NoDataBandValue ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠, ST_Envelope ⊠⊠.

> **Note**
> ST_Envelope ⊠⊠⊠⊠⊠⊠⊠⊠ (floor) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ ST_ConvexHull ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS Raster Specification ⊠⊠⊠⊠⊠⊠⊠.

```
-- Note envelope and convexhull are more or less the same
SELECT ST_AsText(ST_ConvexHull(rast)) As convhull,
    ST_AsText(ST_Envelope(rast)) As env
FROM dummy_rast WHERE rid=1;

                        convhull                        |                env
--------------------------------------------------------+------------------------------------

 POLYGON((0.5 0.5,20.5 0.5,20.5 60.5,0.5 60.5,0.5 0.5)) | POLYGON((0 0,20 0,20 60,0 60,0 0))
```

```
-- now we skew the raster
-- note how the convex hull and envelope are now different
SELECT ST_AsText(ST_ConvexHull(rast)) As convhull,
    ST_AsText(ST_Envelope(rast)) As env
FROM (SELECT ST_SetRotation(rast, 0.1, 0.1) As rast
    FROM dummy_rast WHERE rid=1) As foo;

                        convhull                        |                env
--------------------------------------------------------+------------------------------------

 POLYGON((0.5 0.5,20.5 1.5,22.5 61.5,2.5 60.5,0.5 0.5)) | POLYGON((0 0,22 0,22 61,0 61,0 0))
```

⊠⊠

ST_Envelope, ST_MinConvexHull, ST_ConvexHull, ST_AsText

11.15.3 ST_DumpAsPolygons

ST_DumpAsPolygons — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ geomval(geom, val) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.

Synopsis

setof geomval **ST_DumpAsPolygons**(raster rast, integer band_num=1, boolean exclude_nodata_value=TRU

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRF; Set-Returning Function) ⊠⊠⊠. ⊠⊠ (geom) ⊠⊠⊠⊠⊠⊠ (val) ⊠⊠⊠⊠⊠⊠ geomval ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ val ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

ST_DumpAsPolygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GROUP BY ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Changed 3.3.0, validation and fixing is disabled to improve performance. May result invalid geometries.

GDAL 1.7 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> If there is a no data value set for a band, pixels with that value will not be returned except in the case of exclude_nodata_value=false.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_ValueCount ⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_PixelAsPolygons ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- this syntax requires PostgreSQL 9.3+
SELECT val, ST_AsText(geom) As geomwkt
FROM (
SELECT dp.*
FROM dummy_rast, LATERAL ST_DumpAsPolygons(rast) AS dp
WHERE rid = 2
) As foo
WHERE val BETWEEN 249 and 251
```

```
ORDER BY val;

 val |                                                         geomwkt
-----+--------------------------------------------------------------------------
 249 | POLYGON((3427927.95 5793243.95,3427927.95 5793243.85,3427928 5793243.85,
        3427928 5793243.95,3427927.95 5793243.95))
 250 | POLYGON((3427927.75 5793243.9,3427927.75 5793243.85,3427927.8 5793243.85,
        3427927.8 5793243.9,3427927.75 5793243.9))
 250 | POLYGON((3427927.8 5793243.8,3427927.8 5793243.75,3427927.85 5793243.75,
        3427927.85 5793243.8, 3427927.8 5793243.8))
 251 | POLYGON((3427927.75 5793243.85,3427927.75 5793243.8,3427927.8 5793243.8,
        3427927.8 5793243.85,3427927.75 5793243.85))
```

⊠⊠

geomval, ST_Value, ST_Polygon, ST_ValueCount

11.15.4 ST_Envelope

ST_Envelope — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Envelope**(raster rast);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ float8 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ((MINX, MINY), (MINX, MAXY), (MAXX, MAXY), (MAXX, MINY), (MINX, MINY)).

⊠⊠

```
SELECT rid, ST_AsText(ST_Envelope(rast)) As envgeomwkt
FROM dummy_rast;

 rid |                                         envgeomwkt
-----+--------------------------------------------------------------------
   1 | POLYGON((0 0,20 0,20 60,0 60,0 0))
   2 | POLYGON((3427927 5793243,3427928 5793243,
        3427928 5793244,3427927 5793244, 3427927 5793243))
```

⊠⊠

ST_Envelope, ST_AsText, ST_SRID

11.15.5 ST_MinConvexHull

ST_MinConvexHull — ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_MinConvexHull**(raster rast, integer nband=NULL);

□□

□□□□ NODATA □□□□□□□□□□□□□□□□□□□□□. nband □ NULL □□□, □□□□□□□□□□□□□□□.

2.1.0 □□□□□□□□□□□□□.

□□

```
WITH foo AS (
    SELECT
        ST_SetValues(
            ST_SetValues(
                ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(9, 9, 0, 0, 1, -1, 0, 0, 0), 1, '8 ↩
                    BUI', 0, 0), 2, '8BUI', 1, 0),
                1, 1, 1,
                ARRAY[
                    [0, 0, 0, 0, 0, 0, 0, 0, 0],
                    [0, 0, 0, 0, 0, 0, 0, 0, 0],
                    [0, 0, 0, 0, 0, 0, 0, 0, 0],
                    [0, 0, 0, 1, 0, 0, 0, 0, 1],
                    [0, 0, 0, 1, 1, 0, 0, 0, 0],
                    [0, 0, 0, 1, 0, 0, 0, 0, 0],
                    [0, 0, 0, 0, 0, 0, 0, 0, 0],
                    [0, 0, 0, 0, 0, 0, 0, 0, 0],
                    [0, 0, 0, 0, 0, 0, 0, 0, 0]
                ]::double precision[][]
            ),
            2, 1, 1,
            ARRAY[
                [0, 0, 0, 0, 0, 0, 0, 0, 0],
                [0, 0, 0, 0, 0, 0, 0, 0, 0],
                [0, 0, 0, 0, 0, 0, 0, 0, 0],
                [1, 0, 0, 0, 0, 1, 0, 0, 0],
                [0, 0, 0, 0, 1, 1, 0, 0, 0],
                [0, 0, 0, 0, 0, 1, 0, 0, 0],
                [0, 0, 0, 0, 0, 0, 0, 0, 0],
                [0, 0, 0, 0, 0, 0, 0, 0, 0],
                [0, 0, 1, 0, 0, 0, 0, 0, 0]
            ]::double precision[][]
        ) AS rast
)
SELECT
    ST_AsText(ST_ConvexHull(rast)) AS hull,
    ST_AsText(ST_MinConvexHull(rast)) AS mhull,
    ST_AsText(ST_MinConvexHull(rast, 1)) AS mhull_1,
    ST_AsText(ST_MinConvexHull(rast, 2)) AS mhull_2
FROM foo

               hull               |                mhull                 |                ↩
                   mhull_1                |                mhull_2
----------------------------------+-------------------------------------+-------------------------

 POLYGON((0 0,9 0,9 -9,0 -9,0 0)) | POLYGON((0 -3,9 -3,9 -9,0 -9,0 -3)) | POLYGON((3 -3,9  ↩
    -3,9 -6,3 -6,3 -3)) | POLYGON((0 -3,6 -3,6 -9,0 -9,0 -3))
```

⊠⊠

ST_Envelope, ST_ConvexHull, ST_ConvexHull, ST_AsText

11.15.6 ST_Polygon

ST_Polygon — NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

geometry **ST_Polygon**(raster rast, integer band_num=1);

⊠⊠

Changed 3.3.0, validation and fixing is disabled to improve performance. May result invalid geometries.

0.1.6 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.7 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠ C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- by default no data band value is 0 or not set, so polygon will return a square polygon
SELECT ST_AsText(ST_Polygon(rast)) As geomwkt
FROM dummy_rast
WHERE rid = 2;

geomwkt
--------------------------------------------
MULTIPOLYGON(((3427927.75 5793244,3427928 5793244,3427928 5793243.75,3427927.75 ↩
    5793243.75,3427927.75 5793244)))


-- now we change the no data value of first band
UPDATE dummy_rast SET rast = ST_SetBandNoDataValue(rast,1,254)
WHERE rid = 2;
SELECt rid, ST_BandNoDataValue(rast)
from dummy_rast where rid = 2;

-- ST_Polygon excludes the pixel value 254 and returns a multipolygon
SELECT ST_AsText(ST_Polygon(rast)) As geomwkt
FROM dummy_rast
WHERE rid = 2;

geomwkt
---------------------------------------------------------
MULTIPOLYGON(((3427927.9 5793243.95,3427927.85 5793243.95,3427927.85 5793244,3427927.9 ↩
    5793244,3427927.9 5793243.95)),((3427928 5793243.85,3427928 5793243.8,3427927.95 ↩
    5793243.8,3427927.95 5793243.85,3427927.9 5793243.85,3427927.9 5793243.9,3427927.9 ↩
    5793243.95,3427927.95 5793243.95,3427928 5793243.95,3427928 5793243.85)),((3427927.8 ↩
    5793243.75,3427927.75 5793243.75,3427927.75 5793243.8,3427927.75 5793243.85,3427927.75 ↩
    5793243.9,3427927.75 5793244,3427927.8 5793244,3427927.8 5793243.9,3427927.8 ↩
    5793243.85,3427927.85 5793243.85,3427927.85 5793243.8,3427927.85 5793243.75,3427927.8 ↩
    5793243.75)))
```

```
-- Or if you want the no data value different for just one time

SELECT ST_AsText(
    ST_Polygon(
        ST_SetBandNoDataValue(rast,1,252)
        )
    ) As geomwkt
FROM dummy_rast
WHERE rid =2;

geomwkt
---------------------------------
MULTIPOLYGON(((3427928 5793243.85,3427928 5793243.8,3427928 5793243.75,3427927.85 ↩
    5793243.75,3427927.8 5793243.75,3427927.8 5793243.8,3427927.75 5793243.8,3427927.75 ↩
    5793243.85,3427927.75 5793243.9,3427927.75 5793244,3427927.8 5793244,3427927.85 ↩
    5793244,3427927.9 5793244,3427928 5793244,3427928 5793243.95,3427928 5793243.85) ↩
    ,(3427927.9 5793243.9,3427927.9 5793243.85,3427927.95 5793243.85,3427927.95 ↩
    5793243.9,3427927.9 5793243.9)))
```

⊠⊠

ST_Value, ST_DumpAsPolygons

11.16 ⊠⊠⊠⊠⊠⊠⊠

11.16.1 &&

&& — A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠.

Synopsis

boolean **&&**(raster A , raster B);
boolean **&&**(raster A , geometry B);
boolean **&&**(geometry B , raster A);

⊠⊠

&& ⊠⊠⊠⊠⊠⊠⊠/⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT A.rid As a_rid, B.rid As b_rid, A.rast && B.rast As intersect
 FROM dummy_rast AS A CROSS JOIN dummy_rast AS B LIMIT 3;

 a_rid | b_rid | intersect
-------+-------+---------
     2 |     2 | t
     2 |     3 | f
     2 |     1 | f
```

11.16.2 &<

&< — A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **&<**(raster A , raster B);

⊠⊠

&< ⊠⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT A.rid As a_rid, B.rid As b_rid, A.rast &< B.rast As overleft
 FROM dummy_rast AS A CROSS JOIN dummy_rast AS B;

a_rid | b_rid | overleft
------+-------+----------
    2 |     2 | t
    2 |     3 | f
    2 |     1 | f
    3 |     2 | t
    3 |     3 | t
    3 |     1 | f
    1 |     2 | t
    1 |     3 | t
    1 |     1 | t
```

11.16.3 &>

&> — A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **&>**(raster A , raster B);

□□

&> □□□□□□□□ A □□□□□□□□□□ B □□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□ B □□□□□□□□□□□□□□□□□□□□□□□□, TRUE □□□□□□□.

> **Note**
> □□□□□□ (operand) □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

□□

```
SELECT A.rid As a_rid, B.rid As b_rid, A.rast &
> B.rast As overright
 FROM dummy_rast AS A CROSS JOIN dummy_rast AS B;

 a_rid | b_rid | overright
-------+-------+----------
     2 |     2 | t
     2 |     3 | t
     2 |     1 | t
     3 |     2 | f
     3 |     3 | t
     3 |     1 | f
     1 |     2 | f
     1 |     3 | t
     1 |     1 | t
```

11.16.4 =

= — A □□□□□□□ B □□□□□□□□□□□□□ TRUE □□□□□□□. □□□□□□□□□□□□□□□□□□□□.

Synopsis

boolean **=**(raster A , raster B);

□□

= □□□□□□□□ A □□□□□□□□□□ B □□□□□□□□□□□□□ TRUE □□□□□□□. PostgreSQL □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ =, <, □ > □□□□□□□□□□□ (□: GROUP BY □□ ORDER BY □□□).

> **Caution**
> □□□□□□ (operand) □□□. □□ ~= □□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□ (group by) □□□□□□□.

2.1.0 □□□□□□□□□□□□□□.

⊠⊠

~=

11.16.5 @

@ — B ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **@**(raster A , raster B);
boolean **@**(geometry A , raster B);
boolean **@**(raster B , geometry A);

⊠⊠

@ ⊠⊠⊠⊠⊠⊠⊠/⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠ raster @ raster, raster @ geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.5 ⊠⊠⊠⊠ geometry @ raster ⊠⊠⊠⊠⊠⊠.

⊠⊠

~

11.16.6 ~=

~= — A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **~=**(raster A , raster B);

⊠⊠

~= ⊠⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.

```
SELECT ST_AddBand(prec.rast, alt.rast) As new_rast
    FROM prec INNER JOIN alt ON (prec.rast ~= alt.rast);
```

⊠⊠

ST_AddBand, =

11.16.7 ~

~ — A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **~**(raster A , raster B);
boolean **~**(geometry A , raster B);
boolean **~**(raster B , geometry A);

⊠⊠

~ ⊠⊠⊠⊠⊠⊠⊠/⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

@

11.17 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

11.17.1 ST_Contains

ST_Contains — ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_Contains**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Contains**(raster rastA , raster rastB);

⊠⊠

⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (NODATA ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Contains(ST_Polygon(raster), geometry) ⊠⊠ ST_Contains(geometry, ST_Polygon(raster)) ⊠⊠⊠⊠⊠⊠⊠ ST_Polygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ST_Contains() ⊠ ST_Within() ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠, ST_Contains(rastA, rastB) ⊠⊠⊠⊠ ST_Within(rastB, rastA) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- specified band numbers
SELECT r1.rid, r2.rid, ST_Contains(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS JOIN ↩
    dummy_rast r2 WHERE r1.rid = 1;

NOTICE:  The first raster provided has no bands
 rid | rid | st_contains
-----+-----+-------------
   1 |   1 |
   1 |   2 | f
```

```
-- no band numbers specified
SELECT r1.rid, r2.rid, ST_Contains(r1.rast, r2.rast) FROM dummy_rast r1 CROSS JOIN ↩
    dummy_rast r2 WHERE r1.rid = 1;
 rid | rid | st_contains
-----+-----+-------------
   1 |   1 | t
   1 |   2 | f
```

⊠⊠

ST_Intersects, ST_Within

11.17.2 ST_ContainsProperly

ST_ContainsProperly — rastB ⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_ContainsProperly**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_ContainsProperly**(raster rastA , raster rastB);

⊠⊠

⊠⊠⊠ rastB ⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (NODATA ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_ContainsProperly(ST_Polygon(raster), geometry) ⊠⊠ ST_ContainsProperly(geometry, ST_Polygon(raster)) ⊠⊠⊠⊠⊠⊠⊠ ST_Polygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT r1.rid, r2.rid, ST_ContainsProperly(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS ↩
    JOIN dummy_rast r2 WHERE r1.rid = 2;

 rid | rid | st_containsproperly
-----+-----+---------------------
   2 |   1 | f
   2 |   2 | f
```

⊠⊠

ST_Intersects, ST_Contains

11.17.3 ST_Covers

ST_Covers — ⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_Covers**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Covers**(raster rastA , raster rastB);

⊠⊠

⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠ rastA ⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠ (NODATA ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Covers(ST_Polygon(raster), geometry) ⊠⊠ ST_Covers(geometry, ST_Polygon(raster)) ⊠⊠⊠⊠⊠⊠ ST_Polygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT r1.rid, r2.rid, ST_Covers(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS JOIN ↩
    dummy_rast r2 WHERE r1.rid = 2;

 rid | rid | st_covers
-----+-----+-----------
   2 |   1 | f
   2 |   2 | t
```

⊠⊠

ST_Intersects, ST_CoveredBy

11.17.4 ST_CoveredBy

ST_CoveredBy — ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_CoveredBy**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_CoveredBy**(raster rastA , raster rastB);

⊠⊠

⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠ rastA ⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠ (NODATA ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Note
☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ST_CoveredBy(ST_Polygon(raster), geometry) ☒☒ ST_CoveredBy(geometry, ST_Polygon(raster)) ☒☒☒☒☒☒ ST_Polygon ☒☒☒☒☒☒☒☒☒.

2.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
SELECT r1.rid, r2.rid, ST_CoveredBy(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS JOIN ↩
    dummy_rast r2 WHERE r1.rid = 2;

 rid | rid | st_coveredby
-----+-----+--------------
   2 |   1 | f
   2 |   2 | t
```

☒☒

ST_Intersects, ST_Covers

11.17.5 ST_Disjoint

ST_Disjoint — ☒☒☒ rastA ☒☒☒☒ rastB ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

boolean **ST_Disjoint**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Disjoint**(raster rastA , raster rastB);

☒☒

☒☒☒ rastA ☒☒☒☒ rastB ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ rastA ☒ rastB ☒☒☒☒☒☒☒☒☒. ☒☒☒☒ ☒☒☒☒☒☒☒☒☒☒ NULL ☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒ (NODATA ☒☒☒) ☒☒☒☒☒☒☒☒☒.

Note
☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Disjoint(ST_Polygon(raster), geometry) ⊠⊠⊠⊠⊠⊠ ST_Polygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- rid = 1 has no bands, hence the NOTICE and the NULL value for st_disjoint
SELECT r1.rid, r2.rid, ST_Disjoint(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS JOIN ↩
    dummy_rast r2 WHERE r1.rid = 2;

NOTICE:  The second raster provided has no bands
 rid | rid | st_disjoint
-----+-----+-------------
   2 |   1 |
   2 |   2 | f
```

```
-- this time, without specifying band numbers
SELECT r1.rid, r2.rid, ST_Disjoint(r1.rast, r2.rast) FROM dummy_rast r1 CROSS JOIN ↩
    dummy_rast r2 WHERE r1.rid = 2;

 rid | rid | st_disjoint
-----+-----+-------------
   2 |   1 | t
   2 |   2 | f
```

⊠⊠

ST_Intersects

11.17.6 ST_Intersects

ST_Intersects — ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_Intersects**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Intersects**(raster rastA , raster rastB);
boolean **ST_Intersects**(raster rast , integer nband , geometry geommin);
boolean **ST_Intersects**(raster rast , geometry geommin , integer nband=NULL);
boolean **ST_Intersects**(geometry geommin , raster rast , integer nband=NULL);

⊠⊠

⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (NODATA ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒/☒☒☒☒☒☒☒☒☒☒☒.

Warning
☒☒☒☒: 2.1.0 ☒☒☒☒ ST_Intersects(geometry, raster) ☒☒☒☒☒☒☒☒☒☒☒ ST_Intersects(raster, geometry) ☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
-- different bands of same raster
SELECT ST_Intersects(rast, 2, rast, 3) FROM dummy_rast WHERE rid = 2;

 st_intersects
---------------
 t
```

☒☒

ST_Intersection, ST_Disjoint

11.17.7 ST_Overlaps

ST_Overlaps — ☒☒☒ rastA ☒☒☒☒ rastB ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

boolean **ST_Overlaps**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Overlaps**(raster rastA , raster rastB);

☒☒

☒☒☒ rastA ☒☒☒☒ rastB ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒ rastA ☒ rastB ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ NULL ☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒ (NODATA ☒☒☒) ☒☒☒☒☒☒☒☒☒.

Note
☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Note
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Overlaps(ST_Polygon(raster), geometry) ⊠⊠⊠⊠⊠⊠ ST_Polygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
-- comparing different bands of same raster
SELECT ST_Overlaps(rast, 1, rast, 2) FROM dummy_rast WHERE rid = 2;

 st_overlaps
-------------
 f
```

⊠⊠

ST_Intersects

11.17.8 ST_Touches

ST_Touches — ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_Touches**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Touches**(raster rastA , raster rastB);

⊠⊠

⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠ ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (NODATA ⊠⊠⊠) ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Touches(ST_Polygon(raster), geometry) ⊠⊠⊠⊠⊠⊠ ST_Polygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT r1.rid, r2.rid, ST_Touches(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS JOIN ↩
    dummy_rast r2 WHERE r1.rid = 2;

 rid | rid | st_touches
-----+-----+------------
   2 |   1 | f
   2 |   2 | f
```

⊠⊠

ST_Intersects

11.17.9 ST_SameAlignment

ST_SameAlignment — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_SameAlignment**(raster rastA , raster rastB);
boolean **ST_SameAlignment**(double precision ulx1 , double precision uly1 , double precision scalex1 , double precision scaley1 , double precision skewx1 , double precision skewy1 , double precision ulx2 , double precision uly2 , double precision scalex2 , double precision scaley2 , double precision skewx2 , double precision skewy2);
boolean **ST_SameAlignment**(raster set rastfield);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠ 1, 2): (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠⊠, SRID ⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 4 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (NOTICE) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠ (⊠⊠ 3): ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_SameAlignment(⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠” ⊠⊠ (aggregate)” ⊠⊠⊠⊠⊠. ⊠ SUM() ⊠ AVG() ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠

```
SELECT ST_SameAlignment(
    ST_MakeEmptyRaster(1, 1, 0, 0, 1, 1, 0, 0),
    ST_MakeEmptyRaster(1, 1, 0, 0, 1, 1, 0, 0)
) as sm;

sm
----
t
```

```
SELECT ST_SameAlignment(A.rast,b.rast)
 FROM dummy_rast AS A CROSS JOIN dummy_rast AS B;

 NOTICE:  The two rasters provided have different SRIDs
NOTICE:  The two rasters provided have different SRIDs
 st_samealignment
------------------
 t
 f
 f
 f
```

⊠⊠

Section 10.1, ST_NotSameAlignmentReason, ST_MakeEmptyRaster

11.17.10 ST_NotSameAlignmentReason

ST_NotSameAlignmentReason — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **ST_NotSameAlignmentReason**(raster rastA, raster rastB);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠ ⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT
    ST_SameAlignment(
        ST_MakeEmptyRaster(1, 1, 0, 0, 1, 1, 0, 0),
        ST_MakeEmptyRaster(1, 1, 0, 0, 1.1, 1.1, 0, 0)
    ),
    ST_NotSameAlignmentReason(
        ST_MakeEmptyRaster(1, 1, 0, 0, 1, 1, 0, 0),
        ST_MakeEmptyRaster(1, 1, 0, 0, 1.1, 1.1, 0, 0)
    )
;

 st_samealignment |            st_notsamealignmentreason
------------------+-------------------------------------------------
 f                | The rasters have different scales on the X axis
(1 row)
```

⊠⊠

Section 10.1, ST_SameAlignment

11.17.11 ST_Within

ST_Within — ⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_Within**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Within**(raster rastA , raster rastB);

⊠⊠

⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (NODATA ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Within(ST_Polygon(raster), geometry) ⊠⊠ ST_Within(geometry, ST_Polygon(raster)) ⊠⊠⊠⊠⊠⊠ ST_Polygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ST_Within() ⊠ ST_Contains() ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠, ST_Within(rastA, rastB) ⊠⊠⊠⊠ ST_Contains(rastB, rastA) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT r1.rid, r2.rid, ST_Within(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS JOIN ↩
    dummy_rast r2 WHERE r1.rid = 2;

 rid | rid | st_within
-----+-----+-----------
   2 |   1 | f
   2 |   2 | t
```

⊠⊠

ST_Intersects, ST_Contains, ST_DWithin, ST_DFullyWithin

11.17.12 ST_DWithin

ST_DWithin — ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_DWithin**(raster rastA , integer nbandA , raster rastB , integer nbandB , double precision distance_of_srid);
boolean **ST_DWithin**(raster rastA , raster rastB , double precision distance_of_srid);

⊠⊠

⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (NODATA ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_DWithin(ST_Polygon(raster), geometry) ⊠⊠⊠⊠⊠⊠ ST_Polygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT r1.rid, r2.rid, ST_DWithin(r1.rast, 1, r2.rast, 1, 3.14) FROM dummy_rast r1 CROSS ↩
    JOIN dummy_rast r2 WHERE r1.rid = 2;

 rid | rid | st_dwithin
-----+-----+------------
   2 |   1 | f
   2 |   2 | t
```

⊠⊠

ST_Within, ST_DFullyWithin

11.17.13 ST_DFullyWithin

ST_DFullyWithin — ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

boolean **ST_DFullyWithin**(raster rastA , integer nbandA , raster rastB , integer nbandB , double precision distance_of_srid);
boolean **ST_DFullyWithin**(raster rastA , raster rastB , double precision distance_of_srid);

⊠⊠

⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (NODATA ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠ (operand) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_DFullyWithin(ST_Polygon(raster), geometry) ⊠⊠⊠⊠⊠⊠ ST_Polygon ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT r1.rid, r2.rid, ST_DFullyWithin(r1.rast, 1, r2.rast, 1, 3.14) FROM dummy_rast r1 ↩
    CROSS JOIN dummy_rast r2 WHERE r1.rid = 2;

 rid | rid | st_dfullywithin
-----+-----+-----------------
   2 |   1 | f
   2 |   2 | t
```

⊠⊠

ST_Within, ST_DWithin

11.18 Raster Tips

11.18.1 Out-DB Rasters

11.18.1.1 Directory containing many files

When GDAL opens a file, GDAL eagerly scans the directory of that file to build a catalog of other files. If this directory contains many files (e.g. thousands, millions), opening that file becomes extremely slow (especially if that file happens to be on a network drive such as NFS).

To control this behavior, GDAL provides the following environment variable: GDAL_DISABLE_READDIR_ON_ Set `GDAL_DISABLE_READDIR_ON_OPEN` to `TRUE` to disable directory scanning.

In Ubuntu (and assuming you are using PostgreSQL's packages for Ubuntu), `GDAL_DISABLE_READDIR_ON_OPE` can be set in */etc/postgresql/POSTGRESQL_VERSION/CLUSTER_NAME/environment* (where POSTGRESQL_VERSION is the version of PostgreSQL, e.g. 9.6 and CLUSTER_NAME is the name of the cluster, e.g. maindb). You can also set PostGIS environment variables here as well.

```
# environment variables for postmaster process
# This file has the same syntax as postgresql.conf:
#  VARIABLE = simple_value
#  VARIABLE2 = 'any value!'
# I. e. you need to enclose any value which does not only consist of letters,
# numbers, and '-', '_', '.' in single quotes. Shell commands are not
# evaluated.
POSTGIS_GDAL_ENABLED_DRIVERS = 'ENABLE_ALL'

POSTGIS_ENABLE_OUTDB_RASTERS = 1

GDAL_DISABLE_READDIR_ON_OPEN = 'TRUE'
```

11.18.1.2 Maximum Number of Open Files

The maximum number of open files permitted by Linux and PostgreSQL are typically conservative (typically 1024 open files per process) given the assumption that the system is consumed by human users. For Out-DB Rasters, a single valid query can easily exceed this limit (e.g. a dataset of 10 year's worth of rasters with one raster for each day containing minimum and maximum temperatures and we want to know the absolute min and max value for a pixel in that dataset).

The easiest change to make is the following PostgreSQL setting: max_files_per_process. The default is set to 1000, which is far too low for Out-DB Rasters. A safe starting value could be 65536 but this really depends on your datasets and the queries run against those datasets. This setting can only be made on server start and probably only in the PostgreSQL configuration file (e.g. */etc/postgresql/-POSTGRESQL_VERSION/CLUSTER_NAME/postgresql.conf* in Ubuntu environments).

```
...
# - Kernel Resource Usage -

max_files_per_process = 65536           # min 25
                                        # (change requires restart)
...
```

The major change to make is the Linux kernel's open files limits. There are two parts to this:

- Maximum number of open files for the entire system
- Maximum number of open files per process

11.18.1.2.1 Maximum number of open files for the entire system

You can inspect the current maximum number of open files for the entire system with the following example:

```
$ sysctl -a | grep fs.file-max
fs.file-max = 131072
```

If the value returned is not large enough, add a file to */etc/sysctl.d/* as per the following example:

```
$ echo "fs.file-max = 6145324" >> /etc/sysctl.d/fs.conf

$ cat /etc/sysctl.d/fs.conf
fs.file-max = 6145324

$ sysctl -p --system
* Applying /etc/sysctl.d/fs.conf ...
fs.file-max = 2097152
* Applying /etc/sysctl.conf ...

$ sysctl -a | grep fs.file-max
fs.file-max = 6145324
```

11.18.1.2.2 Maximum number of open files per process

We need to increase the maximum number of open files per process for the PostgreSQL server processes.

To see what the current PostgreSQL service processes are using for maximum number of open files, do as per the following example (make sure to have PostgreSQL running):

```
$ ps aux | grep postgres
postgres 31713  0.0  0.4 179012 17564 pts/0    S    Dec26   0:03 /home/dustymugs/devel/ ↩
    postgresql/sandbox/10/usr/local/bin/postgres -D /home/dustymugs/devel/postgresql/sandbox ↩
    /10/pgdata
postgres 31716  0.0  0.8 179776 33632 ?        Ss   Dec26   0:01 postgres: checkpointer  ↩
    process
postgres 31717  0.0  0.2 179144  9416 ?        Ss   Dec26   0:05 postgres: writer process
postgres 31718  0.0  0.2 179012  8708 ?        Ss   Dec26   0:06 postgres: wal writer  ↩
    process
postgres 31719  0.0  0.1 179568  7252 ?        Ss   Dec26   0:03 postgres: autovacuum  ↩
    launcher process
postgres 31720  0.0  0.1  34228  4124 ?        Ss   Dec26   0:09 postgres: stats collector  ↩
    process
postgres 31721  0.0  0.1 179308  6052 ?        Ss   Dec26   0:00 postgres: bgworker:  ↩
    logical replication launcher

$ cat /proc/31718/limits
Limit                     Soft Limit           Hard Limit           Units
Max cpu time              unlimited            unlimited            seconds
Max file size             unlimited            unlimited            bytes
Max data size             unlimited            unlimited            bytes
Max stack size            8388608              unlimited            bytes
Max core file size        0                    unlimited            bytes
Max resident set          unlimited            unlimited            bytes
Max processes             15738                15738                processes
Max open files            1024                 4096                 files
Max locked memory         65536                65536                bytes
Max address space         unlimited            unlimited            bytes
Max file locks            unlimited            unlimited            locks
Max pending signals       15738                15738                signals
```

```
Max msgqueue size         819200               819200               bytes
Max nice priority         0                    0
Max realtime priority     0                    0
Max realtime timeout      unlimited            unlimited            us
```

In the example above, we inspected the open files limit for Process 31718. It doesn't matter which PostgreSQL process, any of them will do. The response we are interested in is *Max open files*.

We want to increase *Soft Limit* and *Hard Limit* of *Max open files* to be greater than the value we specified for the PostgreSQL setting `max_files_per_process`. In our example, we set `max_files_per_process` to 65536.

In Ubuntu (and assuming you are using PostgreSQL's packages for Ubuntu), the easiest way to change the *Soft Limit* and *Hard Limit* is to edit **/etc/init.d/postgresql** (SysV) or **/lib/systemd/system/postgresql*.service** (systemd).

Let's first address the SysV Ubuntu case where we add **ulimit -H -n 262144** and **ulimit -n 131072** to **/etc/init.d/postgresql**.

```
...
case ”$1” in
    start|stop|restart|reload)
        if [ ”$1” = ”start” ]; then
            create_socket_directory
        fi
    if [ -z ”`pg_lsclusters -h`” ]; then
        log_warning_msg 'No PostgreSQL clusters exist; see ”man pg_createcluster”'
        exit 0
    fi

    ulimit -H -n 262144
    ulimit -n 131072

    for v in $versions; do
        $1 $v || EXIT=$?
    done
    exit ${EXIT:-0}
        ;;
    status)
...
```

Now to address the systemd Ubuntu case. We will add **LimitNOFILE=131072** to every **/lib/systemd/system/postgresql*.service** file in the **[Service]** section.

```
...
[Service]

LimitNOFILE=131072

...

[Install]
WantedBy=multi-user.target
...
```

After making the necessary systemd changes, make sure to reload the daemon

```
systemctl daemon-reload
```

Chapter 12

PostGIS Extras

This chapter documents features found in the extras folder of the PostGIS source tarballs and source repository. These are not always packaged with PostGIS binary releases, but are usually PL/pgSQL based or standard shell scripts that can be run as is.

12.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠ PAGC standardizer ⊠⊠⊠⊠ (fork) ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠ PAGC PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠).

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ (lexicon; lex) ⊠⊠⊠ ⊠ ⊠⊠⊠⊠ (gazetteer; gaz) ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

`CREATE EXTENSION address_standardizer;` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `address_standardizer` ⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `address_standardizer` ⊠⊠⊠⊠⊠⊠⊠⊠⊠, `address_standardizer_data_us` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `CREATE EXTENSION address_standardizer_data_us;` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

PostGIS `extensions/address_standardizer` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Section 2.3 ⊠⊠⊠⊠⊠⊠⊠.

12.1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠/⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (macro) ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (micro) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠/⊠⊠⊠ (zip code) ⊠ (Perl) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ parseaddress-api.c ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠/⊠ ⊠ (Perl) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ parseaddress-api.c ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠"includes" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

12.1.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

12.1.2.1 stdaddr

stdaddr — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `standardize_address` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. standardize_address ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PAGC Postal Attributes ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

rules table ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

This method needs address_standardizer extension.

building ⊠⊠⊠ (⊠⊠⊠⊠ 0) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

house_num ⊠⊠⊠ (⊠⊠⊠⊠ 1) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: `75 State Street` ⊠ *75* ⊠⊠

predir ⊠⊠⊠ (⊠⊠⊠⊠ 2) ⊠⊠⊠: North, South, East, West ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (STREET NAME PRE-DIRECTIONAL) ⊠⊠⊠.

qual ⊠⊠⊠ (⊠⊠⊠⊠ 3) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠ (STREET NAME PRE-MODIFIER) ⊠⊠⊠. ⊠: `3715 OLD HIGHWAY 99` ⊠⊠ *OLD*

pretype ⊠⊠⊠ (⊠⊠⊠⊠ 4) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠ (STREET PREFIX TYPE) ⊠⊠⊠.

name ⊠⊠⊠ (⊠⊠⊠⊠ 5) ⊠⊠⊠: ⊠⊠⊠ (STREET NAME) ⊠⊠⊠.

suftype ⊠⊠⊠ (⊠⊠⊠⊠ 6) ⊠⊠⊠: St, Ave, Cir ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (STREET POST TYPE) ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: `75 State Street` ⊠⊠ *STREET*

sufdir ⊠⊠⊠ (⊠⊠⊠⊠ 7) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (STREET POST-DIRECTIONAL) ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: `3715 TENTH AVENUE WEST` ⊠⊠ *WEST*

ruralroute is text (token number 8): RURAL ROUTE . Example *7* in `RR 7`.

extra ⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

city ⊠⊠⊠ (⊠⊠⊠⊠ 10) ⊠⊠⊠: ⊠: ⊠⊠⊠⊠

state ⊠⊠⊠ (⊠⊠⊠⊠ 11) ⊠⊠⊠: ⊠: ⊠⊠⊠⊠⊠⊠

country ⊠⊠⊠ (⊠⊠⊠⊠ 12) ⊠⊠⊠: ⊠: `USA`

postcode ⊠⊠⊠ (⊠⊠⊠⊠ 13) ⊠⊠⊠⊠ (postal code, zip code) ⊠⊠⊠: ⊠: `02109`

box ⊠⊠⊠ (⊠⊠⊠⊠ 14, 15) ⊠⊠⊠⊠⊠ (POSTAL BOX NUMBER) ⊠⊠⊠: ⊠: `02109`

unit ⊠⊠⊠ (⊠⊠⊠⊠ 17) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠: ⊠: `APT 3B` ⊠⊠ *3B*

12.1.3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

12.1.3.1 rules table

rules table — ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ -1(⊠⊠⊠; terminator), ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ -1, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

id ⊠⊠⊠⊠⊠⊠⊠

rule ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PAGC Address Standardizer Rule records ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ -1, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ -1, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ (⊠⊠) 0 ⊠⊠ (⊠⊠) 17 ⊠⊠⊠⊠⊠.

⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ `2 0 2 22 3 -1 5 5 6 7 3 -1 2 6` ⊠⊠⊠⊠⊠⊠⊠⊠ *TYPE NUMBER TYPE DIRECT QUALIF* ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ *STREET STREET SUFTYP SUFDIR QUALIF* ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ 6 ⊠⊠⊠ ARC_C ⊠⊠⊠⊠⊠.

stdaddr⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `-1` ⊠⊠⊠⊠⊠⊠. PAGC Input Tokens ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

⊠⊠⊠⊠⊠⊠⊠⊠

AMPERS (13). ⊠⊠⊠⊠ (&) ⊠⊠⊠"and" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

DASH (9). ⊠⊠⊠ (句讀法; punctuation) ⊠⊠⊠⊠⊠.

DOUBLE (21). ⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

FRACT (25). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

MIXED (23). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠.

NUMBER (0). ⊠⊠⊠⊠⊠⊠⊠⊠.

ORD (15). "First" ⊠⊠"1st" ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

ORD (18). ⊠⊠⊠⊠⊠⊠⊠.

WORD (1). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ SINGLE ⊠, WORD ⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠

BOXH (14). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ *Box* ⊠⊠ *PO Box* ⊠⊠⊠⊠⊠.

BUILDH (19). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: *Tower 7A* ⊠⊠ *Tower*

BUILDT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: *Shopping Centre*

DIRECT (22). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: *North*

MILE (20). ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠; milepost) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

ROAD (6). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: *Interstate 5* ⊠⊠ *Interstate*

RR (8). ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (rural route) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. *RR*.

TYPE (2). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: *ST* ⊠⊠ *AVE*

UNITH (16). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: *APT* ⊠⊠ *UNIT*

⊠⊠⊠⊠⊠⊠⊠⊠

QUINT (28). ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ (Zip Code) ⊠⊠⊠⊠⊠⊠.

QUAD (29). ⊠⊠⊠⊠⊠⊠⊠⊠. ZIP4 ⊠⊠⊠⊠⊠⊠.

PCH (27). ⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ FSA ⊠⊠⊠⊠⊠⊠.

PCT (26). ⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ LDU ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠ (不用語; stopword)

STOPWORD ⊠ WORD ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ WORD ⊠ STOPWORD ⊠⊠⊠⊠⊠⊠ WORD ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

STOPWORD (7). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: *THE*

⊠⊠⊠⊠

⊠⊠⊠ -1(⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ -1 ⊠⊠⊠⊠⊠⊠. stdaddr ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. the section called "⊠⊠⊠⊠⊠⊠⊠" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ (⊠⊠) 0 ⊠⊠ (⊠⊠) 17 ⊠⊠⊠⊠⊠.

MACRO_C

(⊠⊠⊠⊠ = "**0**"). *PLACE STATE ZIP* ⊠⊠ MACRO ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

MACRO_C output tokens (excerpted from http://www.pagcgeo.org/docs/html/pagc-12.html#--r-typ--.

CITY (⊠⊠⊠⊠"10"). ⊠: "Albany"

STATE (⊠⊠⊠⊠"11"). ⊠: "NY"

NATION (⊠⊠⊠⊠"12"). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: "USA"

POSTAL (⊠⊠⊠⊠"13"). (SADS ⊠⊠"ZIP CODE", "PLUS 4"). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

MICRO_C

(⊠⊠⊠⊠ = "**1**"). (⊠⊠, ⊠⊠, sufdir, predir, pretyp, suftype, qualif ⊠⊠⊠) ⊠⊠⊠ MICRO ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠: ARC_C ⊠ CIVIC_C). ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

MICRO_C output tokens (excerpted from http://www.pagcgeo.org/docs/html/pagc-12.html#--r-typ--.

HOUSE ⊠⊠⊠ (⊠⊠⊠⊠ 1) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: `75 State Street` ⊠ *75* ⊠⊠

predir ⊠⊠⊠ (⊠⊠⊠⊠ 2) ⊠⊠⊠: North, South, East, West ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (STREET NAME PRE-DIRECTIONAL) ⊠⊠⊠.

qual ⊠⊠⊠ (⊠⊠⊠⊠ 3) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠ (STREET NAME PRE-MODIFIER) ⊠⊠⊠. ⊠: `3715 OLD HIGHWAY 99` ⊠⊠ *OLD*

pretype ⊠⊠⊠ (⊠⊠⊠⊠ 4) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠ (STREET PREFIX TYPE) ⊠⊠⊠.

street ⊠⊠⊠ (⊠⊠⊠⊠ 5) ⊠⊠⊠: ⊠⊠⊠ (STREET NAME) ⊠⊠⊠.

suftype ⊠⊠⊠ (⊠⊠⊠⊠ 6) ⊠⊠⊠: St, Ave, Cir ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (STREET POST TYPE) ⊠⊠⊠. ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: `75 State Street` ⊠⊠ *STREET*

sufdir ⊠⊠⊠ (⊠⊠⊠⊠ 7) ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (STREET POST-DIRECTIONAL) ⊠⊠⊠. ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: `3715 TENTH AVENUE WEST` ⊠⊠ *WEST*

ARC_C

(⊠⊠⊠⊠ = "**2**"). HOUSE ⊠⊠⊠⊠⊠⊠⊠⊠ MICRO ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ HOUSE ⊠⊠ ⊠⊠ MICRO_C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

CIVIC_C

(⊠⊠⊠⊠ = "**3**"). HOUSE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

EXTRA_C

(⊠⊠⊠⊠ = "**4**"). EXTRA ⊠⊠ - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

EXTRA_C output tokens (excerpted from http://www.pagcgeo.org/docs/html/pagc-12.html#--r-typ--.

BLDNG (⊠⊠⊠⊠ 0): ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

BOXH (token number 14): The **BOX** in `BOX 3B`

BOXT (⊠⊠⊠⊠ 15): `BOX 3B` ⊠⊠ **3B**

RR (⊠⊠⊠⊠ 8): `RR 7` ⊠⊠ **RR**

UNITH (⊠⊠⊠⊠ 16): `APT 3B` ⊠⊠ **APT**

UNITT (⊠⊠⊠⊠ 17): `APT 3B` ⊠⊠ **3B**

UNKNWN (⊠⊠⊠⊠ 9): ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

12.1.3.2 lex table

lex table — ⊠⊠⊠⊠ (lex) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ (1) ⊠⊠⊠⊠ (the section called "⊠⊠⊠⊠" ⊠⊠) ⊠ (2) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠ (lexicon) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ (1) ⊠⊠⊠⊠ (the section called "⊠⊠⊠⊠" ⊠⊠) ⊠ (2) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠, ⊠⊠⊠ `ONE` ⊠ stdword 1 ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

id ⊠⊠⊠⊠⊠⊠⊠⊠

seq ⊠⊠⊠: ⊠⊠⊠⊠⊠?

word ⊠⊠⊠: ⊠⊠⊠⊠⊠

stdword ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

token ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PAGC Tokens ⊠ ⊠⊠⊠⊠⊠⊠⊠.

12.1.3.3 gaz table

gaz table — ⊠⊠⊠⊠ (gaz) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ (1) ⊠⊠⊠⊠ (the section called “⊠⊠⊠⊠” ⊠⊠) ⊠ (2) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

A gaz (short for gazeteer) table is used to standardize place names and associate that input with the section called “⊠⊠⊠⊠⊠” and (b) standardized representations. For example if you are in US, you may load these with State Names and associated abbreviations.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

id ⊠⊠⊠⊠⊠⊠⊠

seq ⊠⊠⊠: ⊠⊠⊠⊠? - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

word ⊠⊠⊠: ⊠⊠⊠⊠

stdword ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠

token ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PAGC Tokens ⊠⊠⊠⊠⊠⊠⊠.

12.1.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

12.1.4.1 debug_standardize_address

debug_standardize_address — Returns a json formatted text listing the parse tokens and standardizations

Synopsis

text **debug_standardize_address**(text lextab, text gaztab, text rultab, text micro, text macro=NULL);

⊠⊠

This is a function for debugging address standardizer rules and lex/gaz mappings. It returns a json formatted text that includes the matching rules, mapping of tokens, and best standardized address stdaddr form of an input address utilizing lex table table name, gaz table, and rules table table names and an address.

For single line addresses use just `micro`

For two line address A `micro` consisting of standard first line of postal address e.g. `house_num street`, and a macro consisting of standard postal second line of an address e.g `city, state postal_code country`.

Elements returned in the json document are

`input_tokens` For each word in the input address, returns the position of the word, token categorization of the word, and the standard word it is mapped to. Note that for some input words, you might get back multiple records because some inputs can be categorized as more than one thing.

`rules` The set of rules matching the input and the corresponding score for each. The first rule (highest scoring) is what is used for standardization

stdaddr The standardized address elements stdaddr that would be returned when running standardize_address

Availability: 3.4.0

This method needs address_standardizer extension.

□□

address_standardizer_data_us □□□□□□□□

```
CREATE EXTENSION address_standardizer_data_us; -- only needs to be done once
```

Variant 1: Single line address and returning the input tokens

```
SELECT it->>'pos' AS position, it->>'word' AS word, it->>'stdword' AS standardized_word,
            it->>'token' AS token, it->>'token-code' AS token_code
    FROM jsonb(
            debug_standardize_address('us_lex',
                'us_gaz', 'us_rules', 'One Devonshire Place, PH 301, Boston, MA 02109')
             ) AS s, jsonb_array_elements(s->'input_tokens') AS it;
```

```
position |    word    | standardized_word | token  | token_code
----------+------------+-------------------+--------+------------
 0        | ONE        | 1                 | NUMBER | 0
 0        | ONE        | 1                 | WORD   | 1
 1        | DEVONSHIRE | DEVONSHIRE        | WORD   | 1
 2        | PLACE      | PLACE             | TYPE   | 2
 3        | PH         | PATH              | TYPE   | 2
 3        | PH         | PENTHOUSE         | UNITT  | 17
 4        | 301        | 301               | NUMBER | 0
(7 rows)
```

Variant 2: Multi line address and returning first rule input mappings and score

```
SELECT (s->'rules'->0->>'score')::numeric AS score, it->>'pos' AS position,
        it->>'input-word' AS word, it->>'input-token' AS input_token, it->>'mapped-word' AS ↩
             standardized_word,
            it->>'output-token' AS output_token
    FROM jsonb(
            debug_standardize_address('us_lex',
                'us_gaz', 'us_rules', 'One Devonshire Place, PH 301', 'Boston, MA 02109')
             ) AS s, jsonb_array_elements(s->'rules'->0->'rule_tokens') AS it;
```

```
score    | position |    word    | input_token | standardized_word | output_token
----------+----------+------------+-------------+-------------------+-------------
 0.876250 | 0        | ONE        | NUMBER      | 1                 | HOUSE
 0.876250 | 1        | DEVONSHIRE | WORD        | DEVONSHIRE        | STREET
 0.876250 | 2        | PLACE      | TYPE        | PLACE             | SUFTYP
 0.876250 | 3        | PH         | UNITT       | PENTHOUSE         | UNITT
 0.876250 | 4        | 301        | NUMBER      | 301               | UNITT
(5 rows)
```

□□

stdaddr, rules table, lex table, gaz table, Pagc_Normalize_Address

12.1.4.2 parse_address

parse_address — □□□□□□□□□□□□□□□□□□□□.

Synopsis

record **parse_address**(text address);

□□

Returns takes an address as input, and returns a record output consisting of fields *num*, *street*, *street2*, *address1*, *city*, *state*, *zip*, *zipplus*, *country*.

2.2.0 □□□□□□□□□□□□.

This method needs address_standardizer extension.

□□

□□□□

```
SELECT num, street, city, zip, zipplus
        FROM parse_address('1 Devonshire Place, Boston, MA 02109-1234') AS a;
```

```
num |      street      |  city  |  zip  | zipplus
-----+------------------+--------+-------+---------
 1   | Devonshire Place | Boston | 02109 | 1234
```

□□□□□

```
-- basic table
CREATE TABLE places(addid serial PRIMARY KEY, address text);

INSERT INTO places(address)
VALUES ('529 Main Street, Boston MA, 02129'),
 ('77 Massachusetts Avenue, Cambridge, MA 02139'),
 ('25 Wizard of Oz, Walaford, KS 99912323'),
 ('26 Capen Street, Medford, MA'),
 ('124 Mount Auburn St, Cambridge, Massachusetts 02138'),
 ('950 Main Street, Worcester, MA 01610');

 -- parse the addresses
 -- if you want all fields you can use (a).*
SELECT addid, (a).num, (a).street, (a).city, (a).state, (a).zip, (a).zipplus
FROM (SELECT addid, parse_address(address) As a
 FROM places) AS p;
```

```
addid | num |        street        |   city    | state |  zip  | zipplus
-------+-----+----------------------+-----------+-------+-------+---------
     1 | 529 | Main Street          | Boston    | MA    | 02129 |
     2 | 77  | Massachusetts Avenue | Cambridge | MA    | 02139 |
     3 | 25  | Wizard of Oz         | Walaford  | KS    | 99912 | 323
     4 | 26  | Capen Street         | Medford   | MA    |       |
     5 | 124 | Mount Auburn St      | Cambridge | MA    | 02138 |
     6 | 950 | Main Street          | Worcester | MA    | 01610 |
(6 rows)
```

⌧⌧

12.1.4.3 standardize_address

standardize_address — ⌧⌧⌧⌧, ⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ stdaddr ⌧⌧⌧⌧⌧⌧⌧.

Synopsis

stdaddr **standardize_address**(text lextab, text gaztab, text rultab, text address);
stdaddr **standardize_address**(text lextab, text gaztab, text rultab, text micro, text macro);

⌧⌧

lex table, gaz table, rules table ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ stdaddr ⌧⌧⌧⌧⌧⌧⌧.

⌧⌧ 1: ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

⌧⌧ 2: ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. `house_num street` ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ `micro` ⌧⌧, `city, state postal_code country` ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ `macro` ⌧⌧⌧.

2.2.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

This method needs address_standardizer extension.

⌧⌧

address_standardizer_data_us ⌧⌧⌧⌧⌧⌧⌧

```
CREATE EXTENSION address_standardizer_data_us; -- only needs to be done once
```

⌧⌧ 1: ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

```
SELECT house_num, name, suftype, city, country, state, unit  FROM standardize_address('us_lex',
                           'us_gaz', 'us_rules', 'One Devonshire Place, PH 301, Boston, MA 02109');
```

```
house_num |    name    | suftype |  city  | country |     state     |      unit
----------+------------+---------+--------+---------+---------------+-----------------
1         | DEVONSHIRE | PLACE   | BOSTON | USA     | MASSACHUSETTS | # PENTHOUSE 301
```

TIGER ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (⌧⌧⌧⌧⌧⌧⌧ `postgis_tiger_geocoder` ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.)

```
SELECT *  FROM standardize_address('tiger.pagc_lex',
         'tiger.pagc_gaz', 'tiger.pagc_rules', 'One Devonshire Place, PH 301, Boston, MA 02109-1234');
```

⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ hstore ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧ `CREATE EXTENSION hstore;` ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

```
SELECT (each(hstore(p))).*
 FROM standardize_address('tiger.pagc_lex', 'tiger.pagc_gaz',
   'tiger.pagc_rules', 'One Devonshire Place, PH 301, Boston, MA 02109') As p;
```

```
key        |      value
------------+-----------------
 box        |
 city       | BOSTON
 name       | DEVONSHIRE
 qual       |
 unit       | # PENTHOUSE 301
 extra      |
 state      | MA
 predir     |
 sufdir     |
 country    | USA
 pretype    |
 suftype    | PL
 building   |
 postcode   | 02109
 house_num  | 1
 ruralroute |
(16 rows)
```

⊠⊠ 2: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT (each(hstore(p))).*
 FROM standardize_address('tiger.pagc_lex', 'tiger.pagc_gaz',
   'tiger.pagc_rules', 'One Devonshire Place, PH 301', 'Boston, MA 02109, US') As p;
```

```
key        |      value
------------+-----------------
 box        |
 city       | BOSTON
 name       | DEVONSHIRE
 qual       |
 unit       | # PENTHOUSE 301
 extra      |
 state      | MA
 predir     |
 sufdir     |
 country    | USA
 pretype    |
 suftype    | PL
 building   |
 postcode   | 02109
 house_num  | 1
 ruralroute |
(16 rows)
```

⊠⊠

stdaddr, rules table, lex table, gaz table, Pagc_Normalize_Address

12.2 TIGER ⊠⊠⊠⊠⊠⊠

TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- Nominatim ⊠ OpenStreetMap ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ osm2pgsql ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL 8.4 ⊠⊠⊠⊠⊠ PostGIS 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, Nominatim ⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- GIS Graphy ⊠⊠ PostGIS ⊠⊠⊠⊠⊠ Nominatim ⊠⊠ OSM(OpenStreetMap) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. OSM ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, Nominatim ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Nominatim ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Java 1.5, Servlet apps, Solr ⊠⊠⊠⊠⊠⊠. GIS Graphy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

12.2.1 Drop_Indexes_Generate_Script

Drop_Indexes_Generate_Script — TIGER ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `tiger_data` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **Drop_Indexes_Generate_Script**(text param_schema=tiger_data);

⊠⊠

TIGER ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `tiger_data` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (bloat) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Install_Missing_Indexes ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT drop_indexes_generate_script() As actionsql;
actionsql
---------------------------------------------------------
DROP INDEX tiger.idx_tiger_countysub_lookup_lower_name;
DROP INDEX tiger.idx_tiger_edges_countyfp;
DROP INDEX tiger.idx_tiger_faces_countyfp;
DROP INDEX tiger.tiger_place_the_geom_gist;
DROP INDEX tiger.tiger_edges_the_geom_gist;
DROP INDEX tiger.tiger_state_the_geom_gist;
DROP INDEX tiger.idx_tiger_addr_least_address;
DROP INDEX tiger.idx_tiger_addr_tlid;
DROP INDEX tiger.idx_tiger_addr_zip;
DROP INDEX tiger.idx_tiger_county_countyfp;
DROP INDEX tiger.idx_tiger_county_lookup_lower_name;
DROP INDEX tiger.idx_tiger_county_lookup_snd_name;
DROP INDEX tiger.idx_tiger_county_lower_name;
DROP INDEX tiger.idx_tiger_county_snd_name;
DROP INDEX tiger.idx_tiger_county_the_geom_gist;
DROP INDEX tiger.idx_tiger_countysub_lookup_snd_name;
DROP INDEX tiger.idx_tiger_cousub_countyfp;
DROP INDEX tiger.idx_tiger_cousub_cousubfp;
DROP INDEX tiger.idx_tiger_cousub_lower_name;
DROP INDEX tiger.idx_tiger_cousub_snd_name;
```

```
DROP INDEX tiger.idx_tiger_cousub_the_geom_gist;
DROP INDEX tiger_data.idx_tiger_data_ma_addr_least_address;
DROP INDEX tiger_data.idx_tiger_data_ma_addr_tlid;
DROP INDEX tiger_data.idx_tiger_data_ma_addr_zip;
DROP INDEX tiger_data.idx_tiger_data_ma_county_countyfp;
DROP INDEX tiger_data.idx_tiger_data_ma_county_lookup_lower_name;
DROP INDEX tiger_data.idx_tiger_data_ma_county_lookup_snd_name;
DROP INDEX tiger_data.idx_tiger_data_ma_county_lower_name;
DROP INDEX tiger_data.idx_tiger_data_ma_county_snd_name;
:
:
```

⊠⊠

Install_Missing_Indexes, Missing_Indexes_Generate_Script

12.2.2 Drop_Nation_Tables_Generate_Script

Drop_Nation_Tables_Generate_Script — ⊠⊠⊠⊠⊠⊠⊠⊠⊠ county_all, state_all ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ county, state ⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **Drop_Nation_Tables_Generate_Script**(text param_schema=tiger_data);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ county_all, state_all ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ county, state ⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. tiger_2010 ⊠⊠⊠⊠⊠ tiger_2011 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT drop_nation_tables_generate_script();
DROP TABLE tiger_data.county_all;
DROP TABLE tiger_data.county_all_lookup;
DROP TABLE tiger_data.state_all;
DROP TABLE tiger_data.ma_county;
DROP TABLE tiger_data.ma_state;
```

⊠⊠

Loader_Generate_Nation_Script

12.2.3 Drop_State_Tables_Generate_Script

Drop_State_Tables_Generate_Script — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ tiger_data ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **Drop_State_Tables_Generate_Script**(text param_state, text param_schema=tiger_data);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `tiger_data` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT drop_state_tables_generate_script('PA');
DROP TABLE tiger_data.pa_addr;
DROP TABLE tiger_data.pa_county;
DROP TABLE tiger_data.pa_county_lookup;
DROP TABLE tiger_data.pa_cousub;
DROP TABLE tiger_data.pa_edges;
DROP TABLE tiger_data.pa_faces;
DROP TABLE tiger_data.pa_featnames;
DROP TABLE tiger_data.pa_place;
DROP TABLE tiger_data.pa_state;
DROP TABLE tiger_data.pa_zip_lookup_base;
DROP TABLE tiger_data.pa_zip_state;
DROP TABLE tiger_data.pa_zip_state_loc;
```

⊠⊠

Loader_Generate_Script

12.2.4 Geocode

Geocode — ⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠ NAD83 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠ 10) ⊠ restrict_region(⊠⊠⊠ NULL) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

setof record **geocode**(varchar address, integer max_results=10, geometry restrict_region=NULL, norm_addy OUT addy, geometry OUT geomout, integer OUT rating);
setof record **geocode**(norm_addy in_addy, integer max_results=10, geometry restrict_region=NULL, norm_addy OUT addy, geometry OUT geomout, integer OUT rating);

□□

□□□□□□□ (□□□□□□□□□□□) □□□□□□□ NAD83 □□□□□□□□□□□□□, □□□□□□□ normalized_address (addy) □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□. TIGER □□□ (edge, face, addr), PostgreSQL □□□□□□□□ (soundex, levenshtein), □□□ PostGIS □□□□□□□□□□□□ TIGER □□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ (□□/□□□) □□ 10 □□□□□□□□□□.

□□□□: 2.0.0 □□□□□ TIGER 2010 □□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, □□. □□□□□□ max_results □□□.

□□□□

□□□□□ (MA), □□□□ (MN), □□□□□ (CA), □□□□□□ (RI) □□ TIGER □□□□□□□□ PostgreSQL 9.1rc1/PostGIS 2.0 □□□□□□□□ 3.0 GHZ □□□□□□□□ 2GB □□□□□ 7 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

□□□□□□□□□□□□□□□□□ (61 □□□).

```
SELECT g.rating, ST_X(g.geomout) As lon, ST_Y(g.geomout) As lat,
    (addy).address As stno, (addy).streetname As street,
    (addy).streettypeabbrev As styp, (addy).location As city, (addy).stateabbrev As st,( ↩
        addy).zip
    FROM geocode('75 State Street, Boston MA 02109', 1) As g;
 rating |        lon        |      lat       | stno | street | styp |  city  | st |  zip
--------+-------------------+----------------+------+--------+------+--------+----+-------
      0 | -71.0557505845646 | 42.35897920691 |   75 | State  | St   | Boston | MA | 02109
```

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```
SELECT g.rating, ST_AsText(ST_SnapToGrid(g.geomout,0.00001)) As wktlonlat,
    (addy).address As stno, (addy).streetname As street,
    (addy).streettypeabbrev As styp, (addy).location As city, (addy).stateabbrev As st,( ↩
        addy).zip
    FROM geocode('226 Hanover Street, Boston, MA',1) As g;
 rating |         wktlonlat         | stno | street  | styp |  city  | st |  zip
--------+---------------------------+------+---------+------+--------+----+-------
      1 | POINT(-71.05528 42.36316) |  226 | Hanover | St   | Boston | MA | 02113
```

□□□□□□□□□□□□□, □□ (500 □□□).

```
SELECT g.rating, ST_AsText(ST_SnapToGrid(g.geomout,0.00001)) As wktlonlat,
    (addy).address As stno, (addy).streetname As street,
    (addy).streettypeabbrev As styp, (addy).location As city, (addy).stateabbrev As st,( ↩
        addy).zip
    FROM geocode('31 - 37 Stewart Street, Boston, MA 02116',1) As g;
 rating |         wktlonlat         | stno | street | styp |  city  | st |  zip
--------+---------------------------+------+--------+------+--------+----+-------
     70 | POINT(-71.06466 42.35114) |   31 | Stuart | St   | Boston | MA | 02116
```

□□□□□□□□□□□□□□ (batch) □□□□□□□□□. max_results = 1 □□□□□□□□□□□□□□. □□□□□□□□□□ (□□□□□) □□□□□□□□□□.

```
CREATE TABLE addresses_to_geocode(addid serial PRIMARY KEY, address text,
        lon numeric, lat numeric, new_address text, rating integer);

INSERT INTO addresses_to_geocode(address)
VALUES ('529 Main Street, Boston MA, 02129'),
```

```
 ('77 Massachusetts Avenue, Cambridge, MA 02139'),
 ('25 Wizard of Oz, Walaford, KS 99912323'),
 ('26 Capen Street, Medford, MA'),
 ('124 Mount Auburn St, Cambridge, Massachusetts 02138'),
 ('950 Main Street, Worcester, MA 01610');

-- only update the first 3 addresses (323-704 ms -  there are caching and shared memory  ←
   effects so first geocode you do is always slower) --
-- for large numbers of addresses you don't want to update all at once
-- since the whole geocode must commit at once
-- For this example we rejoin with LEFT JOIN
-- and set to rating to -1 rating if no match
-- to ensure we don't regeocode a bad address
UPDATE addresses_to_geocode
  SET  (rating, new_address, lon, lat)
    = ( COALESCE(g.rating,-1), pprint_addy(g.addy),
       ST_X(g.geomout)::numeric(8,5), ST_Y(g.geomout)::numeric(8,5) )
FROM (SELECT addid, address
    FROM addresses_to_geocode
    WHERE rating IS NULL ORDER BY addid LIMIT 3) As a
    LEFT JOIN LATERAL geocode(a.address,1) As g ON true
WHERE a.addid = addresses_to_geocode.addid;

result
-----
Query returned successfully: 3 rows affected, 480 ms execution time.

SELECT * FROM addresses_to_geocode WHERE rating is not null;

 addid |                   address                    |    lon    |   lat    |  ←
                   new_address                | rating
-------+----------------------------------------------+-----------+----------+-----------------------

     1 | 529 Main Street, Boston MA, 02129            | -71.07177 | 42.38357 | 529 Main St, ←
          Boston, MA 02129             |      0
     2 | 77 Massachusetts Avenue, Cambridge, MA 02139 | -71.09396 | 42.35961 | 77  ←
         Massachusetts Ave, Cambridge, MA 02139 |      0
     3 | 25 Wizard of Oz, Walaford, KS 99912323       | -97.92913 | 38.12717 | Willowbrook, ←
          KS 67502                     |    108
(3 rows)
```

□□: □□□□□□

```
SELECT g.rating, ST_AsText(ST_SnapToGrid(g.geomout,0.00001)) As wktlonlat,
    (addy).address As stno, (addy).streetname As street,
    (addy).streettypeabbrev As styp,
    (addy).location As city, (addy).stateabbrev As st,(addy).zip
  FROM geocode('100 Federal Street, MA',
        3,
        (SELECT ST_Union(the_geom)
            FROM place WHERE statefp = '25' AND name = 'Lynn')::geometry
        ) As g;

 rating |         wktlonlat         | stno | street  | styp | city | st |  zip
--------+---------------------------+------+---------+------+------+----+-------
      7 | POINT(-70.96796 42.4659)  |  100 | Federal | St   | Lynn | MA | 01905
     16 | POINT(-70.96786 42.46853) | NULL | Federal | St   | Lynn | MA | 01905
(2 rows)

Time: 622.939 ms
```

⊠⊠

Normalize_Address, Pprint_Addy, ST_AsText, ST_SnapToGrid, ST_X, ST_Y

12.2.5 Geocode_Intersection

Geocode_Intersection — ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠, ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ NAD83 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ geomout, ⊠⊠⊠⊠⊠⊠⊠ normalized_address (addy) ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠ 10) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TIGER ⊠⊠⊠ (edge, face, addr) ⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠ (soundex, levenshtein) ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

setof record **geocode_intersection**(text roadway1, text roadway2, text in_state, text in_city, text in_zip, integer max_results=10, norm_addy OUT addy, geometry OUT geomout, integer OUT rating);

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2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠ (MA) ⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL 9.0/PostGIS 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠ 3.0 GHZ ⊠⊠⊠⊠⊠⊠⊠⊠ 2GB ⊠⊠⊠⊠⊠ 7 ⊠⊠⊠ (3,000 ⊠⊠⊠).

TIGER 2011 ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS 2.0 ⊠ PostgreSQL 64 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 8GB ⊠⊠⊠⊠⊠ 2003 64 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (41 ⊠⊠⊠).

```
SELECT pprint_addy(addy), st_astext(geomout),rating
            FROM geocode_intersection( 'Haverford St','Germania St', 'MA', 'Boston',  ↩
                '02130',1);
           pprint_addy            |         st_astext          | rating
----------------------------------+----------------------------+--------
98 Haverford St, Boston, MA 02130 | POINT(-71.101375 42.31376) |      0
```

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```
SELECT pprint_addy(addy), st_astext(geomout),rating
                FROM geocode_intersection('Weld', 'School', 'MA', 'Boston');
          pprint_addy          |        st_astext         | rating
-------------------------------+--------------------------+--------
 98 Weld Ave, Boston, MA 02119 | POINT(-71.099 42.314234) |      3
 99 Weld Ave, Boston, MA 02119 | POINT(-71.099 42.314234) |      3
```

□□

Geocode, Pprint_Addy, ST_AsText

12.2.6 Get_Geocode_Setting

Get_Geocode_Setting — tiger.geocode_settings □□□□□□□□□□□□□□□□□□.

Synopsis

text **Get_Geocode_Setting**(text setting_name);

□□

tiger.geocode_settings □□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□:

```
name                | setting |  unit   | category  |  ↩
                                                              short_desc
-------------------------------+---------+---------+-----------+------------------------------------

 debug_geocode_address          | false   | boolean | debug     | outputs debug information ↩
     in notice log such as queries when geocode_address is called if true
 debug_geocode_intersection     | false   | boolean | debug     | outputs debug information ↩
     in notice log such as queries when geocode_intersection is called if true
 debug_normalize_address        | false   | boolean | debug     | outputs debug information ↩
     in notice log such as queries and intermediate expressions when normalize_address is  ↩
    called if true
 debug_reverse_geocode          | false   | boolean | debug     | if true, outputs debug  ↩
    information in notice log such as queries and intermediate expressions when  ↩
    reverse_geocode
 reverse_geocode_numbered_roads | 0       | integer | rating    | For state and county  ↩
    highways, 0 - no preference in name,
                                                                  1 - prefer the numbered  ↩
                                                                      highway name, 2 -  ↩
                                                                      prefer local state/ ↩
                                                                      county name
 use_pagc_address_parser        | false   | boolean | normalize | If set to true, will try  ↩
    to use the address_standardizer extension (via pagc_normalize_address)
                                                                 instead of tiger  ↩
                                                                     normalize_address built ↩
                                                                      one
```

□□□□: 2.2.0 □□□□ geocode_settings_default □□□□□□□□□□□□□□□□□. □□□□□□□□□□ geocode_settings □□□□□□□, □ geocode_settings □□□□□□□□□□□□□□□□□□□□□□□□.

2.1.0 □□□□□□□□□□□□.

□□: □□□□□□□□

```
SELECT get_geocode_setting('debug_geocode_address) As result;
result
---------
false
```

⊠⊠

Set_Geocode_Setting

12.2.7 Get_Tract

Get_Tract — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tract) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (field) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **get_tract**(geometry loc_geom, text output_field=name);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NAD83 ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
This function uses the census `tract` which is not loaded by default. If you have already loaded your state table, you can load tract as well as bg, and tabblock using the Loader_Generate_Census_Script script.
If you have not loaded your state data yet and want these additional tables loaded, do the following

```
UPDATE tiger.loader_lookuptables SET load = true WHERE load = false AND lookup_name ↩
    IN('tract', 'bg', 'tabblock');
```

then they will be included by the Loader_Generate_Script.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠

```
SELECT get_tract(ST_Point(-71.101375, 42.31376) ) As tract_name;
tract_name
---------
1203.01
```

```
--this one returns the tiger geoid
SELECT get_tract(ST_Point(-71.101375, 42.31376), 'tract_id' ) As tract_id;
tract_id
---------
25025120301
```

⊠⊠

Geocode>

12.2.8 Install_Missing_Indexes

Install_Missing_Indexes — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (join) ⊠⊠⊠⊠⊠⊠⊠ (key) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

Synopsis

boolean **Install_Missing_Indexes**();

⊠⊠

`tiger` ⊠ `tiger_data` ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL DDL ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Missing_Indexes_Generate_Script ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `update_geocode.sql` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT install_missing_indexes();
         install_missing_indexes
-------------------------
 t
```

⊠⊠

Loader_Generate_Script, Missing_Indexes_Generate_Script

12.2.9 Loader_Generate_Census_Script

Loader_Generate_Census_Script — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠, TIGER ⊠⊠⊠⊠⊠⊠ (州) ⊠⊠ (tract), ⊠⊠⊠⊠⊠ (bg), ⊠⊠ (tabblock) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ `tiger_data` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

setof text **loader_generate_census_script**(text[] param_states, text os);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠, TIGER ⊠⊠⊠⊠⊠⊠ (州) `tract`, `bg`, `tabblocks` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ `tiger_data` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠ unzip ⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 7-zip ⊠) ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ wget ⊠⊠⊠⊠⊠. ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ Section 4.7.2 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠. ⊠⊠⊠⊠⊠”staging” ⊠”temp” ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ OS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

1. loader_variables - ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ (staging) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
2. loader_platform - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
3. loader_lookuptables - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠, ⊠), ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州名) ⊠⊠, TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: tiger.faces ⊠⊠⊠⊠⊠⊠ tiger_data.ma_faces ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> Loader_Generate_Script ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, PostGIS 2.0.0 alpha5 ⊠⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠.

```
SELECT loader_generate_census_script(ARRAY['MA'], 'windows');
-- result --
set STATEDIR="\gisdata\www2.census.gov\geo\pvs\tiger2010st\25_Massachusetts"
set TMPDIR=\gisdata\temp\
set UNZIPTOOL="C:\Program Files\7-Zip\7z.exe"
set WGETTOOL="C:\wget\wget.exe"
set PGBIN=C:\projects\pg\pg91win\bin\
set PGPORT=5432
set PGHOST=localhost
set PGUSER=postgres
set PGPASSWORD=yourpasswordhere
set PGDATABASE=tiger_postgis20
set PSQL="%PGBIN%psql"
set SHP2PGSQL="%PGBIN%shp2pgsql"
cd \gisdata

%WGETTOOL% http://www2.census.gov/geo/pvs/tiger2010st/25_Massachusetts/25/ --no-parent -- ↩
    relative --accept=*bg10.zip,*tract10.zip,*tabblock10.zip --mirror --reject=html
del %TMPDIR%\*.* /Q
%PSQL% -c "DROP SCHEMA tiger_staging CASCADE;"
%PSQL% -c "CREATE SCHEMA tiger_staging;"
cd %STATEDIR%
for /r %%z in (*.zip) do %UNZIPTOOL% e %%z  -o%TMPDIR%
cd %TMPDIR%
%PSQL% -c "CREATE TABLE tiger_data.MA_tract(CONSTRAINT pk_MA_tract PRIMARY KEY (tract_id) ) ↩
     INHERITS(tiger.tract); "
%SHP2PGSQL% -c -s 4269 -g the_geom   -W "latin1" tl_2010_25_tract10.dbf tiger_staging. ↩
    ma_tract10 | %PSQL%
%PSQL% -c "ALTER TABLE tiger_staging.MA_tract10 RENAME geoid10 TO tract_id;  SELECT  ↩
    loader_load_staged_data(lower('MA_tract10'), lower('MA_tract')); "
%PSQL% -c "CREATE INDEX tiger_data_MA_tract_the_geom_gist ON tiger_data.MA_tract USING gist ↩
    (the_geom);"
%PSQL% -c "VACUUM ANALYZE tiger_data.MA_tract;"
%PSQL% -c "ALTER TABLE tiger_data.MA_tract ADD CONSTRAINT chk_statefp CHECK (statefp =  ↩
    '25');"
:
```

.sh □□□□□□□□□□□.

```
STATEDIR="/gisdata/www2.census.gov/geo/pvs/tiger2010st/25_Massachusetts"
TMPDIR="/gisdata/temp/"
UNZIPTOOL=unzip
WGETTOOL="/usr/bin/wget"
export PGBIN=/usr/pgsql-9.0/bin
export PGPORT=5432
export PGHOST=localhost
export PGUSER=postgres
export PGPASSWORD=yourpasswordhere
export PGDATABASE=geocoder
PSQL=${PGBIN}/psql
SHP2PGSQL=${PGBIN}/shp2pgsql
cd /gisdata

wget http://www2.census.gov/geo/pvs/tiger2010st/25_Massachusetts/25/ --no-parent --relative ↩
     --accept=*bg10.zip,*tract10.zip,*tabblock10.zip --mirror --reject=html
rm -f ${TMPDIR}/*.*
${PSQL} -c "DROP SCHEMA tiger_staging CASCADE;"
${PSQL} -c "CREATE SCHEMA tiger_staging;"
cd $STATEDIR
for z in *.zip; do $UNZIPTOOL -o -d $TMPDIR $z; done
:
:
```

□□

Loader_Generate_Script

12.2.10 Loader_Generate_Script

Loader_Generate_Script — □□□□□□□□□□□□□□ (州) □□□, TIGER □□□□□□□□□□□ tiger_data □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□ (州) □□□□□□□□□□□□□□□□□□□□. □□□□□ TIGER 2010 □□□□□□□□□□□□, □□□□□□□, □□□□, □□□□□□□□□□□□.

Synopsis

setof text **loader_generate_script**(text[] param_states, text os);

□□

□□□□□□□□□□□□□□ (州) □□□, TIGER □□□□□□□□□□□ tiger_data □□□□□□□□□□□□□□□□□□□□□□□□□. □□ (州) □□□□□□□□□□□□□□□□□□□.

□□□□□□□ unzip □ (□□□□□□□□□□□□□□ 7-zip □) □□□□, □□□□□□□□ wget □□□□. □□□□□□□□□□ Section 4.7.2 □□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□ (州) □□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□"staging" □"temp" □□□□□□□□□□□□□□□□□□.

□□□□□□□□□□ OS □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.

1. loader_variables - □□□□□□□, □□, □□□□□□□□ (staging) □□□□□□□□□□□□□□□□□□□□□.

2. `loader_platform` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

3. `loader_lookuptables` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠, ⊠), ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州名) ⊠⊠, TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: `tiger.faces` ⊠⊠⊠⊠⊠⊠ `tiger_data.ma_faces` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TIGER 2010 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tract), ⊠⊠⊠⊠⊠ (bg), ⊠⊠ (tabblock) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note
If you are using pgAdmin 3, be warned that by default pgAdmin 3 truncates long text. To fix, change *File -> Options -> Query Tool -> Query Editor - > Max. characters per column* to larger than 50000 characters.

⊠⊠

Using psql where gistest is your database and `/gisdata/data_load.sh` is the file to create with the shell commands to run.

```
psql -U postgres -h localhost -d gistest -A -t \
 -c "SELECT Loader_Generate_Script(ARRAY['MA'], 'gistest')" > /gisdata/data_load.sh;
```

⊠ (州) 2 ⊠⊠.

```
SELECT loader_generate_script(ARRAY['MA','RI'], 'windows') AS result;
-- result --
set TMPDIR=\gisdata\temp\
set UNZIPTOOL="C:\Program Files\7-Zip\7z.exe"
set WGETTOOL="C:\wget\wget.exe"
set PGBIN=C:\Program Files\PostgreSQL\9.4\bin\
set PGPORT=5432
set PGHOST=localhost
set PGUSER=postgres
set PGPASSWORD=yourpasswordhere
set PGDATABASE=geocoder
set PSQL="%PGBIN%psql"
set SHP2PGSQL="%PGBIN%shp2pgsql"
cd \gisdata

cd \gisdata
%WGETTOOL% ftp://ftp2.census.gov/geo/tiger/TIGER2015/PLACE/tl_*_25_* --no-parent --relative ↩
     --recursive --level=2 --accept=zip --mirror --reject=html
cd \gisdata/ftp2.census.gov/geo/tiger/TIGER2015/PLACE
:
:
```

.sh ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT loader_generate_script(ARRAY['MA','RI'], 'sh') AS result;
-- result --
TMPDIR="/gisdata/temp/"
UNZIPTOOL=unzip
WGETTOOL="/usr/bin/wget"
export PGBIN=/usr/lib/postgresql/9.4/bin
-- variables used by psql: https://www.postgresql.org/docs/current/static/libpq-envars.html
export PGPORT=5432
```

```
export PGHOST=localhost
export PGUSER=postgres
export PGPASSWORD=yourpasswordhere
export PGDATABASE=geocoder
PSQL=${PGBIN}/psql
SHP2PGSQL=${PGBIN}/shp2pgsql
cd /gisdata

cd /gisdata
wget ftp://ftp2.census.gov/geo/tiger/TIGER2015/PLACE/tl_*_25_* --no-parent --relative -- ←
    recursive --level=2 --accept=zip --mirror --reject=html
cd /gisdata/ftp2.census.gov/geo/tiger/TIGER2015/PLACE
rm -f ${TMPDIR}/*.*
:
:
```

⊠⊠

Section 2.4.1, Pprint_Addy, ST_AsText

12.2.11 Loader_Generate_Nation_Script

Loader_Generate_Nation_Script — ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **loader_generate_nation_script**(text os);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠, tiger_data ⊠⊠⊠⊠ county_all, county_all_lookup, state_all ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ tiger ⊠⊠⊠⊠ county, county_lookup, state ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠ unzip ⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 7-zip ⊠) ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ wget ⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ Section 4.7.2 ⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠ OS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ tiger.loader_platform, tiger.loader_var ⊠⊠⊠ tiger.loader_lookuptables ⊠⊠⊠⊠⊠⊠.

1. loader_variables - ⊠⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ (staging) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
2. loader_platform - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
3. loader_lookuptables - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠, ⊠), ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州名) ⊠⊠, TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠: tiger.faces ⊠⊠⊠⊠⊠ tiger_data.ma_faces ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Enhanced: 2.4.1 zip code 5 tabulation area (zcta5) load step was fixed and when enabled, zcta5 data is loaded as a single table called zcta5_all as part of the nation script load.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Note

If you want zip code 5 tabulation area (zcta5) to be included in your nation script load, do the following:

```
UPDATE tiger.loader_lookuptables SET load = true WHERE table_name = 'zcta510';
```

Note

⊠⊠⊠⊠ tiger_2010 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠ tiger_2011 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Drop_Nation_Tables_Generate_Script ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠.

```
SELECT loader_generate_nation_script('windows');
```

⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT loader_generate_nation_script('sh');
```

⊠⊠

Loader_Generate_Script, Missing_Indexes_Generate_Script

12.2.12 Missing_Indexes_Generate_Script

Missing_Indexes_Generate_Script — ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (join) ⊠⊠⊠⊠⊠⊠⊠ (key) ⊠⊠⊠ SQL DDL ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **Missing_Indexes_Generate_Script**();

⊠⊠

tiger ⊠ tiger_data ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (join) ⊠⊠⊠⊠⊠⊠⊠ (key) ⊠⊠ SQL DDL ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

```
SELECT missing_indexes_generate_script();
-- output: This was run on a database that was created before many corrections were made to ↩
     the loading script ---
CREATE INDEX idx_tiger_county_countyfp ON tiger.county USING btree(countyfp);
CREATE INDEX idx_tiger_cousub_countyfp ON tiger.cousub USING btree(countyfp);
CREATE INDEX idx_tiger_edges_tfidr ON tiger.edges USING btree(tfidr);
CREATE INDEX idx_tiger_edges_tfidl ON tiger.edges USING btree(tfidl);
CREATE INDEX idx_tiger_zip_lookup_all_zip ON tiger.zip_lookup_all USING btree(zip);
CREATE INDEX idx_tiger_data_ma_county_countyfp ON tiger_data.ma_county USING btree(countyfp ↩
    );
CREATE INDEX idx_tiger_data_ma_cousub_countyfp ON tiger_data.ma_cousub USING btree(countyfp ↩
    );
CREATE INDEX idx_tiger_data_ma_edges_countyfp ON tiger_data.ma_edges USING btree(countyfp);
CREATE INDEX idx_tiger_data_ma_faces_countyfp ON tiger_data.ma_faces USING btree(countyfp);
```

⊠⊠

Loader_Generate_Script, Install_Missing_Indexes

12.2.13 Normalize_Address

Normalize_Address — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠ norm_addy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ tiger_geocoder ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ (TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠.

Synopsis

norm_addy **normalize_address**(varchar in_address);

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ norm_addy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠ tiger ⊠⊠⊠⊠⊠⊠⊠ tiger_geocoder ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠ (州)/⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠. tiger ⊠⊠.

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ tiger ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠ norm_addy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ () ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠, [] ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠:

(address) [predirAbbrev] (streetName) [streetTypeAbbrev] [postdirAbbrev] [internal] [location] [stateAbbrev] [zip] [parsed] [zip4] [address_alphanumeric]

Enhanced: 2.4.0 norm_addy object includes additional fields zip4 and address_alphanumeric.

1. address ⊠⊠⊠⊠⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠.
2. predirAbbrev ⊠ varchar ⊠⊠⊠⊠: N, S, E, W ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. direction_look ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

3. `streetName` ⊠ varchar ⊠⊠⊠⊠.
4. `streetTypeAbbrev` ⊠ varchar ⊠⊠⊠, St, Ave, Cir ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `street_type_lookup` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
5. `postdirAbbrev` ⊠ varchar ⊠⊠⊠, N, S, E, W ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `direction_lookup` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
6. `internal` ⊠ varchar ⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
7. `location` ⊠ varchar ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
8. `stateAbbrev` ⊠ varchar ⊠⊠⊠, MA, NY, MI ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州名) ⊠⊠⊠. `state_lookup` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
9. `zip` ⊠ varchar ⊠⊠⊠⊠. 02109 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
10. `parsed` ⊠⊠ (boolean) ⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. normalize_address ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
11. `zip4` last 4 digits of a 9 digit zip code. Availability: PostGIS 2.4.0.
12. `address_alphanumeric` Full street number even if it has alpha characters like 17R. Parsing of this is better using Pagc_Normalize_Address function. Availability: PostGIS 2.4.0.

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```
SELECT address As orig, (g.na).streetname, (g.na).streettypeabbrev
 FROM (SELECT address, normalize_address(address) As na
        FROM addresses_to_geocode) As g;

                        orig                         |  streetname   | streettypeabbrev
-----------------------------------------------------+---------------+------------------
 28 Capen Street, Medford, MA                        | Capen         | St
 124 Mount Auburn St, Cambridge, Massachusetts 02138 | Mount Auburn  | St
 950 Main Street, Worcester, MA 01610                | Main          | St
 529 Main Street, Boston MA, 02129                   | Main          | St
 77 Massachusetts Avenue, Cambridge, MA 02139        | Massachusetts | Ave
 25 Wizard of Oz, Walaford, KS 99912323              | Wizard of Oz  |
```

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Geocode, Pprint_Addy

12.2.14 Pagc_Normalize_Address

Pagc_Normalize_Address — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ norm_addy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ tiger_geocoder ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠. address_standardizer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

norm_addy **pagc_normalize_address**(varchar in_address);

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☒☒☒☒ `tiger` ☒☒☒☒☒☒☒ tiger_geocoder ☒☒☒☒☒☒☒☒☒☒☒☒☒ pagc_* ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒ TIGER ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. `tiger` ☒☒☒.

☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ `tiger` ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒ `norm_addy` ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒ () ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, [] ☒☒☒☒☒☒☒☒☒☒☒☒☒☒:

Normalize_Address ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

2.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

This method needs address_standardizer extension.

(address) [predirAbbrev] (streetName) [streetTypeAbbrev] [postdirAbbrev] [internal] [location] [stateAbbrev] [zip]

☒☒☒☒☒ address_standardizer ☒☒☒☒☒☒☒☒☒ standardaddr ☒ norm_addy ☒☒☒☒☒☒☒☒☒☒☒. (☒☒☒☒☒☒☒) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. standardaddr ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒:

house_num, predir, name, suftype, sufdir, unit, city, state, postcode

Enhanced: 2.4.0 norm_addy object includes additional fields zip4 and address_alphanumeric.

1. `address` ☒☒☒☒☒☒☒☒: ☒☒☒☒☒☒☒☒☒.
2. `predirAbbrev` ☒ varchar ☒☒☒☒: N, S, E, W ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. `direction_lookup` ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
3. `streetName` ☒ varchar ☒☒☒☒.
4. `streetTypeAbbrev` ☒ varchar ☒☒☒, St, Ave, Cir ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. `street_type_lookup` ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
5. `postdirAbbrev` ☒ varchar ☒☒☒, N, S, E, W ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. `direction_lookup` ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
6. `internal` ☒ varchar ☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
7. `location` ☒ varchar ☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
8. `stateAbbrev` ☒ varchar ☒☒☒, MA, NY, MI ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (州名) ☒☒☒. `state_lookup` ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
9. `zip` ☒ varchar ☒☒☒☒. 02109 ☒☒☒☒☒☒☒☒☒☒☒☒.
10. `parsed` ☒☒ (boolean) ☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. normalize_address ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
11. `zip4` last 4 digits of a 9 digit zip code. Availability: PostGIS 2.4.0.
12. `address_alphanumeric` Full street number even if it has alpha characters like 17R. Parsing of this is better using Pagc_Normalize_Address function. Availability: PostGIS 2.4.0.

⊠⊠

⊠⊠⊠⊠⊠⊠

```
SELECT addy.*
FROM pagc_normalize_address('9000 E ROO ST STE 999, Springfield, CO') AS addy;


 address | predirabbrev | streetname | streettypeabbrev | postdirabbrev | internal  |   ↩
     location   | stateabbrev | zip | parsed
---------+--------------+------------+------------------+---------------+-----------+-------------

    9000 | E            | ROO        | ST               |               | SUITE 999 |  ↩
        SPRINGFIELD | CO          |     | t
```

⊠⊠⊠⊠⊠⊠. ⊠⊠ postgis_tiger_geocoder ⊠ address_standardizer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ normaddy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, Geocode ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Normalize_Address ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ address_standardizer ⊠ standardize_address ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
WITH g AS (SELECT address, ROW((sa).house_num, (sa).predir, (sa).name
  , (sa).suftype, (sa).sufdir, (sa).unit , (sa).city, (sa).state, (sa).postcode, true):: ↩
      norm_addy As na
 FROM (SELECT address, standardize_address('tiger.pagc_lex'
       , 'tiger.pagc_gaz'
       , 'tiger.pagc_rules', address) As sa
        FROM addresses_to_geocode) As g)
SELECT address As orig, (g.na).streetname, (g.na).streettypeabbrev
 FROM  g;

 orig                                                 |  streetname   | streettypeabbrev
-----------------------------------------------------+---------------+------------------
 529 Main Street, Boston MA, 02129                    | MAIN          | ST
 77 Massachusetts Avenue, Cambridge, MA 02139         | MASSACHUSETTS | AVE
 25 Wizard of Oz, Walaford, KS 99912323               | WIZARD OF     |
 26 Capen Street, Medford, MA                         | CAPEN         | ST
 124 Mount Auburn St, Cambridge, Massachusetts 02138 | MOUNT AUBURN  | ST
 950 Main Street, Worcester, MA 01610                 | MAIN          | ST
```

⊠⊠

Normalize_Address, Geocode

12.2.15 Pprint_Addy

Pprint_Addy — norm_addy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ normalize_address ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

varchar **pprint_addy**(norm_addy in_addy);

⊠⊠

norm_addy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠⊠ Normalize_Address ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT pprint_addy(normalize_address('202 East Fremont Street, Las Vegas, Nevada 89101'))
    As pretty_address;
            pretty_address
---------------------------------------
 202 E Fremont St, Las Vegas, NV 89101
```

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

```
SELECT address As orig, pprint_addy(normalize_address(address)) As pretty_address
        FROM addresses_to_geocode;

                        orig                     |              pretty_address
-----------------------------------------------------+-------------------------------------------

 529 Main Street, Boston MA, 02129                   | 529 Main St, Boston MA, 02129
 77 Massachusetts Avenue, Cambridge, MA 02139        | 77 Massachusetts Ave, Cambridge, MA
    02139
 28 Capen Street, Medford, MA                        | 28 Capen St, Medford, MA
 124 Mount Auburn St, Cambridge, Massachusetts 02138 | 124 Mount Auburn St, Cambridge, MA
    02138
 950 Main Street, Worcester, MA 01610                | 950 Main St, Worcester, MA 01610
```

⊠⊠

Normalize_Address

12.2.16 Reverse_Geocode

Reverse_Geocode — ⊠⊠⊠. include_strnum_range = true ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

record **Reverse_Geocode**(geometry pt, boolean include_strnum_range=false, geometry[] OUT intpt, norm_addy[] OUT addy, varchar[] OUT street);

⊠⊠

⊠⊠. include_strnum_range = true ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠

□□□□ include_strnum_range □□□□□□□□□□. □□.

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. TIGER □□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□ 26 Court Sq. □□□□□□□□□□□□□□□□□□□ 26 Court St. □ 26 Court Sq. □□□□□□□. □□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, □□.

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1. `intpt` □□□□□□□□□□□: □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□.
2. `addy` □ norm_addy(□□□□□□□□) □□□□□□: □□□□□□□□□□□, □□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□, □□□□□□□ 2 □□□ 3 □□□, □□□ 1 □□□□□□□□□□.
3. `street` □ varchar □□□□□□□: □□□□□□□□ (□□□□ 1 □) □□□ (□□□□□□□□□□□□□□□□□□□□□□□□□□).

Enhanced: 2.4.1 if optional zcta5 dataset is loaded, the reverse_geocode function can resolve to state and zip even if the specific state data is not loaded. Refer to Loader_Generate_Nation_Script for details on loading zcta5 data.

2.0.0 □□□□□□□□□□□□□□.

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```
SELECT pprint_addy(r.addy[1]) As st1, pprint_addy(r.addy[2]) As st2, pprint_addy(r.addy[3]) ↩
    As st3,
           array_to_string(r.street, ',') As cross_streets
        FROM reverse_geocode(ST_GeomFromText('POINT(-71.093902 42.359446)',4269),true) As r ↩
            ;

 result
 ------
     st1                                   | st2 | st3 |               cross_streets
-------------------------------------------+-----+-----+----------------------------------------------

 67 Massachusetts Ave, Cambridge, MA 02139 |     |     | 67 - 127 Massachusetts Ave,32 - 88 ↩
     Vassar St
```

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□, □□□.

```
SELECT pprint_addy(r.addy[1]) As st1, pprint_addy(r.addy[2]) As st2,
pprint_addy(r.addy[3]) As st3, array_to_string(r.street, ',') As cross_str
FROM reverse_geocode(ST_GeomFromText('POINT(-71.06941 42.34225)',4269)) As r;

result
```

```
--------
              st1              |              st2              | st3 | cross_str ←
--------------------------------+--------------------------------+-----+------------------------ ←

 5 Bradford St, Boston, MA 02118 | 49 Waltham St, Boston, MA 02118 |     | Waltham St
```

⊠⊠⊠⊠⊠ Geocode ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT actual_addr, lon, lat, pprint_addy((rg).addy[1]) As int_addr1,
    (rg).street[1] As cross1, (rg).street[2] As cross2
FROM (SELECT address As actual_addr, lon, lat,
    reverse_geocode( ST_SetSRID(ST_Point(lon,lat),4326) ) As rg
    FROM addresses_to_geocode WHERE rating
> -1) As foo;

                     actual_addr                     |    lon    |   lat    | ←
                         int_addr1                  |     cross1      |    ←
                         cross2
-----------------------------------------------------+-----------+----------+---------------------- ←

 529 Main Street, Boston MA, 02129                    | -71.07181 | 42.38359 | 527 Main St,  ←
    Boston, MA 02129              | Medford St       |
 77 Massachusetts Avenue, Cambridge, MA 02139         | -71.09428 | 42.35988 | 77  ←
    Massachusetts Ave, Cambridge, MA 02139 | Vassar St       |
 26 Capen Street, Medford, MA                         | -71.12377 | 42.41101 | 9 Edison Ave, ←
     Medford, MA 02155            | Capen St         | Tesla Ave
 124 Mount Auburn St, Cambridge, Massachusetts 02138 | -71.12304 | 42.37328 | 3 University  ←
    Rd, Cambridge, MA 02138       | Mount Auburn St |
 950 Main Street, Worcester, MA 01610                 | -71.82368 | 42.24956 | 3 Maywood St, ←
     Worcester, MA 01603          | Main St          | Maywood Pl
```

⊠⊠

Pprint_Addy, Pprint_Addy, ST_AsText

12.2.17 Topology_Load_Tiger

Topology_Load_Tiger — PostGIS ⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠.

Synopsis

text **Topology_Load_Tiger**(varchar topo_name, varchar region_type, varchar region_id);

⊠⊠

PostGIS ⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠, ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠, ⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠⊠ TIGER ⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Chapter 9 ⊠ Section 2.2.3 ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

> **Note**
> ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠⊠⊠:

1. `topo_name` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
2. `region_type` - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ `place` ⊠ `county` ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ `tiger.place`, `tiger.county` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
3. `region_id` - TIGER ⊠⊠⊠ ID(geoid) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. `place` ⊠⊠⊠ `tiger.place` ⊠⊠⊠⊠⊠⊠⊠ `plcidfp` ⊠⊠⊠⊠. `county` ⊠⊠⊠ `tiger.county` ⊠⊠⊠⊠⊠⊠ `cntyidfp` ⊠⊠⊠⊠.

2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (2249) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0.25 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ TIGER ⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT topology.CreateTopology('topo_boston', 2249, 0.25);
createtopology
--------------
   15
-- 60,902 ms ~ 1 minute on windows 7 desktop running 9.1 (with 5 states tiger data loaded)
SELECT tiger.topology_load_tiger('topo_boston', 'place', '2507000');
-- topology_loader_tiger --
29722 edges holding in temporary. 11108 faces added. 1875 edges of faces added.  20576 ←
    nodes added.
19962 nodes contained in a face.  0 edge start end corrected.  31597 edges added.

-- 41 ms --
SELECT topology.TopologySummary('topo_boston');
 -- topologysummary--
Topology topo_boston (15), SRID 2249, precision 0.25
20576 nodes, 31597 edges, 11109 faces, 0 topogeoms in 0 layers

-- 28,797 ms to validate yeh returned no errors --
SELECT * FROM
    topology.ValidateTopology('topo_boston');

       error       |   id1    |    id2
-------------------+----------+-----------
```

⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠

⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (26986) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0.25 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIGER ⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

```
SELECT topology.CreateTopology('topo_suffolk', 26986, 0.25);
-- this took 56,275 ms ~ 1 minute on Windows 7 32-bit with 5 states of tiger loaded
-- must have been warmed up after loading boston
SELECT tiger.topology_load_tiger('topo_suffolk', 'county', '25025');
-- topology_loader_tiger --
 36003 edges holding in temporary. 13518 faces added. 2172 edges of faces added.
 24761 nodes added.  24075 nodes contained in a face.  0 edge start end corrected.  38175 ↩
     edges added.
-- 31 ms --
SELECT topology.TopologySummary('topo_suffolk');
 -- topologysummary--
 Topology topo_suffolk (14), SRID 26986, precision 0.25
24761 nodes, 38175 edges, 13519 faces, 0 topogeoms in 0 layers

-- 33,606 ms to validate --
SELECT * FROM
    topology.ValidateTopology('topo_suffolk');

       error       |   id1    |    id2
-------------------+----------+-----------
 coincident nodes  | 81045651 |  81064553
 edge crosses node | 81045651 |  85737793
 edge crosses node | 81045651 |  85742215
 edge crosses node | 81045651 | 620628939
 edge crosses node | 81064553 |  85697815
 edge crosses node | 81064553 |  85728168
 edge crosses node | 81064553 |  85733413
```

⊠⊠

CreateTopology, CreateTopoGeom, TopologySummary, ValidateTopology

12.2.18 Set_Geocode_Setting

Set_Geocode_Setting — ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Synopsis

text **Set_Geocode_Setting**(text setting_name, text setting_value);

⊠⊠

`tiger.geocode_settings` ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Get_Geocode_Setting ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

□□: □□□□□□□□

□□□□□□□ Geocode □□□□□□, NOTICE □□□□□□□□□□□□□□□□□□.

```
SELECT set_geocode_setting('debug_geocode_address', 'true') As result;
result
---------
true
```

□□

Get_Geocode_Setting

Chapter 13

PostGIS Special Functions Index

13.1 PostGIS Aggregate Functions

The functions below are spatial aggregate functions that are used in the same way as SQL aggregate function such as `sum` and `average`.

- CG_3DUnion - Perform 3D union using postgis_sfcgal.
- ST_3DExtent - Aggregate function that returns the 3D bounding box of geometries.
- ST_3DUnion - Perform 3D union.
- ST_AsFlatGeobuf - Return a FlatGeobuf representation of a set of rows.
- ST_AsGeobuf - Return a Geobuf representation of a set of rows.
- ST_AsMVT - Aggregate function returning a MVT representation of a set of rows.
- ST_ClusterDBSCAN - Window function that returns a cluster id for each input geometry using the DBSCAN algorithm.
- ST_ClusterIntersecting - Aggregate function that clusters input geometries into connected sets.
- ST_ClusterIntersectingWin - Window function that returns a cluster id for each input geometry, clustering input geometries into connected sets.
- ST_ClusterKMeans - Window function that returns a cluster id for each input geometry using the K-means algorithm.
- ST_ClusterWithin - Aggregate function that clusters geometries by separation distance.
- ST_ClusterWithinWin - Window function that returns a cluster id for each input geometry, clustering using separation distance.
- ST_Collect - Creates a GeometryCollection or Multi* geometry from a set of geometries.
- ST_CoverageInvalidEdges - Window function that finds locations where polygons fail to form a valid coverage.
- ST_CoverageSimplify - Window function that simplifies the edges of a polygonal coverage.
- ST_CoverageUnion - Computes the union of a set of polygons forming a coverage by removing shared edges.
- ST_Extent - Aggregate function that returns the bounding box of geometries.

- ST_MakeLine - ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MemUnion - Aggregate function which unions geometries in a memory-efficent but slower way
- ST_Polygonize - Computes a collection of polygons formed from the linework of a set of geometries.
- ST_SameAlignment - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Union - Computes a geometry representing the point-set union of the input geometries.
- ST_Union - ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- TopoElementArray_Agg - Returns a topoelementarray for a set of element_id, type arrays (topoelements).

13.2 PostGIS Window Functions

The functions below are spatial window functions that are used in the same way as SQL window functions such as `row_number()`, `lead()`, and `lag()`. They must be followed by an `OVER()` clause.

- ST_ClusterDBSCAN - Window function that returns a cluster id for each input geometry using the DBSCAN algorithm.
- ST_ClusterIntersectingWin - Window function that returns a cluster id for each input geometry, clustering input geometries into connected sets.
- ST_ClusterKMeans - Window function that returns a cluster id for each input geometry using the K-means algorithm.
- ST_ClusterWithinWin - Window function that returns a cluster id for each input geometry, clustering using separation distance.
- ST_CoverageInvalidEdges - Window function that finds locations where polygons fail to form a valid coverage.
- ST_CoverageSimplify - Window function that simplifies the edges of a polygonal coverage.

13.3 PostGIS SQL-MM Compliant Functions

The functions given below are PostGIS functions that conform to the SQL/MM 3 standard

- CG_3DArea - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DDifference - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DIntersection - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DUnion - Perform 3D union using postgis_sfcgal.
- CG_Volume - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠) 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DArea - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DDWithin - Tests if two 3D geometries are within a given 3D distance
- ST_3DDifference - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_3DDistance - ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DIntersection - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DIntersects - Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)
- ST_3DLength - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DPerimeter - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DUnion - Perform 3D union.
- ST_AddEdgeModFace - ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AddEdgeNewFaces - ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠.
- ST_AddIsoEdge - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ anode ⊠ anothernode ⊠⊠⊠⊠⊠ alinestring ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠.
- ST_AddIsoNode - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (isolated) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ NULL ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Area - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsBinary - Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsGML - ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsText - ⊠⊠/⊠⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Boundary - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Buffer - Computes a geometry covering all points within a given distance from a geometry.
- ST_Centroid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ChangeEdgeGeom - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Contains - Tests if every point of B lies in A, and their interiors have a point in common
- ST_ConvexHull - Computes the convex hull of a geometry.
- ST_CoordDim - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_CreateTopoGeo - ⊠⊠⊠.
- ST_Crosses - Tests if two geometries have some, but not all, interior points in common
- ST_CurveN - Returns the Nth component curve geometry of a CompoundCurve.
- ST_CurveToLine - Converts a geometry containing curves to a linear geometry.
- ST_Difference - Computes a geometry representing the part of geometry A that does not intersect geometry B.
- ST_Dimension - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Disjoint - Tests if two geometries have no points in common
- ST_Distance - ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_EndPoint - ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Envelope - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (double precision; float8) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Equals - Tests if two geometries include the same set of points
- ST_ExteriorRing - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GMLToSQL - GML ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFromGML ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.
- ST_GeomCollFromText - Makes a collection Geometry from collection WKT with the given SRID. If SRID is not given, it defaults to 0.
- ST_GeomFromText - WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromWKB - WKB(Well-Known Binary) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠.
- ST_GeometryFromText - WKT(Well-Known Text) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_GeomFromText ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometryN - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometryType - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GetFaceEdges - aface ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GetFaceGeometry - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_InitTopoGeo - Creates a new topology schema and registers it in the topology.topology table.
- ST_InteriorRingN - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Intersection - Computes a geometry representing the shared portion of geometries A and B.
- ST_Intersects - Tests if two geometries intersect (they have at least one point in common)
- ST_IsClosed - LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠ ⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_IsEmpty - Tests if a geometry is empty.
- ST_IsRing - Tests if a LineString is closed and simple.
- ST_IsSimple - ⊠⊠⊠ TRUE ⊠⊠ ⊠⊠⊠⊠.
- ST_IsValid - Tests if a geometry is well-formed in 2D.
- ST_Length - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_LineFromText - ⊠⊠⊠ SRID ⊠⊠⊠ WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠.
- ST_LineFromWKB - ⊠⊠⊠ SRID ⊠⊠⊠ WKB ⊠⊠⊠ LINESTRING ⊠⊠⊠⊠⊠.
- ST_LinestringFromWKB - ⊠⊠⊠ SRID ⊠⊠⊠ WKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_LocateAlong - Returns the point(s) on a geometry that match a measure value.
- ST_LocateBetween - Returns the portions of a geometry that match a measure range.
- ST_M - Returns the M coordinate of a Point.
- ST_MLineFromText - WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_MultiLineString ⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_MPointFromText - Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.
- ST_MPolyFromText - Makes a MultiPolygon Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.
- ST_ModEdgeHeal - Heals two edges by deleting the node connecting them, modifying the first edge and deleting the second edge. Returns the id of the deleted node.
- ST_ModEdgeSplit - [illegible], [illegible].
- ST_MoveIsoNode - Moves an isolated node in a topology from one point to another. If new apoint geometry exists as a node an error is thrown. Returns description of move.
- ST_NewEdgeHeal - Heals two edges by deleting the node connecting them, deleting both edges, and replacing them with an edge whose direction is the same as the first edge provided.
- ST_NewEdgesSplit - [illegible], [illegible] 2 [illegible]. [illegible] ID [illegible].
- ST_NumCurves - Return the number of component curves in a CompoundCurve.
- ST_NumGeometries - [illegible]. [illegible].
- ST_NumInteriorRings - [illegible].
- ST_NumPatches - [illegible]. [illegible] NULL [illegible].
- ST_NumPoints - ST_LineString [illegible] ST_CircularString [illegible].
- ST_OrderingEquals - Tests if two geometries represent the same geometry and have points in the same directional order
- ST_Overlaps - Tests if two geometries have the same dimension and intersect, but each has at least one point not in the other
- ST_PatchN - ST_Geometry [illegible].
- ST_Perimeter - Returns the length of the boundary of a polygonal geometry or geography.
- ST_Point - Creates a Point with X, Y and SRID values.
- ST_PointFromText - [illegible] SRID [illegible] WKT [illegible]. SRID [illegible], [illegible] 0 [illegible].
- ST_PointFromWKB - [illegible] SRID [illegible] WKB [illegible].
- ST_PointN - ST_LineString [illegible] ST_CircularString [illegible].
- ST_PointOnSurface - Computes a point guaranteed to lie in a polygon, or on a geometry.
- ST_Polygon - Creates a Polygon from a LineString with a specified SRID.
- ST_PolygonFromText - Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.
- ST_Relate - Tests if two geometries have a topological relationship matching an Intersection Matrix pattern, or computes their Intersection Matrix
- ST_RemEdgeModFace - Removes an edge, and if the edge separates two faces deletes one face and modifies the other face to cover the space of both.
- ST_RemEdgeNewFace - [illegible], [illegible], [illegible].

- ST_RemoveIsoEdge - Removes an isolated edge and returns description of action. If the edge is not isolated, then an exception is thrown.
- ST_RemoveIsoNode - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_SRID - Returns the spatial reference identifier for a geometry.
- ST_StartPoint - Returns the first point of a LineString.
- ST_SymDifference - Computes a geometry representing the portions of geometries A and B that do not intersect.
- ST_Touches - Tests if two geometries have at least one point in common, but their interiors do not intersect
- ST_Transform - Return a new geometry with coordinates transformed to a different spatial reference system.
- ST_Union - Computes a geometry representing the point-set union of the input geometries.
- ST_Volume - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_WKBToSQL - WKB(Well-Known Binary) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠ ST_GeomFromWKB ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_WKTToSQL - WKT(Well-Known Text) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFrom ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Within - Tests if every point of A lies in B, and their interiors have a point in common
- ST_X - Returns the X coordinate of a Point.
- ST_Y - Returns the Y coordinate of a Point.
- ST_Z - Returns the Z coordinate of a Point.
- ST_SRID - Returns the spatial reference identifier for a topogeometry.

13.4 PostGIS Geography Support Functions

The functions and operators given below are PostGIS functions/operators that take as input or return as output a geography data type object.

> **Note**
> Functions with a (T) are not native geodetic functions, and use a ST_Transform call to and from geometry to do the operation. As a result, they may not behave as expected when going over dateline, poles, and for large geometries or geometry pairs that cover more than one UTM zone. Basic transform - (favoring UTM, Lambert Azimuthal (North/South), and falling back on mercator in worst case scenario)

- ST_Area - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsBinary - Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKT - ⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsGML - ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_AsGeoJSON - Return a geometry or feature in GeoJSON format.
- ST_AsKML - ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsSVG - Returns SVG path data for a geometry.
- ST_AsText - ⊠⊠/⊠⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Azimuth - ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Buffer - Computes a geometry covering all points within a given distance from a geometry.
- ST_Centroid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ClosestPoint - Returns the 2D point on g1 that is closest to g2. This is the first point of the shortest line from one geometry to the other.
- ST_CoveredBy - Tests if every point of A lies in B
- ST_Covers - Tests if every point of B lies in A
- ST_DWithin - Tests if two geometries are within a given distance
- ST_Distance - ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeogFromText - WKT (⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeogFromWKB - WKB ⊠⊠⊠⊠⊠⊠⊠ EWKB(⊠⊠ WKB) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeographyFromText - WKT (⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- = - Returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B.
- ST_Intersection - Computes a geometry representing the shared portion of geometries A and B.
- ST_Intersects - Tests if two geometries intersect (they have at least one point in common)
- ST_Length - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_LineInterpolatePoint - Returns a point interpolated along a line at a fractional location.
- ST_LineInterpolatePoints - Returns points interpolated along a line at a fractional interval.
- ST_LineLocatePoint - Returns the fractional location of the closest point on a line to a point.
- ST_LineSubstring - Returns the part of a line between two fractional locations.
- ST_Perimeter - Returns the length of the boundary of a polygonal geometry or geography.
- ST_Project - Returns a point projected from a start point by a distance and bearing (azimuth).
- ST_Segmentize - Returns a modified geometry/geography having no segment longer than a given distance.
- ST_ShortestLine - ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Summary - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- <-> - A ⊠ B ⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- && - A ⊠ 2D ⊠⊠⊠⊠⊠ B ⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.

13.5 PostGIS Raster Support Functions

The functions and operators given below are PostGIS functions/operators that take as input or return as output a raster data type object. Listed in alphabetical order.

- Box3D - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ BOX3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- @ - B ⊠⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ~ - A ⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- = - A ⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- && - A ⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠.
- &< - A ⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠.
- &> - A ⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠.
- ~= - A ⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠.
- ST_Retile - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AddBand - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsBinary/ST_AsWKB - Return the Well-Known Binary (WKB) representation of the raster.
- ST_AsGDALRaster - Return the raster tile in the designated GDAL Raster format. Raster formats are one of those supported by your compiled library. Use ST_GDALDrivers() to get a list of formats supported by your library.
- ST_AsHexWKB - Return the Well-Known Binary (WKB) in Hex representation of the raster.
- ST_AsJPEG - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ JPEG(Joint Photographic Exports Group) ⊠⊠⊠ (⊠⊠ ⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠ RGB ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsPNG - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PNG(Portable Network Graphics) ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠ ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠, 3 ⊠, ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ 2 ⊠ ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ RGB ⊠⊠ RGBA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsRaster - PostGIS ⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsTIFF - Return the raster selected bands as a single TIFF image (byte array). If no band is specified or any of specified bands does not exist in the raster, then will try to use all bands.
- ST_Aspect - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Band - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠.
- ST_BandFileSize - Returns the file size of a band stored in file system. If no bandnum specified, 1 is assumed.
- ST_BandFileTimestamp - Returns the file timestamp of a band stored in file system. If no bandnum specified, 1 is assumed.
- ST_BandIsNoData - ⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_BandMetaData - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_BandNoDataValue - ⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.
- ST_BandPath - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. bandnum ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.
- ST_BandPixelType - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. bandnum ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.
- ST_Clip - Returns the raster clipped by the input geometry. If band number is not specified, all bands are processed. If crop is not specified or TRUE, the output raster is cropped. If touched is set to TRUE, then touched pixels are included, otherwise only if the center of the pixel is in the geometry it is included.
- ST_ColorMap - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 8BUI ⊠⊠ (grayscale, RGB, RGBA) ⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.
- ST_Contains - ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ContainsProperly - rastB ⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Contour - Generates a set of vector contours from the provided raster band, using the GDAL contouring algorithm.
- ST_ConvexHull - BandNoDataValue ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ST_Envelope ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Count - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.
- ST_CountAgg - ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_CoveredBy - ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Covers - ⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DFullyWithin - ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DWithin - ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Disjoint - ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DumpAsPolygons - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ geomval(geom, val) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.
- ST_DumpValues - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Envelope - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_FromGDALRaster - ⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeoReference - ⊠⊠ (world) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠ ESRI ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠.
- ST_Grayscale - Creates a new one-8BUI band raster from the source raster and specified bands representing Red, Green and Blue
- ST_HasNoBand - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠ ⊠⊠⊠⊠⊠⊠.

- ST_Height - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_HillShade - ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Histogram - ⊠ (bin; ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_InterpolateRaster - Interpolates a gridded surface based on an input set of 3-d points, using the X- and Y-values to position the points on the grid and the Z-value of the points as the surface elevation.
- ST_Intersection - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠-⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Intersects - ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_IsEmpty - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (width = 0, height = 0) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MakeEmptyCoverage - Cover georeferenced area with a grid of empty raster tiles.
- ST_MakeEmptyRaster - ⊠⊠⊠⊠⊠ (⊠⊠ & ⊠⊠), ⊠⊠⊠ X ⊠ Y, ⊠⊠⊠⊠, ⊠⊠ (scalex, scaley, skewx & skewy) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (SRID) ⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. SRID ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 0(unknown) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebra (callback function version) - ⊠⊠⊠⊠⊠⊠ - ⊠⊠⊠ 1 ⊠⊠⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebraExpr - ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebraExpr - ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠: ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠. extenttype ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. extenttype ⊠⊠⊠ INTERSECTION, UNION, FIRST, SECOND ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebraFct - ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebraFct - ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠: ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ INTERSECTION ⊠⊠⊠.
- ST_MapAlgebraFctNgb - ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠: ⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Map Algebra Nearest Neighbor) ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (neighborhood) ⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebra (expression version) - ⊠⊠⊠⊠⊠ - ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠ 2 ⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MemSize - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠.
- ST_MetaData - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ (skew), ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MinConvexHull - ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NearestValue - columnx ⊠ rowy, ⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_Neighborhood - columnx ⊠ rowy, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NotSameAlignmentReason - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NumBands - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Overlaps - ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.
- ST_PixelAsCentroid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.
- ST_PixelAsCentroids - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelAsPoint - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelAsPoints - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelAsPolygon - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelAsPolygons - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.
- ST_PixelHeight - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelOfValue - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ columnx, rowy ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelWidth - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Polygon - NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Quantile - ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (population) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (quantile) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠, ⊠⊠⊠⊠ 25%, 50%, 75% ⊠⊠⊠ (percentile) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠.
- ST_RastFromHexWKB - Return a raster value from a Hex representation of Well-Known Binary (WKB) raster.
- ST_RastFromWKB - Return a raster value from a Well-Known Binary (WKB) raster.
- ST_RasterToWorldCoord - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y(⊠⊠, ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ ⊠. ⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.
- ST_RasterToWorldCoordX - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.
- ST_RasterToWorldCoordY - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.
- ST_Reclass - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. nband ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠. nband ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ ⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 16BUI ⊠⊠⊠ 8BUI ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Resample - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Rescale - Resample a raster by adjusting only its scale (or pixel size). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline, Lanczos, Max or Min resampling algorithm. Default is NearestNeighbor.
- ST_Resize - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_Reskew - □□□ (□□□□□□□□□) □□□□□□□□□□□□□□□□. NearestNeighbor(□□□□□□□□), Bilinear, Cubic, CubicSpline □□ Lanczos □□□□□□□□□□□□□□□□□□□□□□□□□. □□□□ NearestNeighbor □□□.
- ST_Rotation - □□□□□□□□□□□□□□□□□□□□.
- ST_Roughness - DEM □□□□" □□□ (roughness)" □□□□□□□□□□□□.
- ST_SRID - spatial_ref_sys □□□□□□□□□□□, □□□□□□□□□□□□□□□□□□.
- ST_SameAlignment - □□□□□□□□□□□, □□, □□□□□□□□, □□□□□□□□□□□□□□□ (□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□) □□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□.
- ST_ScaleX - □□□□□ X □□□□□□□□□□□□□□□□□□□□□.
- ST_ScaleY - □□□□□ Y □□□□□□□□□□□□□□□□□□□□□.
- ST_SetBandIndex - Update the external band number of an out-db band
- ST_SetBandIsNoData - □□□ isnodata □□□□□□□□□□□□□.
- ST_SetBandNoDataValue - NODATA □□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□ 1 □□□□□□□. □□□ NODATA □□□□□□□□□□, nodata value = NULL □□□□□□□□□□.
- ST_SetBandPath - Update the external path and band number of an out-db band
- ST_SetGeoReference - □□□□□□□□□□□□□□ 6 □□□□□□□□. □□□□□□□□□□□□□□□□□. GDAL □□ ESRI □□□□□□□□□□□□□□. □□□□ GDAL □□□.
- ST_SetM - Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the M dimension using the requested resample algorithm.
- ST_SetRotation - □□□□□□□□□□□□□□□□□□□□□□.
- ST_SetSRID - □□□□ SRID □ spatial_ref_sys □□□□□□□□□□ SRID □□□□□□□□□□□□.
- ST_SetScale - X □ Y □□□□□□□□□□□□□□□□□□□□□□□□□□. □□/□□□□/□□□□□□□□□□□.
- ST_SetSkew - □□□□ X □ Y □□□ (skew)(□□□□□□□□□□) □□□□□□□. □□□□□□□□□□, X □ Y □□□□□□□□□□□□□□.
- ST_SetUpperLeft - Sets the value of the upper left corner of the pixel of the raster to projected X and Y coordinates.
- ST_SetValue - □□□ columnx, rowy □□□. □□□□□ 1 □□□□□□□, □□□□□□□□□□□ 1 □□□□□□□.
- ST_SetValues - □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.
- ST_SetZ - Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the Z dimension using the requested resample algorithm.
- ST_SkewX - □□□□ X □□□ (skew)(□□□□□□□□□□) □□□□□□□.
- ST_SkewY - □□□□ Y □□□ (□□□□□□□□□□) □□□□□□□.
- ST_Slope - □□□□□□□□□□□ (□□□□□□□) □□□□□□□. □□□□□□□□□□□□□□□.
- ST_SnapToGrid - □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. NearestNeighbor(□□□□□□□□), Bilinear, Cubic, CubicSpline □□ Lanczos □□□□□□□□□□□□□□□□□□□□□□□□□. □□□□ NearestNeighbor □□□.
- ST_Summary - □□□□□□□□□□□□□□□□□□□□□□□.

- ST_SummaryStats - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ count, sum, mean, stddev, min, max ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.
- ST_SummaryStatsAgg - ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ count, sum, mean, stddev, min, max ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.
- ST_TPI - ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Topographic Position Index) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_TRI - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Terrain Ruggedness Index) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Tile - ⊠⊠⊠.
- ST_Touches - ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_Transform - ⊠⊠. NearestNeighbor, Bilinear, Cubic, CubicSpline, Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.
- ST_Union - ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_UpperLeftX - ⊠⊠⊠⊠⊠⊠⊠ X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_UpperLeftY - ⊠⊠⊠⊠⊠⊠⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Value - ⊠⊠ columnx, rowy ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, nodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ValueCount - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠. ⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Width - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Within - ⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_WorldToRasterCoord - ⊠⊠⊠⊠⊠⊠⊠ X, Y(⊠⊠, ⊠⊠) ⊠⊠⊠.
- ST_WorldToRasterCoordX - ⊠⊠⊠⊠⊠ (pt) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠ (xw, yw) ⊠⊠⊠⊠⊠⊠.
- ST_WorldToRasterCoordY - ⊠⊠⊠⊠⊠ (pt) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠ (xw, yw) ⊠⊠⊠⊠⊠⊠.
- UpdateRasterSRID - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠.

13.6 PostGIS Geometry / Geography / Raster Dump Functions

The functions given below are PostGIS functions that take as input or return as output a set of or single geometry_dump or geomval data type object.

- ST_DumpAsPolygons - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ geomval(geom, val) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.
- ST_Intersection - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠-⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_Dump - Returns a set of geometry_dump rows for the components of a geometry.
- ST_DumpPoints - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DumpRings - Returns a set of geometry_dump rows for the exterior and interior rings of a Polygon.
- ST_DumpSegments - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

13.7 PostGIS Box Functions

The functions given below are PostGIS functions that take as input or return as output the box* family of PostGIS spatial types. The box family of types consists of box2d, and box3d

- Box2D - Returns a BOX2D representing the 2D extent of a geometry.
- Box3D - Returns a BOX3D representing the 3D extent of a geometry.
- Box3D - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ BOX3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DExtent - Aggregate function that returns the 3D bounding box of geometries.
- ST_3DMakeBox - Creates a BOX3D defined by two 3D point geometries.
- ST_AsMVTGeom - Transforms a geometry into the coordinate space of a MVT tile.
- ST_AsTWKB - ⊠⊠⊠ TWKB(Tiny Well-Known Binary) ⊠⊠⊠⊠⊠⊠.
- ST_Box2dFromGeoHash - GeoHash ⊠⊠⊠⊠⊠⊠⊠ BOX2D ⊠⊠⊠⊠⊠⊠.
- ST_ClipByBox2D - Computes the portion of a geometry falling within a rectangle.
- ST_EstimatedExtent - Returns the estimated extent of a spatial table.
- ST_Expand - Returns a bounding box expanded from another bounding box or a geometry.
- ST_Extent - Aggregate function that returns the bounding box of geometries.
- ST_MakeBox2D - Creates a BOX2D defined by two 2D point geometries.
- ST_RemoveIrrelevantPointsForView - Removes points that are irrelevant for rendering a specific rectangluar view of a geometry.
- ST_XMax - Returns the X maxima of a 2D or 3D bounding box or a geometry.
- ST_XMin - Returns the X minima of a 2D or 3D bounding box or a geometry.
- ST_YMax - Returns the Y maxima of a 2D or 3D bounding box or a geometry.
- ST_YMin - Returns the Y minima of a 2D or 3D bounding box or a geometry.
- ST_ZMax - Returns the Z maxima of a 2D or 3D bounding box or a geometry.
- ST_ZMin - Returns the Z minima of a 2D or 3D bounding box or a geometry.
- RemoveUnusedPrimitives - Removes topology primitives which not needed to define existing TopoGeometry objects.
- ValidateTopology - Returns a set of validatetopology_returntype objects detailing issues with topology.
- ~(box2df,box2df) - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).

- ~(box2df,geometry) - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bonding box.
- ~(geometry,box2df) - Returns TRUE if a geometry's 2D bonding box contains a 2D float precision bounding box (GIDX).
- @(box2df,box2df) - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.
- @(box2df,geometry) - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.
- @(geometry,box2df) - Returns TRUE if a geometry's 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).
- &&(box2df,box2df) - Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.
- &&(box2df,geometry) - Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.
- &&(geometry,box2df) - Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).

13.8 PostGIS Functions that support 3D

The functions given below are PostGIS functions that do not throw away the Z-Index.

- AddGeometryColumn - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Box3D - Returns a BOX3D representing the 3D extent of a geometry.
- CG_3DArea - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DConvexHull - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DDifference - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DIntersection - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DUnion - Perform 3D union using postgis_sfcgal.
- CG_ApproximateMedialAxis - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_ConstrainedDelaunayTriangles - Return a constrained Delaunay triangulation around the given input geometry.
- CG_Extrude - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_ForceLHR - LHR(Left Hand Reverse; ⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_IsPlanar - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_IsSolid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_MakeSolid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠.
- CG_Orientation - ⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠.
- CG_StraightSkeleton - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (straight skeleton) ⊠⊠⊠⊠⊠⊠.

- CG_Tesselate - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tessellation) ⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_Visibility - Compute a visibility polygon from a point or a segment in a polygon geometry
- CG_Volume - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠) 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- DropGeometryColumn - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- GeometryType - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DArea - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DClosestPoint - g2 ⊠⊠⊠⊠⊠⊠⊠ g1 ⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DConvexHull - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DDFullyWithin - Tests if two 3D geometries are entirely within a given 3D distance
- ST_3DDWithin - Tests if two 3D geometries are within a given 3D distance
- ST_3DDifference - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DDistance - ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DExtent - Aggregate function that returns the 3D bounding box of geometries.
- ST_3DIntersection - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DIntersects - Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)
- ST_3DLength - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DLineInterpolatePoint - Returns a point interpolated along a 3D line at a fractional location.
- ST_3DLongestLine - ⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DMaxDistance - ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DPerimeter - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DShortestLine - ⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (shortest) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DUnion - Perform 3D union.
- ST_AddMeasure - Interpolates measures along a linear geometry.
- ST_AddPoint - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Affine - Apply a 3D affine transformation to a geometry.
- ST_ApproximateMedialAxis - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsBinary - Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKB - Return the Extended Well-Known Binary (EWKB) representation of the geometry with SRID meta data.
- ST_AsEWKT - ⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsGML - ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_AsGeoJSON - Return a geometry or feature in GeoJSON format.
- ST_AsHEXEWKB - ⊠⊠⊠⊠⊠⊠⊠ (NDR) ⊠⊠⊠⊠⊠⊠ (XDR) ⊠⊠⊠⊠⊠⊠ HEXEWKB (⊠⊠⊠) ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.
- ST_AsKML - ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsX3D - ⊠⊠⊠ X3D XML ⊠⊠⊠⊠⊠⊠: ISO-IEC-19776-1.2-X3DEncodings-XML ⊠⊠⊠⊠⊠⊠.
- ST_Boundary - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_BoundingDiagonal - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_CPAWithin - Tests if the closest point of approach of two trajectories is within the specified distance.
- ST_ChaikinSmoothing - Returns a smoothed version of a geometry, using the Chaikin algorithm
- ST_ClosestPointOfApproach - Returns a measure at the closest point of approach of two trajectories.
- ST_Collect - Creates a GeometryCollection or Multi* geometry from a set of geometries.
- ST_ConstrainedDelaunayTriangles - Return a constrained Delaunay triangulation around the given input geometry.
- ST_ConvexHull - Computes the convex hull of a geometry.
- ST_CoordDim - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_CurveN - Returns the Nth component curve geometry of a CompoundCurve.
- ST_CurveToLine - Converts a geometry containing curves to a linear geometry.
- ST_DelaunayTriangles - Returns the Delaunay triangulation of the vertices of a geometry.
- ST_Difference - Computes a geometry representing the part of geometry A that does not intersect geometry B.
- ST_DistanceCPA - Returns the distance between the closest point of approach of two trajectories.
- ST_Dump - Returns a set of geometry_dump rows for the components of a geometry.
- ST_DumpPoints - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DumpRings - Returns a set of geometry_dump rows for the exterior and interior rings of a Polygon.
- ST_DumpSegments - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_EndPoint - ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ExteriorRing - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Extrude - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_FlipCoordinates - Returns a version of a geometry with X and Y axis flipped.
- ST_Force2D - ⊠⊠⊠”2 ⊠⊠⊠⊠” ⊠⊠⊠⊠⊠⊠.
- ST_ForceCurve - ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (upcast) ⊠⊠⊠.
- ST_ForceLHR - LHR(Left Hand Reverse; ⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForcePolygonCCW - Orients all exterior rings counter-clockwise and all interior rings clockwise.
- ST_ForcePolygonCW - Orients all exterior rings clockwise and all interior rings counter-clockwise.

- ST_ForceRHR - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠ (Right-Hand Rule) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceSFS - ⊠⊠⊠ SFS 1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3D - ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠. ST_Force3DZ ⊠⊠⊠⊠⊠⊠.
- ST_Force3DZ - ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Force4D - ⊠⊠⊠ XYZM ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceCollection - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromEWKB - EWKB(Extended Well-Known Binary) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromEWKT - EWKT(Extended Well-Known Text) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromGML - ⊠⊠⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromGeoJSON - GeoJSON ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromKML - ⊠⊠⊠ KML ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometricMedian - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (median) ⊠⊠⊠⊠⊠⊠.
- ST_GeometryN - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometryType - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_HasArc - Tests if a geometry contains a circular arc
- ST_HasM - Checks if a geometry has an M (measure) dimension.
- ST_HasZ - Checks if a geometry has a Z dimension.
- ST_InteriorRingN - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_InterpolatePoint - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (M ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Intersection - Computes a geometry representing the shared portion of geometries A and B.
- ST_IsClosed - LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_IsCollection - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_IsPlanar - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_IsPolygonCCW - Tests if Polygons have exterior rings oriented counter-clockwise and interior rings oriented clockwise.
- ST_IsPolygonCW - Tests if Polygons have exterior rings oriented clockwise and interior rings oriented counter-clockwise.
- ST_IsSimple - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_IsSolid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_IsValidTrajectory - Tests if the geometry is a valid trajectory.
- ST_LengthSpheroid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_LineFromMultiPoint - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_LineInterpolatePoint - Returns a point interpolated along a line at a fractional location.

- ST_LineInterpolatePoints - Returns points interpolated along a line at a fractional interval.
- ST_LineSubstring - Returns the part of a line between two fractional locations.
- ST_LineToCurve - Converts a linear geometry to a curved geometry.
- ST_LocateBetweenElevations - Returns the portions of a geometry that lie in an elevation (Z) range.
- ST_M - Returns the M coordinate of a Point.
- ST_MakeLine - ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MakePoint - Creates a 2D, 3DZ or 4D Point.
- ST_MakePolygon - Creates a Polygon from a shell and optional list of holes.
- ST_MakeSolid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠.
- ST_MakeValid - Attempts to make an invalid geometry valid without losing vertices.
- ST_MemSize - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MemUnion - Aggregate function which unions geometries in a memory-efficent but slower way
- ST_NDims - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NPoints - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NRings - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Node - Nodes a collection of lines.
- ST_NumCurves - Return the number of component curves in a CompoundCurve.
- ST_NumGeometries - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NumPatches - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠ ⊠.
- ST_Orientation - ⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠.
- ST_PatchN - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PointFromWKB - ⊠⊠⊠ SRID ⊠⊠⊠ WKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PointN - ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PointOnSurface - Computes a point guaranteed to lie in a polygon, or on a geometry.
- ST_Points - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Polygon - Creates a Polygon from a LineString with a specified SRID.
- ST_RemovePoint - Remove a point from a linestring.
- ST_RemoveRepeatedPoints - Returns a version of a geometry with duplicate points removed.
- ST_Reverse - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Rotate - Rotates a geometry about an origin point.
- ST_RotateX - Rotates a geometry about the X axis.
- ST_RotateY - Rotates a geometry about the Y axis.
- ST_RotateZ - Rotates a geometry about the Z axis.
- ST_Scale - Scales a geometry by given factors.

- ST_Scroll - Change start point of a closed LineString.
- ST_SetPoint - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ShiftLongitude - Shifts the longitude coordinates of a geometry between -180..180 and 0..360.
- ST_SnapToGrid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (snap) ⊠⊠⊠⊠⊠.
- ST_StartPoint - Returns the first point of a LineString.
- ST_StraightSkeleton - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (straight skeleton) ⊠⊠⊠⊠⊠⊠⊠.
- ST_SwapOrdinates - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_SymDifference - Computes a geometry representing the portions of geometries A and B that do not intersect.
- ST_Tesselate - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tessellation) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_TransScale - Translates and scales a geometry by given offsets and factors.
- ST_Translate - Translates a geometry by given offsets.
- ST_UnaryUnion - Computes the union of the components of a single geometry.
- ST_Union - Computes a geometry representing the point-set union of the input geometries.
- ST_Volume - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_WrapX - X ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_X - Returns the X coordinate of a Point.
- ST_XMax - Returns the X maxima of a 2D or 3D bounding box or a geometry.
- ST_XMin - Returns the X minima of a 2D or 3D bounding box or a geometry.
- ST_Y - Returns the Y coordinate of a Point.
- ST_YMax - Returns the Y maxima of a 2D or 3D bounding box or a geometry.
- ST_YMin - Returns the Y minima of a 2D or 3D bounding box or a geometry.
- ST_Z - Returns the Z coordinate of a Point.
- ST_ZMax - Returns the Z maxima of a 2D or 3D bounding box or a geometry.
- ST_ZMin - Returns the Z minima of a 2D or 3D bounding box or a geometry.
- ST_Zmflag - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Equals - ⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Intersects - ⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- UpdateGeometrySRID - Updates the SRID of all features in a geometry column, and the table metadata.
- &&& - A ⊠ n ⊠⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠ n ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠⊠.
- &&&(geometry,gidx) - Returns TRUE if a geometry's (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).
- &&&(gidx,geometry) - Returns TRUE if a n-D float precision bounding box (GIDX) intersects a geometry's (cached) n-D bounding box.
- &&&(gidx,gidx) - Returns TRUE if two n-D float precision bounding boxes (GIDX) intersect each other.

13.9 PostGIS Curved Geometry Support Functions

The functions given below are PostGIS functions that can use CIRCULARSTRING, CURVEPOLYGON, and other curved geometry types

- AddGeometryColumn - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Box2D - Returns a BOX2D representing the 2D extent of a geometry.
- Box3D - Returns a BOX3D representing the 3D extent of a geometry.
- DropGeometryColumn - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- GeometryType - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- PostGIS_AddBBox - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- PostGIS_DropBBox - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- PostGIS_HasBBox - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DExtent - Aggregate function that returns the 3D bounding box of geometries.
- ST_Affine - Apply a 3D affine transformation to a geometry.
- ST_AsBinary - Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKB - Return the Extended Well-Known Binary (EWKB) representation of the geometry with SRID meta data.
- ST_AsEWKT - ⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsHEXEWKB - ⊠⊠⊠⊠⊠⊠⊠⊠ (NDR) ⊠⊠⊠⊠⊠⊠⊠ (XDR) ⊠⊠⊠⊠⊠⊠⊠ HEXEWKB (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsSVG - Returns SVG path data for a geometry.
- ST_AsText - ⊠⊠/⊠⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ClusterDBSCAN - Window function that returns a cluster id for each input geometry using the DBSCAN algorithm.
- ST_ClusterWithin - Aggregate function that clusters geometries by separation distance.
- ST_ClusterWithinWin - Window function that returns a cluster id for each input geometry, clustering using separation distance.
- ST_Collect - Creates a GeometryCollection or Multi* geometry from a set of geometries.
- ST_CoordDim - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_CurveToLine - Converts a geometry containing curves to a linear geometry.
- ST_Distance - ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Dump - Returns a set of geometry_dump rows for the components of a geometry.
- ST_DumpPoints - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_EndPoint - ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_EstimatedExtent - Returns the estimated extent of a spatial table.
- ST_FlipCoordinates - Returns a version of a geometry with X and Y axis flipped.

- ST_Force2D - ⊠⊠⊠"2 ⊠⊠⊠⊠" ⊠⊠⊠⊠⊠⊠.
- ST_ForceCurve - ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (upcast) ⊠⊠⊠.
- ST_ForceSFS - ⊠⊠⊠ SFS 1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3D - ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠. ST_Force3DZ ⊠⊠⊠⊠⊠⊠.
- ST_Force3DM - ⊠⊠⊠ XYM ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3DZ - ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Force4D - ⊠⊠⊠ XYZM ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceCollection - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeoHash - ⊠⊠⊠ GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeogFromWKB - WKB ⊠⊠⊠⊠⊠⊠⊠ EWKB(⊠⊠ WKB) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromEWKB - EWKB(Extended Well-Known Binary) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromEWKT - EWKT(Extended Well-Known Text) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromText - WKT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromWKB - WKB(Well-Known Binary) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometryN - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- = - Returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B.
- &<| - A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_HasArc - Tests if a geometry contains a circular arc
- ST_Intersects - Tests if two geometries intersect (they have at least one point in common)
- ST_IsClosed - LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_IsCollection - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_IsEmpty - Tests if a geometry is empty.
- ST_LineToCurve - Converts a linear geometry to a curved geometry.
- ST_MemSize - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NPoints - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NRings - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PointFromWKB - ⊠⊠⊠ SRID ⊠⊠⊠ WKB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PointN - ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Points - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Rotate - Rotates a geometry about an origin point.
- ST_RotateZ - Rotates a geometry about the Z axis.
- ST_SRID - Returns the spatial reference identifier for a geometry.

- ST_Scale - Scales a geometry by given factors.
- ST_SetSRID - Set the SRID on a geometry.
- ST_StartPoint - Returns the first point of a LineString.
- ST_Summary - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_SwapOrdinates - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_TransScale - Translates and scales a geometry by given offsets and factors.
- ST_Transform - Return a new geometry with coordinates transformed to a different spatial reference system.
- ST_Translate - Translates a geometry by given offsets.
- ST_XMax - Returns the X maxima of a 2D or 3D bounding box or a geometry.
- ST_XMin - Returns the X minima of a 2D or 3D bounding box or a geometry.
- ST_YMax - Returns the Y maxima of a 2D or 3D bounding box or a geometry.
- ST_YMin - Returns the Y minima of a 2D or 3D bounding box or a geometry.
- ST_ZMax - Returns the Z maxima of a 2D or 3D bounding box or a geometry.
- ST_ZMin - Returns the Z minima of a 2D or 3D bounding box or a geometry.
- ST_Zmflag - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- UpdateGeometrySRID - Updates the SRID of all features in a geometry column, and the table metadata.
- ~(box2df,box2df) - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).
- ~(box2df,geometry) - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bonding box.
- ~(geometry,box2df) - Returns TRUE if a geometry's 2D bonding box contains a 2D float precision bounding box (GIDX).
- && - A ⊠ 2D ⊠⊠⊠⊠⊠ B ⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- &&& - A ⊠ n ⊠⊠⊠⊠⊠⊠⊠ B ⊠ n ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- @(box2df,box2df) - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.
- @(box2df,geometry) - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.
- @(geometry,box2df) - Returns TRUE if a geometry's 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).
- &&(box2df,box2df) - Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.
- &&(box2df,geometry) - Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.
- &&(geometry,box2df) - Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).
- &&&(geometry,gidx) - Returns TRUE if a geometry's (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).

- &&&(gidx,geometry) - Returns TRUE if a n-D float precision bounding box (GIDX) intersects a geometry's (cached) n-D bounding box.
- &&&(gidx,gidx) - Returns TRUE if two n-D float precision bounding boxes (GIDX) intersect each other.

13.10 PostGIS Polyhedral Surface Support Functions

The functions given below are PostGIS functions that can use POLYHEDRALSURFACE, POLYHEDRALSURFACEM geometries

- Box2D - Returns a BOX2D representing the 2D extent of a geometry.
- Box3D - Returns a BOX3D representing the 3D extent of a geometry.
- CG_3DArea - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DConvexHull - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DDifference - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DIntersection - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DUnion - Perform 3D union using postgis_sfcgal.
- CG_ApproximateMedialAxis - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_Extrude - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_ForceLHR - LHR(Left Hand Reverse; ⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_IsPlanar - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_IsSolid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_MakeSolid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠.
- CG_StraightSkeleton - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (straight skeleton) ⊠⊠⊠⊠⊠⊠.
- CG_Tesselate - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tessellation) ⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠ TIN ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.
- CG_Visibility - Compute a visibility polygon from a point or a segment in a polygon geometry
- CG_Volume - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠) 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- GeometryType - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DArea - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DClosestPoint - g2 ⊠⊠⊠⊠⊠⊠ g1 ⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 3D ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DConvexHull - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DDFullyWithin - Tests if two 3D geometries are entirely within a given 3D distance
- ST_3DDWithin - Tests if two 3D geometries are within a given 3D distance
- ST_3DDifference - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DDistance - ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠.

- ST_3DExtent - Aggregate function that returns the 3D bounding box of geometries.
- ST_3DIntersection - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DIntersects - Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)
- ST_3DLongestLine - ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DMaxDistance - ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DShortestLine - ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (shortest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DUnion - Perform 3D union.
- ST_Affine - Apply a 3D affine transformation to a geometry.
- ST_ApproximateMedialAxis - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Area - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsBinary - Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKB - Return the Extended Well-Known Binary (EWKB) representation of the geometry with SRID meta data.
- ST_AsEWKT - ⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsGML - ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsX3D - ⊠⊠⊠ X3D XML ⊠⊠⊠⊠⊠⊠: ISO-IEC-19776-1.2-X3DEncodings-XML ⊠⊠⊠⊠⊠⊠.
- ST_CoordDim - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Dimension - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Dump - Returns a set of geometry_dump rows for the components of a geometry.
- ST_DumpPoints - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Expand - Returns a bounding box expanded from another bounding box or a geometry.
- ST_Extent - Aggregate function that returns the bounding box of geometries.
- ST_Extrude - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_FlipCoordinates - Returns a version of a geometry with X and Y axis flipped.
- ST_Force2D - ⊠⊠⊠”2 ⊠⊠⊠⊠” ⊠⊠⊠⊠⊠⊠.
- ST_ForceLHR - LHR(Left Hand Reverse; ⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceRHR - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠ (Right-Hand Rule) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceSFS - ⊠⊠⊠ SFS 1.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3D - ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠. ST_Force3DZ ⊠⊠⊠⊠⊠⊠.
- ST_Force3DZ - ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceCollection - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromEWKB - EWKB(Extended Well-Known Binary) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠.

- ST_GeomFromEWKT - EWKT(Extended Well-Known Text) ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromGML - ⊠⊠⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometryN - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometryType - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- = - Returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B.
- &<| - A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ~= - A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_IsClosed - LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_IsPlanar - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_IsSolid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MakeSolid - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠.
- ST_MemSize - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NPoints - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NumGeometries - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NumPatches - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PatchN - ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_RemoveRepeatedPoints - Returns a version of a geometry with duplicate points removed.
- ST_Reverse - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Rotate - Rotates a geometry about an origin point.
- ST_RotateX - Rotates a geometry about the X axis.
- ST_RotateY - Rotates a geometry about the Y axis.
- ST_RotateZ - Rotates a geometry about the Z axis.
- ST_Scale - Scales a geometry by given factors.
- ST_ShiftLongitude - Shifts the longitude coordinates of a geometry between -180..180 and 0..360.
- ST_StraightSkeleton - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (straight skeleton) ⊠⊠⊠⊠⊠⊠.
- ST_Summary - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_SwapOrdinates - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Tesselate - ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tessellation) ⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Transform - Return a new geometry with coordinates transformed to a different spatial reference system.
- ST_Volume - 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠) 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- ~(box2df,box2df) - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).

- ~(box2df,geometry) - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bonding box.
- ~(geometry,box2df) - Returns TRUE if a geometry's 2D bonding box contains a 2D float precision bounding box (GIDX).
- && - A ⊠ 2D ⊠⊠⊠⊠⊠ B ⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- &&& - A ⊠ n ⊠⊠⊠⊠⊠⊠⊠ B ⊠ n ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- @(box2df,box2df) - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.
- @(box2df,geometry) - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.
- @(geometry,box2df) - Returns TRUE if a geometry's 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).
- &&(box2df,box2df) - Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.
- &&(box2df,geometry) - Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.
- &&(geometry,box2df) - Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).
- &&&(geometry,gidx) - Returns TRUE if a geometry's (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).
- &&&(gidx,geometry) - Returns TRUE if a n-D float precision bounding box (GIDX) intersects a geometry's (cached) n-D bounding box.
- &&&(gidx,gidx) - Returns TRUE if two n-D float precision bounding boxes (GIDX) intersect each other.

13.11 PostGIS Function Support Matrix

Below is an alphabetical listing of spatial specific functions in PostGIS and the kinds of spatial types they work with or OGC/SQL compliance they try to conform to.

- A  means the function works with the type or subtype natively.
- A  means it works but with a transform cast built-in using cast to geometry, transform to a "best srid" spatial ref and then cast back. Results may not be as expected for large areas or areas at poles and may accumulate floating point junk.
- A  means the function works with the type because of a auto-cast to another such as to box3d rather than direct type support.
- A  means the function only available if PostGIS compiled with SFCGAL support.
- geom - Basic 2D geometry support (x,y).
- geog - Basic 2D geography support (x,y).

- 2.5D - basic 2D geometries in 3 D/4D space (has Z or M coord).
- PS - Polyhedral surfaces
- T - Triangles and Triangulated Irregular Network surfaces (TIN)

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_Collect	✓		✓	✓			
ST_LineFromMultiPoint	✓		✓				
ST_MakeEnvelope	✓						
ST_MakeLine	✓		✓				
ST_MakePoint	✓		✓				
ST_MakePointM	✓						
ST_MakePolygon	✓		✓				
ST_Point	✓				✓		
ST_PointZ	✓						
ST_PointM	✓						
ST_PointZM	✓						
ST_Polygon	✓		✓		✓		
ST_TileEnvelope	✓						
ST_HexagonGrid	✓						
ST_Hexagon	✓						
ST_SquareGrid	✓						
ST_Square	✓						
ST_Letters	✓						
GeometryType	✓		✓	✓		✓	✓
ST_Boundary	✓		✓		✓		
ST_BoundingDiagonal	✓		✓				
ST_CoordDim	✓		✓	✓	✓	✓	✓
ST_Dimension	✓				✓	✓	✓
ST_Dump	✓		✓	✓		✓	✓
ST_DumpPoints	✓		✓	✓		✓	✓
ST_DumpSegments	✓		✓				✓
ST_DumpRings	✓		✓				
ST_EndPoint	✓		✓	✓	✓		
ST_Envelope	✓				✓		
ST_ExteriorRing	✓		✓		✓		

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_GeometryN	✓		✓	✓	✓	✓	✓
ST_GeometryType	✓		✓		✓	✓	
ST_HasArc	✓		✓	✓			
ST_InteriorRingN	✓		✓		✓		
ST_NumCurves	✓		✓		✓		
ST_CurveN	✓		✓		✓		
ST_IsClosed	✓		✓	✓	✓	✓	
ST_IsCollection	✓		✓	✓			
ST_IsEmpty	✓			✓	✓		
ST_IsPolygonCCW	✓		✓				
ST_IsPolygonCW	✓		✓				
ST_IsRing	✓				✓		
ST_IsSimple	✓		✓		✓		
ST_M	✓		✓		✓		
ST_MemSize	✓		✓	✓		✓	✓
ST_NDims	✓		✓				
ST_NPoints	✓		✓	✓		✓	
ST_NRings	✓		✓	✓			
ST_NumGeometries	✓		✓		✓	✓	✓
ST_NumInteriorRings	✓				✓		
ST_NumInteriorRing	✓						
ST_NumPatches	✓		✓		✓	✓	
ST_NumPoints	✓				✓		
ST_PatchN	✓		✓		✓	✓	
ST_PointN	✓		✓	✓	✓		
ST_Points	✓		✓	✓			
ST_StartPoint	✓		✓	✓	✓		
ST_Summary	✓	✓		✓		✓	✓
ST_X	✓		✓		✓		
ST_Y	✓		✓		✓		
ST_Z	✓		✓		✓		
ST_Zmflag	✓		✓	✓			
ST_HasZ	✓		✓				
ST_HasM	✓		✓				

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_AddPoint	✓		✓				
ST_CollectionExtract	✓						
ST_CollectionHomogenize	✓						
ST_CurveToLine	✓		✓	✓	✓		
ST_Scroll	✓		✓				
ST_FlipCoordinates	✓		✓	✓		✓	✓
ST_Force2D	✓		✓	✓		✓	
ST_Force3D	✓		✓	✓		✓	
ST_Force3DZ	✓		✓	✓		✓	
ST_Force3DM	✓			✓			
ST_Force4D	✓		✓	✓			
ST_ForceCollection	✓		✓	✓		✓	
ST_ForceCurve	✓		✓	✓			
ST_ForcePolygonCCW	✓		✓				
ST_ForcePolygonCW	✓		✓				
ST_ForceSFS	✓		✓	✓		✓	✓
ST_ForceRHR	✓		✓			✓	
ST_LineExtend	✓						
ST_LineToCurve	✓		✓	✓			
ST_Multi	✓						
ST_Normalize	✓						
ST_Project	✓	✓					
ST_QuantizeCoordinates	✓						
ST_RemovePoint	✓		✓				
ST_RemoveRepeatedPoints	✓		✓			✓	
ST_RemoveIrrelevantPointsForView	✓						
ST_RemoveSmallParts	✓						
ST_Reverse	✓		✓			✓	
ST_Segmentize	✓	✓					
ST_SetPoint	✓		✓				
ST_ShiftLongitude	✓		✓			✓	✓
ST_WrapX	✓		✓				
ST_SnapToGrid	✓		✓				
ST_Snap	✓						

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_SwapOrdinates	✓		✓	✓		✓	✓
ST_IsValid	✓				✓		
ST_IsValidDetail	✓						
ST_IsValidReason	✓						
ST_MakeValid	✓		✓				
ST_InverseTransformPipeline	✓						
ST_SetSRID	✓			✓			
ST_SRID	✓			✓	✓		
ST_Transform	✓			✓	✓	✓	
ST_TransformPipeline	✓						
postgis_srs_codes							
postgis_srs							
postgis_srs_all							
postgis_srs_search	✓						
ST_BdPolyFromText	✓						
ST_BdMPolyFromText	✓						
ST_GeogFromText		✓					
ST_GeographyFromText		✓					
ST_GeomCollFromText	✓				✓		
ST_GeomFromEWKT	✓		✓	✓		✓	✓
ST_GeomFromMARC21	✓						
ST_GeometryFromText	✓				✓		
ST_GeomFromText	✓			✓	✓		
ST_LineFromText	✓				✓		
ST_MLineFromText	✓				✓		
ST_MPointFromText	✓				✓		
ST_MPolyFromText	✓				✓		
ST_PointFromText	✓				✓		
ST_PolygonFromText	✓				✓		
ST_WKTToSQL	✓				✓		
ST_GeogFromWKB		✓		✓			
ST_GeomFromEWKB	✓		✓	✓		✓	✓
ST_GeomFromWKB	✓			✓	✓		
ST_LineFromWKB	✓				✓		
ST_LinestringFromWKB	✓				✓		

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_PointFromWKB	✓		✓	✓	✓		
ST_WKBToSQL	✓				✓		
ST_Box2dFromGeoHash	✓						
ST_GeomFromGeoHash	✓						
ST_GeomFromGML	✓		✓			✓	✓
ST_GeomFromGeoJSON	✓		✓				
ST_GeomFromKML	✓		✓				
ST_GeomFromTWKB	✓						
ST_GMLToSQL	✓				✓		
ST_LineFromEncodedPolyline	✓						
ST_PointFromGeoHash							
ST_FromFlatGeobufToTable							
ST_FromFlatGeobuf							
ST_AsEWKT	✓	✓	✓	✓		✓	✓
ST_AsText	✓	✓		✓	✓		
ST_AsBinary	✓	✓	✓	✓	✓	✓	✓
ST_AsEWKB	✓		✓	✓		✓	✓
ST_AsHEXEWKB	✓		✓	✓			
ST_AsEncodedPolyline	✓						
ST_AsFlatGeobuf	✓						
ST_AsGeobuf	✓						
ST_AsGeoJSON	✓	✓	✓				
ST_AsGML	✓	✓	✓		✓	✓	✓
ST_AsKML	✓	✓	✓				
ST_AsLatLonText	✓						
ST_AsMARC21	✓						
ST_AsMVTGeom	✓						
ST_AsMVT	✓						
ST_AsSVG	✓	✓		✓			
ST_AsTWKB	✓						
ST_AsX3D	✓		✓			✓	✓
ST_GeoHash	✓			✓			
&&	✓	✓		✓		✓	
&&(geometry,box2df)	✓			✓		✓	
&&(box2df,geometry)	✓			✓		✓	

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
&&(box2df,box2df)	☑			✓		✓	
&&&	✓		✓	✓		✓	✓
&&&(geometry,gidx)	✓		✓	✓		✓	✓
&&&(gidx,geometry)	✓		✓	✓		✓	✓
&&&(gidx,gidx)			✓	✓		✓	✓
&<	✓						
&<|	✓			✓		✓	
&>	✓						
<<	✓						
<<|	✓						
=	✓	✓		✓		✓	
>>	✓						
@	✓						
@(geometry,box2df)	✓			✓		✓	
@(box2df,geometry)	✓			✓		✓	
@(box2df,box2df)	☑			✓		✓	
|&>	✓						
|>>	✓						
~	✓						
~(geometry,box2df)	✓			✓		✓	
~(box2df,geometry)	✓			✓		✓	
~(box2df,box2df)	☑			✓		✓	
~=	✓					✓	
<->	✓	✓					
|=|	✓						
<#>	✓						
<<->>	✓						
ST_3DIntersects	✓		✓		✓	✓	✓
ST_Contains	✓				✓		
ST_ContainsProperly	✓						
ST_CoveredBy	✓	✓					
ST_Covers	✓	✓					
ST_Crosses	✓				✓		
ST_Disjoint	✓				✓		

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_Equals	✓				✓		
ST_Intersects	✓	✓		✓	✓		✓
ST_LineCrossingDirection	✓						
ST_OrderingEquals	✓				✓		
ST_Overlaps	✓				✓		
ST_Relate	✓				✓		
ST_RelateMatch							
ST_Touches	✓				✓		
ST_Within	✓				✓		
ST_3DDWithin	✓		✓		✓	✓	
ST_3DDFullyWithin	✓		✓			✓	
ST_DFullyWithin	✓						
ST_DWithin	✓	✓					
ST_PointInsideCircle	✓						
ST_Area	✓	✓			✓	✓	
ST_Azimuth	✓	✓					
ST_Angle	✓						
ST_ClosestPoint	✓	✓					
ST_3DClosestPoint	✓		✓			✓	
ST_Distance	✓	✓		✓	✓		
ST_3DDistance	✓		✓		✓	✓	
ST_DistanceSphere	✓						
ST_DistanceSpheroid	✓						
ST_FrechetDistance	✓						
ST_HausdorffDistance	✓						
ST_Length	✓	✓			✓		
ST_Length2D	✓						
ST_3DLength	✓		✓		✓		
ST_LengthSpheroid	✓		✓				
ST_LongestLine	✓						
ST_3DLongestLine	✓		✓			✓	
ST_MaxDistance	✓						
ST_3DMaxDistance	✓		✓			✓	
ST_MinimumClearance	✓						

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_MinimumClearanceLine	✓						
ST_Perimeter	✓	✓			✓		
ST_Perimeter2D	✓						
ST_3DPerimeter	✓		✓		✓		
ST_ShortestLine	✓	✓					
ST_3DShortestLine	✓		✓			✓	
ST_ClipByBox2D	✓						
ST_Difference	✓		✓		✓		
ST_Intersection	✓		✓		✓		
ST_MemUnion	✓		✓				
ST_Node	✓		✓				
ST_Split	✓						
ST_Subdivide	✓						
ST_SymDifference	✓		✓		✓		
ST_UnaryUnion	✓		✓				
ST_Union	✓		✓		✓		
ST_Buffer	✓				✓		
ST_BuildArea	✓						
ST_Centroid	✓	✓			✓		
ST_ChaikinSmoothing	✓		✓				
ST_ConcaveHull	✓						
ST_ConvexHull	✓		✓		✓		
ST_DelaunayTriangles	✓		✓				✓
ST_FilterByM	✓						
ST_GeneratePoints	✓						
ST_GeometricMedian	✓		✓				
ST_LineMerge	✓						
ST_MaximumInscribedCircle	✓						
ST_LargestEmptyCircle	✓						
ST_MinimumBoundingCircle	✓						
ST_MinimumBoundingRadius	✓						
ST_OrientedEnvelope	✓						
ST_OffsetCurve	✓						
ST_PointOnSurface	✓		✓		✓		

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_Polygonize	✓						
ST_ReducePrecision	✓						
ST_SharedPaths	✓						
ST_Simplify	✓						
ST_SimplifyPreserveTopology	✓						
ST_SimplifyPolygonHull	✓						
ST_SimplifyVW	✓						
ST_SetEffectiveArea	✓						
ST_TriangulatePolygon	✓						
ST_VoronoiLines	✓						
ST_VoronoiPolygons	✓						
ST_CoverageInvalidEdges	✓						
ST_CoverageSimplify	✓						
ST_CoverageUnion	✓						
ST_Affine	✓		✓	✓		✓	✓
ST_Rotate	✓		✓	✓		✓	✓
ST_RotateX	✓		✓			✓	✓
ST_RotateY	✓		✓			✓	✓
ST_RotateZ	✓		✓	✓		✓	✓
ST_Scale	✓		✓	✓		✓	✓
ST_Translate	✓		✓	✓			
ST_TransScale	✓		✓	✓			
ST_ClusterDBSCAN	✓			✓			
ST_ClusterIntersecting	✓						
ST_ClusterIntersectingWin	✓						
ST_ClusterKMeans	✓						
ST_ClusterWithin	✓			✓			
ST_ClusterWithinWin	✓			✓			
Box2D	✓			✓		✓	✓
Box3D	✓		✓	✓		✓	✓
ST_EstimatedExtent	✓			✓			
ST_Expand	✓					✓	✓
ST_Extent	✓					✓	✓
ST_3DExtent	✓		✓	✓		✓	✓

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_MakeBox2D	✓						
ST_3DMakeBox	✓						
ST_XMax	✓		✓	✓			
ST_XMin	✓		✓	✓			
ST_YMax	✓		✓	✓			
ST_YMin	✓		✓	✓			
ST_ZMax	✓		✓	✓			
ST_ZMin	✓		✓	✓			
ST_LineInterpolatePoint	✓	✓	✓				
ST_3DLineInterpolatePoint	✓		✓				
ST_LineInterpolatePoints	✓	✓	✓				
ST_LineLocatePoint	✓	✓					
ST_LineSubstring	✓	✓	✓				
ST_LocateAlong	✓				✓		
ST_LocateBetween	✓				✓		
ST_LocateBetweenElevations	✓		✓				
ST_InterpolatePoint	✓		✓				
ST_AddMeasure	✓		✓				
ST_IsValidTrajectory	✓		✓				
ST_ClosestPointOfApproach	✓		✓				
ST_DistanceCPA	✓		✓				
ST_CPAWithin	✓		✓				
postgis.backend							
postgis.gdal_datapath							
postgis.gdal_enabled_drivers							
postgis.enable_outdb_rasters							
postgis.gdal_vsi_options							
PostGIS_AddBBox	✓			✓			
PostGIS_DropBBox	✓			✓			
PostGIS_HasBBox	✓			✓			
postgis_sfcgal_version							
postgis_sfcgal_full_version							
CG_ForceLHR	✓		✓			✓	✓
CG_IsPlanar	✓		✓			✓	✓
CG_IsSolid	✓		✓			✓	✓

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
CG_MakeSolid	✓		✓			✓	✓
CG_Orientation	✓		✓				
CG_Area	✓						
CG_3DArea	✓		✓		✓	✓	✓
CG_Volume	✓		✓		✓	✓	✓
ST_ForceLHR	✓		✓			✓	✓
ST_IsPlanar	✓		✓			✓	✓
ST_IsSolid	✓		✓			✓	✓
ST_MakeSolid	✓		✓			✓	✓
ST_Orientation	✓		✓				
ST_3DArea	✓		✓		✓	✓	✓
ST_Volume	✓		✓		✓	✓	✓
CG_Intersectio	✓						
CG_Intersects	✓						✓
CG_3DIntersect	✓						✓
CG_Difference	✓						✓
ST_3DDifferenc	✓		✓		✓	✓	✓
CG_3DDifferen	✓		✓		✓	✓	✓
CG_Distance	✓						✓
CG_3DDistance	✓						✓
ST_3DConvexH	✓		✓			✓	✓
CG_3DConvexH	✓		✓			✓	✓
ST_3DIntersect	✓		✓		✓	✓	✓
CG_3DIntersect	✓		✓		✓	✓	✓

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
CG_Union	✓						
ST_3DUnion	✓		✓		✓	✓	✓
CG_3DUnion	✓		✓		✓	✓	✓
ST_AlphaShape	✓						
CG_AlphaShape	✓						
CG_ApproxConvexPartition	✓						
ST_ApproximateMedialAxis	✓		✓			✓	✓
CG_ApproximateMedialAxis	✓		✓			✓	✓
ST_ConstrainedDelaunayTriangles	✓		✓				
CG_ConstrainedDelaunayTriangles	✓		✓				
ST_Extrude	✓		✓			✓	✓
CG_Extrude	✓		✓			✓	✓
CG_ExtrudeStraightSkeleton	✓						
CG_GreeneApproxConvexPartition	✓						
ST_MinkowskiSum	✓						
CG_MinkowskiSum	✓						
ST_OptimalAlphaShape	✓						
CG_OptimalAlphaShape	✓						
CG_OptimalConvexPartition	✓						
CG_StraightSkeleton	✓		✓			✓	✓
ST_StraightSkeleton	✓		✓			✓	✓
ST_Tesselate	✓		✓			✓	✓
CG_Tesselate	✓		✓			✓	✓
CG_Triangulate	✓						

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
CG_Visibility	✓		✓			✓	✓
CG_YMonotonePartition	✓						
getfaceedges_returntype							
TopoGeometry							
validatetopology_returntype							
TopoElement							
TopoElementArray							
AddTopoGeometryColumn							
RenameTopoGeometryColumn							
DropTopology							
RenameTopology							
DropTopoGeometryColumn							
Populate_Topology_Layer							
TopologySummary							
ValidateTopology	✓						
ValidateTopologyRelation							
FindTopology							
FindLayer							
CreateTopology							
CopyTopology							
ST_InitTopoGeo					✓		
ST_CreateTopoGeo	✓				✓		
TopoGeo_AddPoint	✓						
TopoGeo_AddLineString	✓						
TopoGeo_AddPolygon	✓						
TopoGeo_LoadGeometry	✓						
ST_AddIsoNode	✓				✓		
ST_AddIsoEdge	✓				✓		
ST_AddEdgeNewFaces	✓				✓		
ST_AddEdgeModFace	✓				✓		
ST_RemEdgeNewFace					✓		
ST_RemEdgeModFace					✓		
ST_ChangeEdgeGeom	✓				✓		
ST_ModEdgeSplit	✓				✓		
ST_ModEdgeHeal					✓		
ST_NewEdgeHeal					✓		
ST_MoveIsoNode	✓				✓		
ST_NewEdgesSplit	✓				✓		
ST_RemoveIsoNode					✓		
ST_RemoveIsoEdge					✓		

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
GetEdgeByPoint	✓						
GetFaceByPoint	✓						
GetFaceContainingPoint	✓						
GetNodeByPoint	✓						
GetTopologyID							
GetTopologySRID							
GetTopologyName							
ST_GetFaceEdges					✓		
ST_GetFaceGeometry	✓				✓		
GetRingEdges							
GetNodeEdges							
Polygonize							
AddNode	✓						
AddEdge	✓						
AddFace	✓						
ST_Simplify	✓						
RemoveUnusedPrimitives	✓						
CreateTopoGeom	✓						
toTopoGeom	✓						
TopoElementArray_Agg							
TopoElement	✓						
clearTopoGeom	✓						
TopoGeom_addElement	✓						
TopoGeom_remElement	✓						
TopoGeom_addTopoGeom	✓						
toTopoGeom							
GetTopoGeomElementArray							
GetTopoGeomElements							
ST_SRID	✓				✓		
AsGML	✓						
AsTopoJSON	✓						
Equals	✓		✓				
Intersects	✓		✓				
geomval							
addbandarg							
rastbandarg							
raster							
reclassarg							
summarystats							
unionarg							
AddRasterConstraints							

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
DropRasterConstraints							
AddOverviewConstraints							
DropOverviewConstraints							
PostGIS_GDAL_Version							
PostGIS_Raster_Lib_Build_Date							
PostGIS_Raster_Lib_Version							
ST_GDALDrivers							
ST_Contour							
ST_InterpolateRaster	✓						
UpdateRasterSRID							
ST_CreateOverview							
ST_AddBand							
ST_AsRaster	✓						
ST_Band							
ST_MakeEmptyCoverage							
ST_MakeEmptyRaster							
ST_Tile							
ST_Retile	✓						
ST_FromGDALRaster							
ST_GeoReference							
ST_Height							
ST_IsEmpty							
ST_MemSize							
ST_MetaData							
ST_NumBands							
ST_PixelHeight							
ST_PixelWidth							
ST_ScaleX							
ST_ScaleY							
ST_RasterToWorldCoord							
ST_RasterToWorldCoordX							
ST_RasterToWorldCoordY							
ST_Rotation							
ST_SkewX							
ST_SkewY							
ST_SRID							
ST_Summary							
ST_UpperLeftX							
ST_UpperLeftY							
ST_Width							
ST_WorldToRasterCoord	✓						
ST_WorldToRasterCoordX	✓						
ST_WorldToRasterCoordY	✓						
ST_BandMetaData							
ST_BandNoDataValue							
ST_BandIsNoData							
ST_BandPath							
ST_BandFileSize							
ST_BandFileTimestamp							
ST_BandPixelType							
ST_MinPossibleValue							
ST_HasNoBand							

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_PixelAsPolygon	✓						
ST_PixelAsPolygons							
ST_PixelAsPoint	✓						
ST_PixelAsPoints							
ST_PixelAsCentroid	✓						
ST_PixelAsCentroids							
ST_Value	✓						
ST_NearestValue	✓						
ST_SetZ	✓						
ST_SetM	✓						
ST_Neighborhood	✓						
ST_SetValue	✓						
ST_SetValues							
ST_DumpValues							
ST_PixelOfValue							
ST_SetGeoReference							
ST_SetRotation							
ST_SetScale							
ST_SetSkew							
ST_SetSRID							
ST_SetUpperLeft							
ST_Resample							
ST_Rescale							
ST_Reskew							
ST_SnapToGrid							
ST_Resize							
ST_Transform							
ST_SetBandNoDataValue							
ST_SetBandIsNoData							
ST_SetBandPath							
ST_SetBandIndex							
ST_Count							
ST_CountAgg							
ST_Histogram							
ST_Quantile							
ST_SummaryStats							
ST_SummaryStatsAgg							
ST_ValueCount							
ST_RastFromWKB							
ST_RastFromHexWKB							
ST_AsBinary/ST_AsWKB							
ST_AsHexWKB							
ST_AsGDALRaster							
ST_AsJPEG							
ST_AsPNG							
ST_AsTIFF							
ST_Clip	✓						
ST_ColorMap							
ST_Grayscale							

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_Intersection	✓						
ST_MapAlgebra (callback function version)							
ST_MapAlgebra (expression version)							
ST_MapAlgebraExpr							
ST_MapAlgebraExpr							
ST_MapAlgebraFct							
ST_MapAlgebraFct							
ST_MapAlgebraFctNgb							
ST_Reclass							
ST_Union							
ST_Distinct4ma							
ST_InvDistWeight4ma							
ST_Max4ma							
ST_Mean4ma							
ST_Min4ma							
ST_MinDist4ma							
ST_Range4ma							
ST_StdDev4ma							
ST_Sum4ma							
ST_Aspect							
ST_HillShade							
ST_Roughness							
ST_Slope							
ST_TPI							
ST_TRI							
Box3D	✓						
ST_ConvexHull	✓						
ST_DumpAsPolygons							
ST_Envelope	✓						
ST_MinConvexHull	✓						
ST_Polygon	✓						
&&	✓						
&<							
&>							
=							
@	✓						
~=							
~	✓						
ST_Contains							
ST_ContainsProperly							
ST_Covers							
ST_CoveredBy							
ST_Disjoint							

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_Intersects	✓						
ST_Overlaps							
ST_Touches							
ST_SameAlignment							
ST_NotSameAlignmentReason							
ST_Within							
ST_DWithin							
ST_DFullyWithin							
stdaddr							
rules table							
lex table							
gaz table							
debug_standardize_address							
parse_address							
standardize_address							
Drop_Indexes_Generate_Script							
Drop_Nation_Tables_Generate_Script							
Drop_State_Tables_Generate_Script							
Geocode	✓						
Geocode_Intersection	✓						
Get_Geocode_Setting							
Get_Tract	✓						
Install_Missing_Indexes							
Loader_Generate_Census_Script							
Loader_Generate_Script							
Loader_Generate_Nation_Script							
Missing_Indexes_Generate_Script							
Normalize_Address							
Pagc_Normalize_Address							
Pprint_Addy							
Reverse_Geocode	✓						
Topology_Load_Tiger							
Set_Geocode_Setting							

13.12 New, Enhanced or changed PostGIS Functions

13.12.1 PostGIS Functions new or enhanced in 3.5

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.5

- CG_3DArea - Availability: 3.5.0 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DConvexHull - Availability: 3.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DDifference - Availability: 3.5.0 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_3DDistance - Availability: 3.5.0 Computes the minimum 3D distance between two geometries
- CG_3DIntersection - Availability: 3.5.0 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- CG_3DIntersects - Availability: 3.5.0 Tests if two 3D geometries intersect
- CG_3DUnion - Availability: 3.5.0 Perform 3D union using postgis_sfcgal.
- CG_AlphaShape - Availability: 3.5.0 - requires SFCGAL >= 1.4.1. Computes an Alpha-shape enclosing a geometry
- CG_ApproxConvexPartition - Availability: 3.5.0 - requires SFCGAL >= 1.5.0. Computes approximal convex partition of the polygon geometry
- CG_ApproximateMedialAxis - Availability: 3.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_Area - Availability: 3.5.0 Calculates the area of a geometry
- CG_Difference - Availability: 3.5.0 Computes the geometric difference between two geometries
- CG_Distance - Availability: 3.5.0 Computes the minimum distance between two geometries
- CG_Extrude - Availability: 3.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_ExtrudeStraightSkeleton - Availability: 3.5.0 - requires SFCGAL >= 1.5.0. Straight Skeleton Extrusion
- CG_ForceLHR - Availability: 3.5.0 LHR(Left Hand Reverse; ⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_GreeneApproxConvexPartition - Availability: 3.5.0 - requires SFCGAL >= 1.5.0. Computes approximal convex partition of the polygon geometry
- CG_Intersection - Availability: 3.5.0 Computes the intersection of two geometries
- CG_Intersects - Availability: 3.5.0 Tests if two geometries intersect (they have at least one point in common)
- CG_IsPlanar - Availability: 3.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_IsSolid - Availability: 3.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_MakeSolid - Availability: 3.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠.
- CG_MinkowskiSum - Availability: 3.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_OptimalAlphaShape - Availability: 3.5.0 - requires SFCGAL >= 1.4.1. Computes an Alpha-shape enclosing a geometry using an ”optimal” alpha value.
- CG_OptimalConvexPartition - Availability: 3.5.0 - requires SFCGAL >= 1.5.0. Computes an optimal convex partition of the polygon geometry
- CG_Orientation - Availability: 3.5.0 ⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠.
- CG_StraightSkeleton - Availability: 3.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (straight skeleton) ⊠⊠⊠⊠⊠⊠.
- CG_Tesselate - Availability: 3.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tessellation) ⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_Triangulate - Availability: 3.5.0 Triangulates a polygonal geometry
- CG_Union - Availability: 3.5.0 Computes the union of two geometries
- CG_Visibility - Availability: 3.5.0 - requires SFCGAL >= 1.5.0. Compute a visibility polygon from a point or a segment in a polygon geometry
- CG_Volume - Availability: 3.5.0 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠) 0 ⊠⊠⊠⊠⊠⊠⊠⊠.
- CG_YMonotonePartition - Availability: 3.5.0 - requires SFCGAL >= 1.5.0. Computes y-monotone partition of the polygon geometry

- ST_HasM - Availability: 3.5.0 Checks if a geometry has an M (measure) dimension.
- ST_HasZ - Availability: 3.5.0 Checks if a geometry has a Z dimension.
- ST_RemoveIrrelevantPointsForView - Availability: 3.5.0 Removes points that are irrelevant for rendering a specific rectangluar view of a geometry.
- ST_RemoveSmallParts - Availability: 3.5.0 Removes small parts (polygon rings or linestrings) of a geometry.
- TopoGeo_LoadGeometry - Availability: 3.5.0 Load a geometry into an existing topology, snapping and splitting as needed.

Functions enhanced in PostGIS 3.5

- ST_Clip - Enhanced: 3.5.0 - touched argument added. Returns the raster clipped by the input geometry. If band number is not specified, all bands are processed. If crop is not specified or TRUE, the output raster is cropped. If touched is set to TRUE, then touched pixels are included, otherwise only if the center of the pixel is in the geometry it is included.

Functions changed in PostGIS 3.5

- ST_AsGeoJSON - Changed: 3.5.0 allow specifying the column containing the feature id Return a geometry or feature in GeoJSON format.
- ST_DFullyWithin - Changed: 3.5.0 : the logic behind the function now uses a test of containment within a buffer, rather than the ST_MaxDistance algorithm. Results will differ from prior versions, but should be closer to user expectations. Tests if a geometry is entirely inside a distance of another

13.12.2 PostGIS Functions new or enhanced in 3.4

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.4

- PostGIS_GEOS_Compiled_Version - Availability: 3.4.0 Returns the version number of the GEOS library against which PostGIS was built.
- PostGIS_PROJ_Compiled_Version - Availability: 3.5.0 Returns the version number of the PROJ library against which PostGIS was built.
- RenameTopoGeometryColumn - Availability: 3.4.0 Renames a topogeometry column
- RenameTopology - Availability: 3.4.0 Renames a topology
- ST_ClusterIntersectingWin - Availability: 3.4.0 Window function that returns a cluster id for each input geometry, clustering input geometries into connected sets.
- ST_ClusterWithinWin - Availability: 3.4.0 Window function that returns a cluster id for each input geometry, clustering using separation distance.
- ST_CoverageInvalidEdges - Availability: 3.4.0 Window function that finds locations where polygons fail to form a valid coverage.
- ST_CoverageSimplify - Availability: 3.4.0 Window function that simplifies the edges of a polygonal coverage.
- ST_CoverageUnion - Availability: 3.4.0 - requires GEOS >= 3.8.0 Computes the union of a set of polygons forming a coverage by removing shared edges.

- ST_InverseTransformPipeline - Availability: 3.4.0 Return a new geometry with coordinates transformed to a different spatial reference system using the inverse of a defined coordinate transformation pipeline.
- ST_LargestEmptyCircle - Availability: 3.4.0. Computes the largest circle not overlapping a geometry.
- ST_LineExtend - Availability: 3.4.0 Returns a line extended forwards and backwards by specified distances.
- ST_TransformPipeline - Availability: 3.4.0 Return a new geometry with coordinates transformed to a different spatial reference system using a defined coordinate transformation pipeline.
- TopoElement - Availability: 3.4.0 Converts a topogeometry to a topoelement.
- debug_standardize_address - Availability: 3.4.0 Returns a json formatted text listing the parse tokens and standardizations
- postgis_srs - Availability: 3.4.0 Return a metadata record for the requested authority and srid.
- postgis_srs_all - Availability: 3.4.0 Return metadata records for every spatial reference system in the underlying Proj database.
- postgis_srs_codes - Availability: 3.4.0 Return the list of SRS codes associated with the given authority.
- postgis_srs_search - Availability: 3.4.0 Return metadata records for projected coordinate systems that have areas of usage that fully contain the bounds parameter.

Functions enhanced in PostGIS 3.4

- PostGIS_Full_Version - Enhanced: 3.4.0 now includes extra PROJ configurations NETWORK_ENABLED, URL_ENDPOINT and DATABASE_PATH of proj.db location Reports full PostGIS version and build configuration infos.
- PostGIS_PROJ_Version - Enhanced: 3.4.0 now includes NETWORK_ENABLED, URL_ENDPOINT and DATABASE_PATH of proj.db location Returns the version number of the PROJ4 library.
- ST_AsSVG - Enhanced: 3.4.0 to support all curve types Returns SVG path data for a geometry.
- ST_ClosestPoint - Enhanced: 3.4.0 - Support for geography. Returns the 2D point on g1 that is closest to g2. This is the first point of the shortest line from one geometry to the other.
- ST_LineSubstring - Enhanced: 3.4.0 - Support for geography was introduced. Returns the part of a line between two fractional locations.
- ST_Project - Enhanced: 3.4.0 Allow geometry arguments and two-point form omitting azimuth. Returns a point projected from a start point by a distance and bearing (azimuth).
- ST_Resample - Enhanced: 3.4.0 max and min resampling options added ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠.
- ST_Rescale - Enhanced: 3.4.0 max and min resampling options added Resample a raster by adjusting only its scale (or pixel size). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline, Lanczos, Max or Min resampling algorithm. Default is NearestNeighbor.
- ST_ShortestLine - Enhanced: 3.4.0 - support for geography. ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Functions changed in PostGIS 3.4

- PostGIS_Extensions_Upgrade - Changed: 3.4.0 to add target_version argument. Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.

13.12.3 PostGIS Functions new or enhanced in 3.3

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.3

- RemoveUnusedPrimitives - Availability: 3.3.0 Removes topology primitives which not needed to define existing TopoGeometry objects.
- ST_3DConvexHull - Availability: 3.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DUnion - Availability: 3.3.0 aggregate variant was added Perform 3D union.
- ST_AsMARC21 - Availability: 3.3.0 Returns geometry as a MARC21/XML record with a geographic datafield (034).
- ST_GeomFromMARC21 - Availability: 3.3.0, requires libxml2 2.6+ Takes MARC21/XML geographic data as input and returns a PostGIS geometry object.
- ST_Letters - Availability: 3.3.0 Returns the input letters rendered as geometry with a default start position at the origin and default text height of 100.
- ST_OptimalAlphaShape - Availability: 3.3.0 - requires SFCGAL >= 1.4.1. Computes an Alpha-shape enclosing a geometry using an "optimal" alpha value.
- ST_SimplifyPolygonHull - Availability: 3.3.0. Computes a simplifed topology-preserving outer or inner hull of a polygonal geometry.
- ST_TriangulatePolygon - Availability: 3.3.0. Computes the constrained Delaunay triangulation of polygons
- postgis_sfcgal_full_version - Availability: 3.3.0 Returns the full version of SFCGAL in use including CGAL and Boost versions

Functions enhanced in PostGIS 3.3

- ST_ConcaveHull - Enhanced: 3.3.0, GEOS native implementation enabled for GEOS 3.11+ Computes a possibly concave geometry that contains all input geometry vertices
- ST_LineMerge - Enhanced: 3.3.0 accept a directed parameter. Return the lines formed by sewing together a MultiLineString.

Functions changed in PostGIS 3.3

- PostGIS_Extensions_Upgrade - Changed: 3.3.0 support for upgrades from any PostGIS version. Does not work on all systems. Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.

13.12.4 PostGIS Functions new or enhanced in 3.2

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.2

- FindLayer - Availability: 3.2.0 Returns a topology.layer record by different means.
- FindTopology - Availability: 3.2.0 Returns a topology record by different means.
- GetFaceContainingPoint - Availability: 3.2.0 Finds the face containing a point.
- ST_AsFlatGeobuf - Availability: 3.2.0 Return a FlatGeobuf representation of a set of rows.

- ST_Contour - Availability: 3.2.0 Generates a set of vector contours from the provided raster band, using the GDAL contouring algorithm.
- ST_DumpSegments - Availability: 3.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_FromFlatGeobuf - Availability: 3.2.0 Reads FlatGeobuf data.
- ST_FromFlatGeobufToTable - Availability: 3.2.0 Creates a table based on the structure of FlatGeobuf data.
- ST_InterpolateRaster - Availability: 3.2.0 Interpolates a gridded surface based on an input set of 3-d points, using the X- and Y-values to position the points on the grid and the Z-value of the points as the surface elevation.
- ST_SRID - Availability: 3.2.0 Returns the spatial reference identifier for a topogeometry.
- ST_Scroll - Availability: 3.2.0 Change start point of a closed LineString.
- ST_SetM - Availability: 3.2.0 Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the M dimension using the requested resample algorithm.
- ST_SetZ - Availability: 3.2.0 Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the Z dimension using the requested resample algorithm.
- TopoGeom_addTopoGeom - Availability: 3.2 Adds element of a TopoGeometry to the definition of another TopoGeometry.
- ValidateTopologyRelation - Availability: 3.2.0 Returns info about invalid topology relation records
- postgis.gdal_vsi_options - Availability: 3.2.0 DB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Functions enhanced in PostGIS 3.2

- GetFaceByPoint - Enhanced: 3.2.0 more efficient implementation and clearer contract, stops working with invalid topologies. Finds face intersecting a given point.
- ST_ClusterKMeans - Enhanced: 3.2.0 Support for max_radius Window function that returns a cluster id for each input geometry using the K-means algorithm.
- ST_MakeValid - Enhanced: 3.2.0, added algorithm options, 'linework' and 'structure' which requires GEOS >= 3.10.0. Attempts to make an invalid geometry valid without losing vertices.
- ST_PixelAsCentroid - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠.
- ST_PixelAsCentroids - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ C ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠.
- ST_Point - Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry. Creates a Point with X, Y and SRID values.
- ST_PointM - Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry. Creates a Point with X, Y, M and SRID values.
- ST_PointZ - Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry. Creates a Point with X, Y, Z and SRID values.
- ST_PointZM - Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry. Creates a Point with X, Y, Z, M and SRID values.

- ST_RemovePoint - Enhanced: 3.2.0 Remove a point from a linestring.
- ST_RemoveRepeatedPoints - Enhanced: 3.2.0 Returns a version of a geometry with duplicate points removed.
- ST_StartPoint - Enhanced: 3.2.0 returns a point for all geometries. Prior behavior returns NULLs if input was not a LineString. Returns the first point of a LineString.
- ST_Value - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ columnx, rowy ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, nodata ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- TopoGeo_AddLineString - Enhanced: 3.2.0 added support for returning signed identifier. Adds a linestring to an existing topology using a tolerance and possibly splitting existing edges/faces.

Functions changed in PostGIS 3.2

- ST_Boundary - Changed: 3.2.0 support for TIN, does not use geos, does not linearize curves ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ValidateTopology - Changed: 3.2.0 added optional bbox parameter, perform face labeling and edge linking checks. Returns a set of validatetopology_returntype objects detailing issues with topology.

13.12.5 PostGIS Functions new or enhanced in 3.1

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.1

- ST_Hexagon - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a single hexagon, using the provided edge size and cell coordinate within the hexagon grid space.
- ST_HexagonGrid - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a set of hexagons and cell indices that completely cover the bounds of the geometry argument.
- ST_MaximumInscribedCircle - Availability: 3.1.0. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ReducePrecision - Availability: 3.1.0. Returns a valid geometry with points rounded to a grid tolerance.
- ST_Square - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a single square, using the provided edge size and cell coordinate within the square grid space.
- ST_SquareGrid - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a set of grid squares and cell indices that completely cover the bounds of the geometry argument.

Functions enhanced in PostGIS 3.1

- ST_AsEWKT - Enhanced: 3.1.0 support for optional precision parameter. ⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ClusterKMeans - Enhanced: 3.1.0 Support for 3D geometries and weights Window function that returns a cluster id for each input geometry using the K-means algorithm.
- ST_Difference - Enhanced: 3.1.0 accept a gridSize parameter. Computes a geometry representing the part of geometry A that does not intersect geometry B.
- ST_Intersection - Enhanced: 3.1.0 accept a gridSize parameter Computes a geometry representing the shared portion of geometries A and B.

- ST_MakeValid - Enhanced: 3.1.0, added removal of Coordinates with NaN values. Attempts to make an invalid geometry valid without losing vertices.
- ST_Subdivide - Enhanced: 3.1.0 accept a gridSize parameter. Computes a rectilinear subdivision of a geometry.
- ST_SymDifference - Enhanced: 3.1.0 accept a gridSize parameter. Computes a geometry representing the portions of geometries A and B that do not intersect.
- ST_TileEnvelope - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Creates a rectangular Polygon in Web Mercator (SRID:3857) using the XYZ tile system.
- ST_UnaryUnion - Enhanced: 3.1.0 accept a gridSize parameter. Computes the union of the components of a single geometry.
- ST_Union - Enhanced: 3.1.0 accept a gridSize parameter. Computes a geometry representing the point-set union of the input geometries.

Functions changed in PostGIS 3.1

- ST_Count - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠ ST_Count(rastertable, rastercolumn, ...) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, NODATA ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3D - Changed: 3.1.0. Added support for supplying a non-zero Z value. ⊠⊠⊠ XYZ ⊠⊠⊠⊠ ⊠⊠⊠⊠. ST_Force3DZ ⊠⊠⊠⊠⊠⊠.
- ST_Force3DM - Changed: 3.1.0. Added support for supplying a non-zero M value. ⊠⊠⊠ XYM ⊠⊠ ⊠⊠⊠⊠⊠⊠.
- ST_Force3DZ - Changed: 3.1.0. Added support for supplying a non-zero Z value. ⊠⊠⊠ XYZ ⊠⊠⊠ ⊠⊠⊠⊠⊠.
- ST_Force4D - Changed: 3.1.0. Added support for supplying non-zero Z and M values. ⊠⊠⊠ XYZM ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Histogram - Changed: 3.1.0 Removed ST_Histogram(table_name, column_name) variant. ⊠ (bin; ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Quantile - Changed: 3.1.0 Removed ST_Quantile(table_name, column_name) variant. ⊠⊠⊠⊠ ⊠⊠⊠⊠ (population) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (quantile) ⊠⊠⊠⊠⊠⊠. ⊠⊠ ⊠, ⊠⊠⊠⊠ 25%, 50%, 75% ⊠⊠⊠ (percentile) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_SummaryStats - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠ ST_SummaryStats(rastertable, rastercolumn, ...) ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ count, sum, mean, stddev, min, max ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠ ⊠⊠⊠.

13.12.6 PostGIS Functions new or enhanced in 3.0

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.0

- CG_ConstrainedDelaunayTriangles - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Return a constrained Delaunay triangulation around the given input geometry.
- ST_3DLineInterpolatePoint - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a point interpolated along a 3D line at a fractional location.

- ST_ConstrainedDelaunayTriangles - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Return a constrained Delaunay triangulation around the given input geometry.
- ST_TileEnvelope - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Creates a rectangular Polygon in Web Mercator (SRID:3857) using the XYZ tile system.

Functions enhanced in PostGIS 3.0

- ST_AsMVT - Enhanced: 3.0 - added support for Feature ID. Aggregate function returning a MVT representation of a set of rows.
- ST_Contains - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of B lies in A, and their interiors have a point in common
- ST_ContainsProperly - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of B lies in the interior of A
- ST_CoveredBy - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of A lies in B
- ST_Covers - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of B lies in A
- ST_Crosses - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have some, but not all, interior points in common
- ST_CurveToLine - Enhanced: 3.0.0 implemented a minimum number of segments per linearized arc to prevent topological collapse. Converts a geometry containing curves to a linear geometry.
- ST_Disjoint - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have no points in common
- ST_Equals - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries include the same set of points
- ST_GeneratePoints - Enhanced: 3.0.0, added seed parameter Generates a multipoint of random points contained in a Polygon or MultiPolygon.
- ST_GeomFromGeoJSON - Enhanced: 3.0.0 parsed geometry defaults to SRID=4326 if not specified otherwise. GeoJSON ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_LocateBetween - Enhanced: 3.0.0 - added support for POLYGON, TIN, TRIANGLE. Returns the portions of a geometry that match a measure range.
- ST_LocateBetweenElevations - Enhanced: 3.0.0 - added support for POLYGON, TIN, TRIANGLE. Returns the portions of a geometry that lie in an elevation (Z) range.
- ST_Overlaps - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have the same dimension and intersect, but each has at least one point not in the other
- ST_Relate - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have a topological relationship matching an Intersection Matrix pattern, or computes their Intersection Matrix
- ST_Segmentize - Enhanced: 3.0.0 Segmentize geometry now produces equal-length subsegments Returns a modified geometry/geography having no segment longer than a given distance.
- ST_Touches - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have at least one point in common, but their interiors do not intersect
- ST_Within - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of A lies in B, and their interiors have a point in common

Functions changed in PostGIS 3.0

- PostGIS_Extensions_Upgrade - Changed: 3.0.0 to repackage loose extensions and support postgis_raster. Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.
- ST_3DDistance - Changed: 3.0.0 - SFCGAL version removed ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠ ⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DIntersects - Changed: 3.0.0 SFCGAL backend removed, GEOS backend supports TINs. Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)
- ST_Area - Changed: 3.0.0 - does not depend on SFCGAL anymore. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsGeoJSON - Changed: 3.0.0 support records as input Return a geometry or feature in GeoJSON format.
- ST_AsGeoJSON - Changed: 3.0.0 output SRID if not EPSG:4326. Return a geometry or feature in GeoJSON format.
- ST_AsKML - Changed: 3.0.0 - Removed the ”versioned” variant signature ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Distance - Changed: 3.0.0 - does not depend on SFCGAL anymore. ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Intersection - Changed: 3.0.0 does not depend on SFCGAL. Computes a geometry representing the shared portion of geometries A and B.
- ST_Intersects - Changed: 3.0.0 SFCGAL version removed and native support for 2D TINS added. Tests if two geometries intersect (they have at least one point in common)
- ST_Union - Changed: 3.0.0 does not depend on SFCGAL. Computes a geometry representing the point-set union of the input geometries.

13.12.7 PostGIS Functions new or enhanced in 2.5

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.5

- PostGIS_Extensions_Upgrade - Availability: 2.5.0 Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.
- ST_Angle - Availability: 2.5.0 ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsHexWKB - Availability: 2.5.0 Return the Well-Known Binary (WKB) in Hex representation of the raster.
- ST_BandFileSize - Availability: 2.5.0 Returns the file size of a band stored in file system. If no bandnum specified, 1 is assumed.
- ST_BandFileTimestamp - Availability: 2.5.0 Returns the file timestamp of a band stored in file system. If no bandnum specified, 1 is assumed.
- ST_ChaikinSmoothing - Availability: 2.5.0 Returns a smoothed version of a geometry, using the Chaikin algorithm
- ST_FilterByM - Availability: 2.5.0 Removes vertices based on their M value

- ST_Grayscale - Availability: 2.5.0 Creates a new one-8BUI band raster from the source raster and specified bands representing Red, Green and Blue
- ST_LineInterpolatePoints - Availability: 2.5.0 Returns points interpolated along a line at a fractional interval.
- ST_OrientedEnvelope - Availability: 2.5.0. Returns a minimum-area rectangle containing a geometry.
- ST_QuantizeCoordinates - Availability: 2.5.0 Sets least significant bits of coordinates to zero
- ST_RastFromHexWKB - Availability: 2.5.0 Return a raster value from a Hex representation of Well-Known Binary (WKB) raster.
- ST_RastFromWKB - Availability: 2.5.0 Return a raster value from a Well-Known Binary (WKB) raster.
- ST_SetBandIndex - Availability: 2.5.0 Update the external band number of an out-db band
- ST_SetBandPath - Availability: 2.5.0 Update the external path and band number of an out-db band

Functions enhanced in PostGIS 2.5

- ST_AsBinary/ST_AsWKB - Enhanced: 2.5.0 Addition of ST_AsWKB Return the Well-Known Binary (WKB) representation of the raster.
- ST_AsMVT - Enhanced: 2.5.0 - added support parallel query. Aggregate function returning a MVT representation of a set of rows.
- ST_AsText - Enhanced: 2.5 - optional parameter precision introduced. ⊠⊠/⊠⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_BandMetaData - Enhanced: 2.5.0 to include outdbbandnum, filesize and filetimestamp for outdb rasters. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Buffer - Enhanced: 2.5.0 - ST_Buffer geometry support was enhanced to allow for side buffering specification side=both|left|right. Computes a geometry covering all points within a given distance from a geometry.
- ST_GeomFromGeoJSON - Enhanced: 2.5.0 can now accept json and jsonb as inputs. GeoJSON ⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometricMedian - Enhanced: 2.5.0 Added support for M as weight of points. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (median) ⊠⊠⊠⊠⊠⊠⊠.
- ST_Intersects - Enhanced: 2.5.0 Supports GEOMETRYCOLLECTION. Tests if two geometries intersect (they have at least one point in common)
- ST_OffsetCurve - Enhanced: 2.5 - added support for GEOMETRYCOLLECTION and MULTILINESTRING Returns an offset line at a given distance and side from an input line.
- ST_Scale - Enhanced: 2.5.0 support for scaling relative to a local origin (origin parameter) was introduced. Scales a geometry by given factors.
- ST_Split - Enhanced: 2.5.0 support for splitting a polygon by a multiline was introduced. Returns a collection of geometries created by splitting a geometry by another geometry.
- ST_Subdivide - Enhanced: 2.5.0 reuses existing points on polygon split, vertex count is lowered from 8 to 5. Computes a rectilinear subdivision of a geometry.

Functions changed in PostGIS 2.5

- ST_GDALDrivers - Changed: 2.5.0 - add can_read and can_write columns. Returns a list of raster formats supported by PostGIS through GDAL. Only those formats with can_write=True can be used by ST_AsGDALRaster

13.12.8 PostGIS Functions new or enhanced in 2.4

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.4

- ST_AsGeobuf - 2.2.0 □□□□□□□□□□□□. Return a Geobuf representation of a set of rows.
- ST_AsMVT - 2.2.0 □□□□□□□□□□□□. Aggregate function returning a MVT representation of a set of rows.
- ST_AsMVTGeom - 2.2.0 □□□□□□□□□□□□. Transforms a geometry into the coordinate space of a MVT tile.
- ST_Centroid - Availability: 2.4.0 support for geography was introduced. □□□□□□□□□□□□□□□.
- ST_ForcePolygonCCW - 2.2.0 □□□□□□□□□□□□. Orients all exterior rings counter-clockwise and all interior rings clockwise.
- ST_ForcePolygonCW - 2.2.0 □□□□□□□□□□□□. Orients all exterior rings clockwise and all interior rings counter-clockwise.
- ST_FrechetDistance - Availability: 2.4.0 - requires GEOS >= 3.7.0 □□□□□□ 3 □□□□ (shortest) □□□□□□□□.
- ST_IsPolygonCCW - 2.2.0 □□□□□□□□□□□□. Tests if Polygons have exterior rings oriented counter-clockwise and interior rings oriented clockwise.
- ST_IsPolygonCW - 2.2.0 □□□□□□□□□□□□. Tests if Polygons have exterior rings oriented clockwise and interior rings oriented counter-clockwise.
- ST_MakeEmptyCoverage - 2.2.0 □□□□□□□□□□□□. Cover georeferenced area with a grid of empty raster tiles.

Functions enhanced in PostGIS 2.4

- Loader_Generate_Nation_Script - Enhanced: 2.4.1 zip code 5 tabulation area (zcta5) load step was fixed and when enabled, zcta5 data is loaded as a single table called zcta5_all as part of the nation script load. □□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.
- Normalize_Address - Enhanced: 2.4.0 norm_addy object includes additional fields zip4 and address_alphanumeric. □□□□□□□□□□□□□, □□□□□, □□□□□□□□□□□□□□□, □□□□□□□□□□□□□□ norm_addy □□□□□□□□□□. □□□□ tiger_geocoder □□□□□□□□□□□□□□□□□□ (TIGER □□□□□□□□□□□□) □□□□□□□.
- Pagc_Normalize_Address - Enhanced: 2.4.0 norm_addy object includes additional fields zip4 and address_alphanumeric. □□□□□□□□□□□□□, □□□□□, □□□□□□□□□□□□□□□, □□□□□□□□□□□□□□ norm_addy □□□□□□□□□□. □□□□ tiger_geocoder □□□□□□□□□□□□□□□□□□ (TIGER □□□□□□□□□□□□) □□□□□□□. address_standardizer □□□□□□□□□□□□.
- Reverse_Geocode - Enhanced: 2.4.1 if optional zcta5 dataset is loaded, the reverse_geocode function can resolve to state and zip even if the specific state data is not loaded. Refer to for details on loading zcta5 data. □□□. include_strnum_range = true □□□, □□□□□□□□□□□□□□□□□.
- ST_AsTWKB - Enhanced: 2.4.0 memory and speed improvements. □□□ TWKB(Tiny Well-Known Binary) □□□□□□.

- ST_Covers - Enhanced: 2.4.0 Support for polygon in polygon and line in polygon added for geography type Tests if every point of B lies in A
- ST_CurveToLine - Enhanced: 2.4.0 added support for max-deviation and max-angle tolerance, and for symmetric output. Converts a geometry containing curves to a linear geometry.
- ST_Project - Enhanced: 2.4.0 Allow negative distance and non-normalized azimuth. Returns a point projected from a start point by a distance and bearing (azimuth).
- ST_Reverse - Enhanced: 2.4.0 support for curves was introduced. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Functions changed in PostGIS 2.4

- = - Changed: 2.4.0, in prior versions this was bounding box equality not a geometric equality. If you need bounding box equality, use instead. Returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B.
- ST_Node - Changed: 2.4.0 this function uses GEOSNode internally instead of GEOSUnaryUnion. This may cause the resulting linestrings to have a different order and direction compared to PostGIS < 2.4. Nodes a collection of lines.

13.12.9 PostGIS Functions new or enhanced in 2.3

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.3

- &&&(geometry,gidx) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a geometry's (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).
- &&&(gidx,geometry) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a n-D float precision bounding box (GIDX) intersects a geometry's (cached) n-D bounding box.
- &&&(gidx,gidx) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if two n-D float precision bounding boxes (GIDX) intersect each other.
- &&(box2df,box2df) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.
- &&(box2df,geometry) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.
- &&(geometry,box2df) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).
- @(box2df,box2df) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.
- @(box2df,geometry) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.

- @(geometry,box2df) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a geometry's 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).
- Populate_Topology_Layer - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Adds missing entries to topology.layer table by reading metadata from topo tables.
- ST_ClusterDBSCAN - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Window function that returns a cluster id for each input geometry using the DBSCAN algorithm.
- ST_ClusterKMeans - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Window function that returns a cluster id for each input geometry using the K-means algorithm.
- ST_GeneratePoints - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Generates a multipoint of random points contained in a Polygon or MultiPolygon.
- ST_GeometricMedian - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (median) ⌧⌧⌧⌧⌧⌧.
- ST_MakeLine - 2.0.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_MinimumBoundingRadius - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Returns the center point and radius of the smallest circle that contains a geometry.
- ST_MinimumClearance - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧ (robustness) ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (clearance) ⌧⌧⌧⌧⌧⌧.
- ST_MinimumClearanceLine - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. GEOS 3.6.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧ 2 ⌧⌧⌧⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Normalize - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Points - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_VoronoiLines - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Returns the boundaries of the Voronoi diagram of the vertices of a geometry.
- ST_VoronoiPolygons - 2.3.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Returns the cells of the Voronoi diagram of the vertices of a geometry.
- ST_WrapX - Availability: 2.3.0 requires GEOS X ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- TopoGeom_addElement - 2.3 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Adds an element to the definition of a TopoGeometry.
- TopoGeom_remElement - 2.3 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Removes an element from the definition of a TopoGeometry.
- ~(box2df,box2df) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).
- ~(box2df,geometry) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bonding box.
- ~(geometry,box2df) - Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a geometry's 2D bonding box contains a 2D float precision bounding box (GIDX).

Functions enhanced in PostGIS 2.3

- ST_Contains - Enhanced: 2.3.0 Enhancement to PIP short-circuit extended to support MultiPoints with few points. Prior versions only supported point in polygon. Tests if every point of B lies in A, and their interiors have a point in common
- ST_Covers - Enhanced: 2.3.0 Enhancement to PIP short-circuit for geometry extended to support MultiPoints with few points. Prior versions only supported point in polygon. Tests if every point of B lies in A
- ST_Expand - Enhanced: 2.3.0 support was added to expand a box by different amounts in different dimensions. Returns a bounding box expanded from another bounding box or a geometry.
- ST_Intersects - Enhanced: 2.3.0 Enhancement to PIP short-circuit extended to support MultiPoints with few points. Prior versions only supported point in polygon. Tests if two geometries intersect (they have at least one point in common)
- ST_Segmentize - Enhanced: 2.3.0 Segmentize geography now produces equal-length subsegments Returns a modified geometry/geography having no segment longer than a given distance.
- ST_Transform - Enhanced: 2.3.0 support for direct PROJ.4 text was introduced. Return a new geometry with coordinates transformed to a different spatial reference system.
- ST_Within - Enhanced: 2.3.0 Enhancement to PIP short-circuit for geometry extended to support MultiPoints with few points. Prior versions only supported point in polygon. Tests if every point of A lies in B, and their interiors have a point in common

Functions changed in PostGIS 2.3

- ST_PointN - ⊠⊠⊠⊠: 2.3.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (-1 ⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

13.12.10 PostGIS Functions new or enhanced in 2.2

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.2

- <<->> - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.1 ⊠⊠⊠⊠⊠⊠⊠ KNN ⊠⊠⊠⊠⊠⊠⊠. Returns the n-D distance between the A and B geometries or bounding boxes
- ST_3DDifference - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DUnion - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Perform 3D union.
- ST_ApproximateMedialAxis - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsEncodedPolyline - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsTWKB - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ TWKB(Tiny Well-Known Binary) ⊠⊠⊠⊠⊠⊠.
- ST_BoundingDiagonal - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_CPAWithin - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Tests if the closest point of approach of two trajectories is within the specified distance.
- ST_ClipByBox2D - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Computes the portion of a geometry falling within a rectangle.
- ST_ClosestPointOfApproach - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a measure at the closest point of approach of two trajectories.

- ST_ClusterIntersecting - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒. Aggregate function that clusters input geometries into connected sets.
- ST_ClusterWithin - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. Aggregate function that clusters geometries by separation distance.
- ST_CountAgg - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ 1 ☒☒☒. exclude_nodata_value ☒☒☒☒☒☒☒☒☒, NODATA ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ST_CreateOverview - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ST_DistanceCPA - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. Returns the distance between the closest point of approach of two trajectories.
- ST_ForceCurve - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (upcast) ☒☒☒.
- ST_IsPlanar - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒ 2.1.0 ☒☒☒☒☒☒☒☒☒ 2.1 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ST_IsSolid - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ST_IsValidTrajectory - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. Tests if the geometry is a valid trajectory.
- ST_LineFromEncodedPolyline - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒ (polyline) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ST_MakeSolid - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ TIN ☒☒☒☒☒☒☒.
- ST_MapAlgebra (callback function version) - 2.2.0 ☒☒☒☒ mask ☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒ - ☒☒☒ 1 ☒☒☒, ☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒ 1 ☒☒☒☒☒☒☒☒ 1 ☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ST_MemSize - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (☒☒☒☒☒☒) ☒☒☒☒☒.
- ST_RemoveRepeatedPoints - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. Returns a version of a geometry with duplicate points removed.
- ST_Retile - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ST_SetEffectiveArea - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. Sets the effective area for each vertex, using the Visvalingam-Whyatt algorithm.
- ST_SimplifyVW - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. Returns a simplified representation of a geometry, using the Visvalingam-Whyatt algorithm
- ST_Subdivide - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. Computes a rectilinear subdivision of a geometry.
- ST_SummaryStatsAgg - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒ count, sum, mean, stddev, min, max ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ 1 ☒☒☒☒☒☒.
- ST_SwapOrdinates - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ST_Volume - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. 3 ☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒ (☒☒☒☒☒☒☒☒) 0 ☒☒☒☒☒☒☒☒.
- parse_address - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- postgis.enable_outdb_rasters - 2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒. DB ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

- postgis.gdal_datapath - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL ⊠ GDAL_DATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL_DATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- postgis.gdal_enabled_drivers - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL ⊠⊠⊠⊠ GDAL_SKIP ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- standardize_address - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠, ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ stdaddr ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- |=| - 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (index-supported) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠ B ⊠⊠⊠⊠⊠⊠⊠ (closest point of approach) ⊠⊠⊠⊠⊠ (trajectory) ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Functions enhanced in PostGIS 2.2

- <-> - ⊠⊠⊠⊠: 2.2.0 ⊠⊠ -- PostgreSQL 9.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ KNN(”K nearest neighbor”) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ KNN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠ B ⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- AsTopoJSON - ⊠⊠⊠⊠: 2.2.1 ⊠⊠⊠⊠⊠⊠ (puntal) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TopoGeometry ⊠ TopoJSON ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Area - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GeographicLib ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Proj 4.9.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsX3D - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (x/y, ⊠⊠/⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ X3D XML ⊠⊠⊠⊠⊠⊠: ISO-IEC-19776-1.2-X3DEncodings-XML ⊠⊠⊠⊠⊠⊠.
- ST_Azimuth - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GeographicLib ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Proj 4.9.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Distance - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ GeographicLib ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Proj 4.9.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Scale - Enhanced: 2.2.0 support for scaling all dimension (factor parameter) was introduced. Scales a geometry by given factors.
- ST_Split - Enhanced: 2.2.0 support for splitting a line by a multiline, a multipoint or (multi)polygon boundary was introduced. Returns a collection of geometries created by splitting a geometry by another geometry.
- ST_Summary - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠ (curve) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

Functions changed in PostGIS 2.2

- <-> - ⊠⊠⊠⊠: 2.2.0 ⊠⊠ -- PostgreSQL 9.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Hybrid syntax) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS 2.2 ⊠⊠, PostgreSQL 9.5 ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠ B ⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Get_Geocode_Setting - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠ geocode_settings_default ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ geocode_settings ⊠⊠⊠⊠⊠⊠⊠, ⊠ geocode_settings ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. tiger.geocode_settings ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DClosestPoint - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, (⊠⊠⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2D ⊠ 3D ⊠⊠⊠, ⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. g2 ⊠⊠⊠⊠⊠⊠ g1 ⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_3DDistance - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠, 2D ⊠ 3D ⊠⊠⊠⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DLongestLine - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, (⊠⊠⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2D ⊠ 3D ⊠⊠⊠, ⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DMaxDistance - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠, 2D ⊠ 3D ⊠⊠⊠⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠) 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DShortestLine - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, (⊠⊠⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2D ⊠ 3D ⊠⊠⊠, ⊠⊠⊠ Z ⊠⊠⊠⊠ Z ⊠ 0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (shortest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DistanceSphere - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Distance_Sphere ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DistanceSpheroid - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Distance_Spheroid ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Equals - Changed: 2.2.0 Returns true even for invalid geometries if they are binary equal Tests if two geometries include the same set of points
- ST_LengthSpheroid - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Length_Spheroid ⊠⊠⊠⊠⊠⊠⊠⊠, ST_3DLength_S⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MemSize - Changed: 2.2.0 name changed to ST_MemSize to follow naming convention. ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PointInsideCircle - Changed: 2.2.0 In prior versions this was called ST_Point_Inside_Circle Tests if a point geometry is inside a circle defined by a center and radius
- ValidateTopology - ⊠⊠⊠⊠: 2.2.0 ⊠⊠⊠⊠'edge crosses node' ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ id1 ⊠ id2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a set of validatetopology_returntype objects detailing issues with topology.

13.12.11 PostGIS Functions new or enhanced in 2.1

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.1

- = - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- AsTopoJSON - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TopoGeometry ⊠ TopoJSON ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Drop_Nation_Tables_Generate_Script - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ county_all, state_all ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ county, state ⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Get_Geocode_Setting - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. tiger.geocode_settings ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Loader_Generate_Nation_Script - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Pagc_Normalize_Address - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ norm_addy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ tiger_geocoder ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. address_standardizer ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_3DArea - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 0 ⊠⊠⊠⊠⊠ ⊠⊠⊠.
- ST_3DIntersection - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Box2dFromGeoHash - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GeoHash ⊠⊠⊠⊠⊠⊠⊠ BOX2D ⊠⊠⊠⊠⊠ ⊠.
- ST_ColorMap - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 8BUI ⊠⊠ (grayscale, RGB, RGBA) ⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.
- ST_Contains - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠, ⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ContainsProperly - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. rastB ⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_CoveredBy - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Covers - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ rastA ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠.
- ST_DFullyWithin - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DWithin - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.
- ST_DelaunayTriangles - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns the Delaunay triangulation of the vertices of a geometry.
- ST_Disjoint - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.
- ST_DumpValues - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Extrude - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceLHR - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. LHR(Left Hand Reverse; ⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_FromGDALRaster - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ GDAL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠.
- ST_GeomFromGeoHash - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_InvDistWeight4ma - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebra (callback function version) - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ - ⊠⊠⊠ 1 ⊠⊠⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebra (expression version) - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ - ⊠⊠⊠⊠⊠ 1 ⊠⊠ ⊠ 2 ⊠, ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SQL ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MinConvexHull - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.
- ST_MinDist4ma - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MinkowskiSum - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NearestValue - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. columnx ⊠ rowy, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_Neighborhood - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. columnx ⊠ rowy, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NotSameAlignmentReason - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Orientation - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠.
- ST_Overlaps - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelAsCentroid - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠⊠⊠ ⊠⊠⊠.
- ST_PixelAsCentroids - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠) ⊠ ⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelAsPoint - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelAsPoints - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelOfValue - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ columnx, rowy ⊠⊠ ⊠⊠⊠⊠⊠⊠.
- ST_PointFromGeoHash - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_RasterToWorldCoord - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y(⊠⊠, ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠.
- ST_Resize - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠/⊠ ⊠⊠⊠⊠⊠⊠⊠.
- ST_Roughness - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. DEM ⊠⊠⊠⊠" ⊠⊠⊠ (roughness)" ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.
- ST_SetValues - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠.
- ST_Simplify - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠-⊠⊠ (Douglas-Peucker) ⊠⊠⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠" ⊠⊠⊠⊠" ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_StraightSkeleton - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (straight skeleton) ⊠⊠⊠ ⊠⊠⊠.
- ST_Summary - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_TPI - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Topographic Position Index) ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.
- ST_TRI - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Terrain Ruggedness Index) ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.
- ST_Tesselate - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tessellation) ⊠⊠⊠ ⊠⊠⊠⊠⊠ TIN ⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Tile - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Touches - 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ rastA ⊠⊠⊠⊠ rastB ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_Union - 2.1.0 ⊠⊠⊠⊠ ST_Union(rast, unionarg) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_Within - 2.1.0 □□□□□□□□□□□□□□. □□□ rastB □□□□□□□□□ rastA □□□□□□□□□□□□, □□□ rastA □□□□□□□□□□ rastB □□□□□□□□□□□□□□□□□□□.
- ST_WorldToRasterCoord - 2.1.0 □□□□□□□□□□□□□□. □□□□□□□□□ X, Y(□□, □□) □□□□□□□ □□□.
- Set_Geocode_Setting - 2.1.0 □□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□.
- UpdateRasterSRID - 2.1.0 □□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□□□□ SRID □□□□□□□.
- clearTopoGeom - 2.1 □□□□□□□□□□□□□□. Clears the content of a topo geometry.
- postgis.backend - 2.1.0 □□□□□□□□□□□□□□. GEOS □ SFCGAL □□□□□□□□□□□□□□□□□□□□ □□□□□. geos □□ sfcgal □□□□□□□□□□, □□□□□ geos □□□.
- postgis_sfcgal_version - 2.1.0 □□□□□□□□□□□□□□. □□□□□ SFCGAL □□□□□□□□□□□.

Functions enhanced in PostGIS 2.1

- ST_AddBand - □□□□□: 2.1.0 □□□□□ addbandarg □□□□□□□□. □□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□ (□) □□□□□□□□□□□□□□□. □□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□ □.
- ST_AddBand - □□□□□: 2.1.0 □□□□□□□□□ DB □□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□ (□) □□□□□□□□□□□□□□□. □□□□□□□□□□□□□□, □□□□□□□□□□□□□ □□□.
- ST_AsBinary/ST_AsWKB - □□□□□: 2.1.0 □□□□□ outasin □□□□□□□□□. Return the Well-Known Binary (WKB) representation of the raster.
- ST_AsGML - □□□□□: 2.1.0 □□□□□ GML 3 □□□□ ID □□□□□□□□□□□□□□. □□□□ GML 2 □□ GML 3 □□□□□□□□□□□□□.
- ST_Aspect - □□□□□: 2.1.0 □□□□□ ST_MapAlgebra() □□□□□□, □□□□□ interpolate_nodata □□□ □□□□□□□□□□□□□. □□□□□□□□□□□□ (□□□□□□□□) □□□□□□□□. □□□□□□□□□□□□□□□□□□□.
- ST_Boundary - □□□□□: 2.1.0 □□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□ □□□□□□.
- ST_Clip - □□□□□: 2.1.0 □□□□□ C □□□□□□□□□□□□□. Returns the raster clipped by the input geometry. If band number is not specified, all bands are processed. If crop is not specified or TRUE, the output raster is cropped. If touched is set to TRUE, then touched pixels are included, otherwise only if the center of the pixel is in the geometry it is included.
- ST_DWithin - Enhanced: 2.1.0 improved speed for geography. See Making Geography faster for details. Tests if two geometries are within a given distance
- ST_DWithin - Enhanced: 2.1.0 support for curved geometries was introduced. Tests if two geometries are within a given distance
- ST_Distance - □□□□□: 2.1.0 □□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□ Making Geography faster □□□□□□□□□. □□□□□□□□ 3 □□□□□ (longest) □□□□□□□□□□□.
- ST_Distance - □□□□□: 2.1.0 □□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□ 3 □□□□□ (longest) □□□□□□□□□□□.
- ST_Distinct4ma - □□□□□: 2.1.0 □□□□□□□□ 2 □□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□.
- ST_DumpPoints - Enhanced: 2.1.0 Faster speed. Reimplemented as native-C. □□□□□□□□□□□□ □□□□□□□□□□.

- ST_HillShade - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧ ST_MapAlgebra() ⌧⌧⌧⌧⌧, ⌧⌧⌧⌧ interpolate_nodata ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧, ⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_MakeValid - Enhanced: 2.1.0, added support for GEOMETRYCOLLECTION and MULTIPOINT. Attempts to make an invalid geometry valid without losing vertices.
- ST_Max4ma - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧ 2 ⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Mean4ma - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧ 2 ⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Min4ma - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧ 2 ⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_PixelAsPolygons - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧⌧⌧ exclude_nodata_value ⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ X, Y ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Polygon - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (⌧⌧⌧ C ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧). ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. NODATA ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Range4ma - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧ 2 ⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_SameAlignment - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧, ⌧⌧, ⌧⌧⌧⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧) ⌧⌧⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Segmentize - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. Returns a modified geometry/geography having no segment longer than a given distance.
- ST_SetGeoReference - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧ ST_SetGeoReference(raster, double precision, ...) ⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ 6 ⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. GDAL ⌧⌧ ESRI ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧ GDAL ⌧⌧⌧.
- ST_SetValue - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧ ST_SetValue() ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧ ST_SetValues() ⌧ geomval[] ⌧⌧⌧⌧⌧⌧⌧⌧ (wrapper) ⌧⌧⌧. ⌧⌧⌧ columnx, rowy ⌧⌧. ⌧⌧⌧⌧⌧ 1 ⌧⌧⌧⌧⌧⌧, ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ 1 ⌧⌧⌧⌧⌧⌧.
- ST_Slope - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧ ST_MapAlgebra() ⌧⌧⌧⌧⌧, ⌧⌧⌧⌧ units, scale, interpolate_nodata ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (⌧⌧⌧⌧⌧⌧) ⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_StdDev4ma - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧ 2 ⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Sum4ma - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧ 2 ⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Summary - ⌧⌧⌧⌧: 2.1.0 ⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ S ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.
- ST_Transform - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧ ST_Transform(rast, alignto) ⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧. NearestNeighbor, Bilinear, Cubic, CubicSpline, Lanczos ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧. ⌧⌧⌧⌧ NearestNeighbor ⌧⌧⌧.
- ST_Union - ⌧⌧⌧⌧: 2.1.0 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧ (⌧⌧⌧ C ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧). ⌧⌧⌧⌧⌧⌧⌧⌧ 1 ⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧⌧.

- ST_Union - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_Union(rast) ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Union - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ ST_Union(rast, uniontype) ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- toTopoGeom - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠ TopoGeometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Converts a simple Geometry into a topo geometry.

Functions changed in PostGIS 2.1

- ST_Aspect - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_EstimatedExtent - Changed: 2.1.0. Up to 2.0.x this was called ST_Estimated_Extent. Returns the estimated extent of a spatial table.
- ST_Force2D - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_2D ⊠⊠⊠⊠. ⊠⊠⊠”2 ⊠⊠⊠⊠” ⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3D - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_3D ⊠⊠⊠⊠. ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_Force3DZ ⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3DM - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_3DM ⊠⊠⊠⊠⊠. ⊠⊠⊠ XYM ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3DZ - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_3DZ ⊠⊠⊠⊠. ⊠⊠⊠ XYZ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Force4D - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_4D ⊠⊠⊠⊠. ⊠⊠⊠ XYZM ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceCollection - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Force_Collection ⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_HillShade - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_LineInterpolatePoint - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Line_Interpolate_Point ⊠⊠⊠⊠. Returns a point interpolated along a line at a fractional location.
- ST_LineLocatePoint - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Line_Locate_Point ⊠⊠⊠⊠. Returns the fractional location of the closest point on a line to a point.
- ST_LineSubstring - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠, ⊠ 2.0.x ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_Line_Substring ⊠⊠⊠⊠⊠. Returns the part of a line between two fractional locations.
- ST_PixelAsCentroids - ⊠⊠⊠⊠: 2.1.1 ⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelAsPoints - ⊠⊠⊠⊠: 2.1.1 ⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_PixelAsPolygons - ⊠⊠⊠⊠: 2.1.1 ⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Polygon - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_RasterToWorldCoordX - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Raster2WorldCoordX ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_RasterToWorldCoordY - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠ ST_Raster2WorldCoordY ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Rescale - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Resample a raster by adjusting only its scale (or pixel size). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline, Lanczos, Max or Min resampling algorithm. Default is NearestNeighbor.
- ST_Reskew - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NearestNeighbor(⊠⊠⊠⊠⊠⊠⊠⊠⊠), Bilinear, Cubic, CubicSpline ⊠⊠ Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.
- ST_Segmentize - Changed: 2.1.0 As a result of the introduction of geography support, the usage ST_Segmentize('LINESTRING(1 2, 3 4)', 0.5) causes an ambiguous function error. The input needs to be properly typed as a geometry or geography. Use ST_GeomFromText, ST_GeogFromText or a cast to the required type (e.g. ST_Segmentize('LINESTRING(1 2, 3 4)'::geometry, 0.5)) Returns a modified geometry/geography having no segment longer than a given distance.
- ST_Slope - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_SnapToGrid - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NearestNeighbor(⊠⊠⊠⊠⊠⊠⊠⊠⊠), Bilinear, Cubic, CubicSpline ⊠⊠ Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.
- ST_WorldToRasterCoordX - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠ ST_World2RasterCoordX ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ (pt) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠ (xw, yw) ⊠⊠⊠⊠⊠⊠.
- ST_WorldToRasterCoordY - ⊠⊠⊠⊠: 2.1.0 ⊠⊠⊠⊠⊠⊠⊠⊠ ST_World2RasterCoordY ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ (pt) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠ (xw, yw) ⊠⊠⊠⊠⊠⊠.

13.12.12 PostGIS Functions new or enhanced in 2.0

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.0

- && - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠.
- &&& - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠ n ⊠⊠⊠⊠⊠⊠⊠⊠ B ⊠ n ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠.
- <#> - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.1 ⊠⊠⊠⊠⊠⊠⊠⊠ KNN ⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- <-> - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ KNN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostgreSQL 9.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠ B ⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- @ - 2.0.0 ⊠⊠⊠⊠ raster @ raster, raster @ geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. B ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- @ - 2.0.5 ⊠⊠⊠⊠ geometry @ raster ⊠⊠⊠⊠⊠⊠⊠. B ⊠⊠⊠⊠⊠⊠ A ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- AddEdge - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ (⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠ ID(edgeid) ⊠⊠⊠⊠⊠⊠.
- AddFace - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (face primitive) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- AddNode - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ID(nodeid) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ ID ⊠⊠⊠⊠⊠⊠.
- AddOverviewConstraints - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (overview) ⊠⊠⊠⊠⊠⊠.
- AddRasterConstraints - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Adds raster constraints to a loaded raster table for a specific column that constrains spatial ref, scaling, blocksize, alignment, bands, band type and a flag to denote if raster column is regularly blocked. The table must be loaded with data for the constraints to be inferred. Returns true if the constraint setting was accomplished and issues a notice otherwise.
- AsGML - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TopoGeometry ⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- CopyTopology - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Makes a copy of a topology (nodes, edges, faces, layers and TopoGeometries) into a new schema
- DropOverviewConstraints - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (overview) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- DropRasterConstraints - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Drop_Indexes_Generate_Script - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TIGER ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ tiger_data ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Drop_State_Tables_Generate_Script - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ tiger_data ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Geocode_Intersection - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠, ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠ NAD83 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ geomout, ⊠⊠⊠⊠⊠⊠ normalized_address (addy) ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠ 10) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TIGER ⊠⊠⊠ (edge, face, addr) ⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠ (soundex, levenshtein) ⊠⊠⊠⊠⊠⊠.
- GetEdgeByPoint - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Finds the edge-id of an edge that intersects a given point.
- GetFaceByPoint - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Finds face intersecting a given point.
- GetNodeByPoint - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Finds the node-id of a node at a point location.
- GetNodeEdges - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- GetRingEdges - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠.
- GetTopoGeomElements - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a set of topoelement objects containing the topological element_id,element_type of the given TopoGeometry (primitive elements).
- GetTopologySRID - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ topology.topology ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠.

- Get_Tract - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (tract) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ (field) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Install_Missing_Indexes - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (join) ⊠⊠⊠⊠⊠⊠ (key) ⊠⊠ ⊠⊠⊠⊠⊠.
- Loader_Generate_Census_Script - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠, TIGER ⊠⊠⊠⊠⊠ (州) ⊠⊠ (tract), ⊠⊠⊠⊠ (bg), ⊠⊠ (tabblock) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ tiger_data ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ (州) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠.
- Loader_Generate_Script - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. TIGER 2010 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ (tract), ⊠⊠⊠⊠ (bg), ⊠⊠ (tabblock) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (州) ⊠⊠⊠, TIGER ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ tiger_data ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ (州) ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ TIGER 2010 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- Missing_Indexes_Generate_Script - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (join) ⊠⊠⊠ ⊠⊠⊠ (key) ⊠⊠⊠ SQL DDL ⊠⊠⊠⊠⊠⊠.
- Polygonize - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Finds and registers all faces defined by topology edges.
- Reverse_Geocode - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. include_strnum_range = true ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DClosestPoint - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. g2 ⊠⊠⊠⊠⊠⊠ g1 ⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠. ⊠⊠⊠⊠⊠⊠ 3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DDFullyWithin - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Tests if two 3D geometries are entirely within a given 3D distance
- ST_3DDWithin - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Tests if two 3D geometries are within a given 3D distance
- ST_3DDistance - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠) 3 ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DIntersects - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)
- ST_3DLongestLine - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠ ⊠.
- ST_3DMaxDistance - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠ (SRS ⊠⊠⊠⊠) 3 ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_3DShortestLine - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (shortest) ⊠⊠⊠⊠⊠⊠⊠ ⊠.
- ST_AddEdgeModFace - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AddEdgeNewFaces - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠.
- ST_AsGDALRaster - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Return the raster tile in the designated GDAL Raster format. Raster formats are one of those supported by your compiled library. Use ST_GDALDrivers() to get a list of formats supported by your library.

- ST_AsJPEG - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ JPEG(Joint Photographic Exports Group) ⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠ 1 ⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠⊠⊠ RGB ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsLatLonText - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsPNG - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PNG(Portable Network Graphics) ⊠⊠⊠ (⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠, 3 ⊠, ⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ 2 ⊠⊠⊠ 4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠. ⊠⊠⊠ RGB ⊠⊠ RGBA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsRaster - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsTIFF - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Return the raster selected bands as a single TIFF image (byte array). If no band is specified or any of specified bands does not exist in the raster, then will try to use all bands.
- ST_AsX3D - 2.0.0 ⊠⊠⊠⊠ ISO-IEC-19776-1.2-X3DEncodings-XML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ X3D XML ⊠⊠⊠⊠⊠⊠⊠: ISO-IEC-19776-1.2-X3DEncodings-XML ⊠⊠⊠⊠⊠⊠⊠.
- ST_Aspect - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Band - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_BandIsNoData - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Clip - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns the raster clipped by the input geometry. If band number is not specified, all bands are processed. If crop is not specified or TRUE, the output raster is cropped. If touched is set to TRUE, then touched pixels are included, otherwise only if the center of the pixel is in the geometry it is included.
- ST_CollectionHomogenize - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns the simplest representation of a geometry collection.
- ST_ConcaveHull - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Computes a possibly concave geometry that contains all input geometry vertices
- ST_Count - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, NODATA ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_CreateTopoGeo - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠.
- ST_Distinct4ma - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_FlipCoordinates - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a version of a geometry with X and Y axis flipped.
- ST_GDALDrivers - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a list of raster formats supported by PostGIS through GDAL. Only those formats with can_write=True can be used by ST_AsGDALRaster
- ST_GeomFromGeoJSON - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. JSON-C 0.9 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GeoJSON ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GetFaceEdges - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. aface ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_HasNoBand - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.
- ST_HillShade - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Histogram - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ (bin; ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_InterpolatePoint - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (M ⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_IsEmpty - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (width = 0, height = 0) ⊠⊠⊠⊠⊠ ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_IsValidDetail - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a valid_detail row stating if a geometry is valid or if not a reason and a location.
- ST_IsValidReason - Availability: 2.0 version taking flags. Returns text stating if a geometry is valid, or a reason for invalidity.
- ST_MakeLine - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MakeValid - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Attempts to make an invalid geometry valid without losing vertices.
- ST_MapAlgebraExpr - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebraExpr - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠: ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠ ⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠ (⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠. extenttype ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. extenttype ⊠⊠⊠ INTERSECTION, UNION, FIRST, SECOND ⊠⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebraFct - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠.
- ST_MapAlgebraFct - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠: ⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ 1 ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ INTERSECTION ⊠ ⊠⊠.
- ST_MapAlgebraFctNgb - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠: ⊠⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (Map Algebra Nearest Neighbor) ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (neighborhood) ⊠⊠⊠⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Max4ma - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Mean4ma - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Min4ma - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ModEdgeHeal - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Heals two edges by deleting the node connecting them, modifying the first edge and deleting the second edge. Returns the id of the deleted node.
- ST_MoveIsoNode - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Moves an isolated node in a topology from one point to another. If new apoint geometry exists as a node an error is thrown. Returns description of move.

- ST_NewEdgeHeal - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Heals two edges by deleting the node connecting them, deleting both edges, and replacing them with an edge whose direction is the same as the first edge provided.
- ST_Node - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Nodes a collection of lines.
- ST_NumPatches - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_OffsetCurve - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns an offset line at a given distance and side from an input line.
- ST_PatchN - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Perimeter - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns the length of the boundary of a polygonal geometry or geography.
- ST_PixelAsPolygon - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠.
- ST_PixelAsPolygons - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠ X, Y ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Project - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a point projected from a start point by a distance and bearing (azimuth).
- ST_Quantile - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (population) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (quantile) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠, ⊠⊠⊠⊠ 25%, 50%, 75% ⊠⊠⊠ (percentile) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Range4ma - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠.
- ST_Reclass - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠. nband ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. nband ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠: ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 16BUI ⊠⊠⊠ 8BUI ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_RelateMatch - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Tests if a DE-9IM Intersection Matrix matches an Intersection Matrix pattern
- ST_RemEdgeModFace - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Removes an edge, and if the edge separates two faces deletes one face and modifies the other face to cover the space of both.
- ST_RemEdgeNewFace - 2.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Resample - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠, ⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Rescale - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Resample a raster by adjusting only its scale (or pixel size). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline, Lanczos, Max or Min resampling algorithm. Default is NearestNeighbor.
- ST_Reskew - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GDAL 1.6.1 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ (⊠⊠⊠⊠ ⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. NearestNeighbor(⊠⊠⊠⊠⊠⊠⊠⊠⊠), Bilinear, Cubic, CubicSpline ⊠⊠ Lanczos ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ NearestNeighbor ⊠⊠⊠.
- ST_SameAlignment - 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠, ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠, ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_SetBandIsNoData - 2.0.0 [illegible]. [illegible] isnodata [illegible].
- ST_SharedPaths - 2.0.0 [illegible]. [illegible]/[illegible].
- ST_Slope - 2.0.0 [illegible]. [illegible] ([illegible]) [illegible]. [illegible].
- ST_Snap - 2.0.0 [illegible]. [illegible].
- ST_SnapToGrid - 2.0.0 [illegible]. GDAL 1.6.1 [illegible]. [illegible]. NearestNeighbor([illegible]), Bilinear, Cubic, CubicSpline [illegible] Lanczos [illegible]. [illegible] NearestNeighbor [illegible].
- ST_Split - Availability: 2.0.0 requires GEOS Returns a collection of geometries created by splitting a geometry by another geometry.
- ST_StdDev4ma - 2.0.0 [illegible]. [illegible].
- ST_Sum4ma - 2.0.0 [illegible]. [illegible].
- ST_SummaryStats - 2.0.0 [illegible]. [illegible] count, sum, mean, stddev, min, max [illegible]. [illegible] 1 [illegible].
- ST_Transform - 2.0.0 [illegible]. GDAL 1.6.1 [illegible]. [illegible]. NearestNeighbor, Bilinear, Cubic, CubicSpline, Lanczos [illegible]. [illegible] NearestNeighbor [illegible].
- ST_UnaryUnion - 2.0.0 [illegible]. Computes the union of the components of a single geometry.
- ST_Union - 2.0.0 [illegible]. [illegible] 1 [illegible].
- ST_ValueCount - 2.0.0 [illegible]. [illegible] ([illegible]) [illegible]. [illegible] 1 [illegible]. [illegible] NODATA [illegible]. [illegible], [illegible].
- TopoElementArray_Agg - 2.0.0 [illegible]. Returns a topoelementarray for a set of element_id, type arrays (topoelements).
- TopoGeo_AddLineString - 2.0.0 [illegible]. Adds a linestring to an existing topology using a tolerance and possibly splitting existing edges/faces.
- TopoGeo_AddPoint - 2.0.0 [illegible]. [illegible] (split) [illegible].
- TopoGeo_AddPolygon - 2.0.0 [illegible]. Adds a polygon to an existing topology using a tolerance and possibly splitting existing edges/faces. Returns face identifiers.
- TopologySummary - 2.0.0 [illegible]. Takes a topology name and provides summary totals of types of objects in topology.
- Topology_Load_Tiger - 2.0.0 [illegible]. PostGIS [illegible] TIGER [illegible] TIGER [illegible].
- toTopoGeom - 2.0 [illegible]. Converts a simple Geometry into a topo geometry.

- ~ - 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒. A ☒☒☒☒☒☒☒ B ☒☒☒☒☒☒☒☒☒☒☒☒☒ TRUE ☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ~= - 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒. A ☒☒☒☒☒☒☒ B ☒☒☒☒☒☒☒☒☒☒☒☒ TRUE ☒☒☒☒☒☒☒.

Functions enhanced in PostGIS 2.0

- && - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒ (polyhedral surface) ☒☒☒☒☒☒☒. A ☒ 2D ☒☒☒☒☒ B ☒ 2D ☒☒☒☒☒☒☒☒☒☒☒☒☒ TRUE ☒☒☒☒☒☒☒.
- AddGeometryColumn - ☒☒☒☒☒: 2.0.0 ☒☒. use_typmod ☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ typmod ☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- Box2D - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒☒. Returns a BOX2D representing the 2D extent of a geometry.
- Box3D - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒☒. Returns a BOX3D representing the 3D extent of a geometry.
- CreateTopology - Enhanced: 2.0 added the signature accepting hasZ Creates a new topology schema and registers it in the topology.topology table.
- Geocode - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒ TIGER 2010 ☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒. ☒☒☒☒☒☒ max_results ☒☒☒. ☒☒☒☒☒☒☒ (☒☒☒☒☒☒☒☒☒☒☒☒☒) ☒☒☒☒☒☒☒☒ NAD83 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒. ☒☒. ☒☒☒☒☒☒☒☒☒ (☒☒☒☒ 10) ☒ restrict_region(☒☒☒☒ NULL) ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- GeometryType - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒☒. ST_Geometry ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- Populate_Geometry_Columns - ☒☒☒☒☒: 2.0.0 ☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ use_typmod ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints.
- ST_3DExtent - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒☒. Aggregate function that returns the 3D bounding box of geometries.
- ST_Affine - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒☒. Apply a 3D affine transformation to a geometry.
- ST_Area - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒ 2 ☒☒☒☒☒☒☒☒☒ (polyhedral surface) ☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.
- ST_AsBinary - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒☒. Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsBinary - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsBinary - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKB - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒☒. Return the Extended Well-Known Binary (EWKB) representation of the geometry with SRID meta data.
- ST_AsEWKT - ☒☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒, ☒☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒ WKT(Well-Known Text) ☒☒☒☒☒ SRID ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

- ST_AsGML - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ GML 3 ⊠⊠⊠'4' ⊠⊠⊠⊠⊠⊠⊠⊠. GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠'32' ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsKML - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠. ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Azimuth - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Dimension - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Dump - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a set of geometry_dump rows for the components of a geometry.
- ST_DumpPoints - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Expand - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a bounding box expanded from another bounding box or a geometry.
- ST_Extent - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Aggregate function that returns the bounding box of geometries.
- ST_Force2D - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠"2 ⊠⊠⊠⊠" ⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3D - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ XYZ ⊠⊠⊠ ⊠⊠⊠⊠⊠⊠. ST_Force3DZ ⊠⊠⊠⊠⊠⊠⊠.
- ST_Force3DZ - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ XYZ ⊠⊠ ⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceCollection - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ForceRHR - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠ (orientation) ⊠⊠⊠⊠⊠⊠⊠ (Right-Hand Rule) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GMLToSQL - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠⊠. GML ⊠ ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFromGML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GMLToSQL - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GML ⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFromGML ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromEWKB - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠⊠. EWKB(Extended Well-Known Binary) ⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromEWKT - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠⊠. EWKT(Extended Well-Known Text) ⊠⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromGML - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠⊠. ⊠ ⊠⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromGML - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometryN - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeometryType - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠⊠. ST_Geometry ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_IsClosed - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠. LINESTRING ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠⊠⊠⊠⊠) ⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠.
- ST_MakeEnvelope - ⊠⊠⊠⊠: 2.0 ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (envelope) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ SRID ⊠⊠⊠⊠ SRS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MakeValid - Enhanced: 2.0.1, speed improvements Attempts to make an invalid geometry valid without losing vertices.
- ST_NPoints - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (⊠⊠⊠) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_NumGeometries - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Relate - Enhanced: 2.0.0 - added support for specifying boundary node rule. Tests if two geometries have a topological relationship matching an Intersection Matrix pattern, or computes their Intersection Matrix
- ST_Rotate - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Rotates a geometry about an origin point.
- ST_Rotate - Enhanced: 2.0.0 additional parameters for specifying the origin of rotation were added. Rotates a geometry about an origin point.
- ST_RotateX - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Rotates a geometry about the X axis.
- ST_RotateY - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Rotates a geometry about the Y axis.
- ST_RotateZ - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Rotates a geometry about the Z axis.
- ST_Scale - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ TIN ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Scales a geometry by given factors.
- ST_ShiftLongitude - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠ TIN ⊠⊠⊠⊠⊠⊠. Shifts the longitude coordinates of a geometry between -180..180 and 0..360.
- ST_Summary - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Transform - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (polyhedral surface) ⊠⊠⊠⊠⊠⊠. Return a new geometry with coordinates transformed to a different spatial reference system.
- ST_Value - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠ exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠ columnx, rowy ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 1 ⊠⊠⊠⊠⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, nodata ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. exclude_nodata_value ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ValidateTopology - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (false positive) ⊠⊠⊠⊠⊠⊠⊠. Returns a set of validatetopology_returntype objects detailing issues with topology.

Functions changed in PostGIS 2.0

- AddGeometryColumn - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠ ⊠ PostgreSQL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ WGS84 POINT ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠: ALTER TABLE some_table ADD COLUMN geom geometry(Point,4326); ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- AddGeometryColumn - ⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠ use_typmod ⊠ ⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- AddGeometryColumn - ⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠, ⊠⊠ typmod ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ typmod ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ typmod ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- Box3D - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ BOX3D ⊠⊠ BOX2D ⊠⊠⊠⊠⊠⊠⊠. BOX2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠, 2.0.0 ⊠⊠⊠⊠ BOX3D ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ BOX3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- DropGeometryColumn - ⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ALTER TABLE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- DropGeometryTable - ⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠ DROP TABLE ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ geometry_columns ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- Populate_Geometry_Columns - ⊠⊠⊠⊠: 2.0.0 ⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ use_typmod ⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints.

- ST_3DExtent - Changed: 2.0.0 In prior versions this used to be called ST_Extent3D Aggregate function that returns the 3D bounding box of geometries.

- ST_3DLength - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ ST_Length3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠.

- ST_3DMakeBox - Changed: 2.0.0 In prior versions this used to be called ST_MakeBox3D Creates a BOX3D defined by two 3D point geometries.

- ST_3DPerimeter - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠ ST_Perimeter3D ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_AsBinary - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠. ST_AsBinary('POINT(1 2)') ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, n st_asbinary(unknown) is not unique error ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ ST_AsBinary('POINT(1 2)'::geometry); ⊠⊠⊠⊠⊠⊠⊠ ⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, legacy.sql ⊠⊠⊠⊠⊠⊠⊠. Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.

- ST_AsGML - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (named arg) ⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GML 2 ⊠ ⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_AsGeoJSON - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (default arg) ⊠⊠⊠⊠⊠⊠⊠⊠ (named arg) ⊠⊠ ⊠⊠⊠⊠. Return a geometry or feature in GeoJSON format.

- ST_AsSVG - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (default arg) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (named arg) ⊠⊠⊠⊠⊠⊠. Returns SVG path data for a geometry.

- ST_EndPoint - ⊠⊠⊠⊠: 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 2.0.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ 2.0 ⊠⊠⊠⊠ NULL ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ST_LineString ⊠⊠ ST_CircularString ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_GDALDrivers - □□□□: 2.0.6, 2.1.3 □□ - GUC □□□□□□□ gdal_enabled_drivers □□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□. Returns a list of raster formats supported by PostGIS through GDAL. Only those formats with can_write=True can be used by ST_AsGDALRaster
- ST_GeomFromText - □□□□: PostGIS 2.0.0 □□□□□□□□ ST_GeomFromText('GEOMETRYCOLLECTION □□□□□□□□□□□. PostGIS 2.0.0 □□□□□, SQL/MM □□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□□ ST_GeomFromText('GEOMETRYCOLLECTION EMPTY') □□□□□□□□□□□. WKT □□□□□□□□□□□ ST_Geometry □□□□□□□□.
- ST_GeometryN - □□□□: 2.0.0 □□□□□□□□□□□□□□ NULL □□□□□□□□□□. 2.0.0 □□□□□ ST_GeometryN(..,1) □□□□□□□□□□□□□□□□□□□□□□□□. ST_Geometry □□□□□□□□□□□□□□□.
- ST_IsEmpty - □□□□: PostGIS 2.0.0 □□□□□□□□ ST_GeomFromText('GEOMETRYCOLLECTION(EMPT □□□□□□□□□□□. PostGIS 2.0.0 □□□□□, SQL/MM □□□□□□□□□□□□□□□□□□□□□□□□□□□□. Tests if a geometry is empty.
- ST_Length - □□□□: 2.0.0 □□□□□□□□□□□□□□□□□□□□. 2.0.0 □□□□□□□□□□□□□□□/□□□□□□□□□□□□□□□□□□□□□□/□□□□□□□□□□□□□□□□□□□□. 2.0.0 □□□□□□□□□□□□□□□□□ 0 □□□□□□□□□□□□□□□. □□□□□□□□□□□□□ ST_Perimeter □□□□□□□□□□□. □□□□□□□□□□□□□□□□□.
- ST_LocateAlong - □□□□: 2.0.0 □□□□□□□□□ ST_Locate_Along_Measure □□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□. Returns the point(s) on a geometry that match a measure value.
- ST_LocateBetween - □□□□: 2.0.0 □□□□□□□□□ ST_Locate_Along_Measure □□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□. Returns the portions of a geometry that match a measure range.
- ST_ModEdgeSplit - □□□□: 2.0 □□□□□□□, □□□□ ST_ModEdgesSplit □□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□.
- ST_NumGeometries - □□□□: 2.0.0 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ NULL □□□□□□□□. 2.0.0 □□□□□□□□□, □□□□□□, □□□□□□□□□□□□□□□□ 1 □□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□. □□□□□□□□□□□□□□□□□□□.
- ST_NumInteriorRings - □□□□: 2.0.0 □□. □□□□□□□□□□□□□□□□□□□□□□□□□.
- ST_PointN - □□□□: 2.0.0 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. PostGIS □□. 2.0.0 □□□□□□□□□□□□□□□□□□□ NULL □□□□□□□□□□. ST_LineString □□ ST_CircularString □□□□□□□□□□□□□□□□□□□□.
- ST_ScaleX - □□□□: 2.0.0 □□ WKTRaster □□□□□□ ST_PixelSizeX □□□□□□□□□□□. □□□□□□ X □□□□□□□□□□□□□□□□□□□□□□□□.
- ST_ScaleY - □□□□: 2.0.0 □□ WKTRaster □□□□□□ ST_PixelSizeY □□□□□□□□□□□. □□□□□□ Y □□□□□□□□□□□□□□□□□□□□□□□□.
- ST_SetScale - □□□□: 2.0.0 □□ WKTRaster □□□□□□ ST_SetPixelSize □□□□□□□□□□□. 2.0.0 □□□□□□□□□□□□□□□□□□□□□. X □ Y □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. □□/□□□□/□□□□□□□□□□.
- ST_StartPoint - □□□□: 2.0.0 □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□. PostGIS □□□. 2.0.0 □□□□□□□□□□□□□□□□□□□ NULL □□□□□□□□□□. □□□□□□□□□□□□□□□□□□□□□□□, □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ 2.0 □□□□ NULL □□□□□□□□□□□□. Returns the first point of a LineString.

13.12.13 PostGIS Functions new or enhanced in 1.5

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 1.5

- && - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠ 2D ⊠⊠⊠⊠⊠ B ⊠ 2D ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠ ⊠⊠⊠⊠.
- PostGIS_LibXML_Version - 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns the version number of the libxml2 library.
- ST_AddMeasure - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Interpolates measures along a linear geometry.
- ST_AsBinary - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsGML - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsGeoJSON - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Return a geometry or feature in GeoJSON format.
- ST_AsText - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠/⊠⊠⊠⊠ WKT(Well-Known Text) ⊠⊠⊠⊠ SRID ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Buffer - Availability: 1.5 - ST_Buffer was enhanced to support different endcaps and join types. These are useful for example to convert road linestrings into polygon roads with flat or square edges instead of rounded edges. Thin wrapper for geography was added. Computes a geometry covering all points within a given distance from a geometry.
- ST_ClosestPoint - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns the 2D point on g1 that is closest to g2. This is the first point of the shortest line from one geometry to the other.
- ST_CollectionExtract - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Given a geometry collection, returns a multi-geometry containing only elements of a specified type.
- ST_Covers - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Tests if every point of B lies in A
- ST_DFullyWithin - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Tests if a geometry is entirely inside a distance of another
- ST_DWithin - Availability: 1.5.0 support for geography was introduced Tests if two geometries are within a given distance
- ST_Distance - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DistanceSphere - 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.5 ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DistanceSpheroid - 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. 1.5 ⊠⊠⊠⊠⊠⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. PostGIS 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_DumpPoints - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Envelope - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠, float4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠ ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ (double precision; float8) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Expand - Availability: 1.5.0 behavior changed to output double precision instead of float4 coordinates. Returns a bounding box expanded from another bounding box or a geometry.
- ST_GMLToSQL - 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. LibXML2 1.6 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. GML ⊠⊠⊠⊠⊠⊠ ST_Geometry ⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠ ST_GeomFromGML ⊠⊠⊠⊠⊠⊠⊠⊠.

- ST_GeomFromGML - 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. LibXML2 1.6 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GML ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_GeomFromKML - Availability: 1.5, requires libxml2 2.6+ ⊠⊠⊠ KML ⊠⊠⊠⊠⊠⊠⊠⊠⊠ PostGIS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_HausdorffDistance - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (shortest) ⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_Intersection - Availability: 1.5 support for geography data type was introduced. Computes a geometry representing the shared portion of geometries A and B.
- ST_Intersects - Availability: 1.5 support for geography was introduced. Tests if two geometries intersect (they have at least one point in common)
- ST_Length - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_LongestLine - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 3 ⊠⊠⊠⊠ (longest) ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MakeEnvelope - 1.5 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠ SRID ⊠⊠⊠⊠⊠ SRS ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MaxDistance - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_ShortestLine - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠ 2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ~= - 1.5.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. A ⊠⊠⊠⊠⊠⊠⊠ B ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ TRUE ⊠⊠⊠⊠⊠⊠⊠.

13.12.14 PostGIS Functions new or enhanced in 1.4

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 1.4

- Populate_Geometry_Columns - 1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints.
- ST_Collect - 1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ST_MakeLine ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_MakeLine ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Creates a GeometryCollection or Multi* geometry from a set of geometries.
- ST_ContainsProperly - 1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Tests if every point of B lies in the interior of A
- ST_GeoHash - 1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GeoHash ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_IsValidReason - Availability: 1.4 Returns text stating if a geometry is valid, or a reason for invalidity.
- ST_LineCrossingDirection - Availability: 1.4 Returns a number indicating the crossing behavior of two LineStrings
- ST_LocateBetweenElevations - 1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns the portions of a geometry that lie in an elevation (Z) range.
- ST_MakeLine - 1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠ ST_MakeLine ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠ ST_MakeLine ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠, ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_MinimumBoundingCircle - 1.4.0 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns the smallest circle polygon that contains a geometry.
- ST_Union - Availability: 1.4.0 - ST_Union was enhanced. ST_Union(geomarray) was introduced and also faster aggregate collection in PostgreSQL. Computes a geometry representing the point-set union of the input geometries.

13.12.15 PostGIS Functions new or enhanced in 1.3

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 1.3

- ST_AsGML - 1.3.2 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. ⊠⊠⊠ GML 2 ⊠⊠ GML 3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠.
- ST_AsGeoJSON - 1.3.4 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Return a geometry or feature in GeoJSON format.
- ST_CurveToLine - Availability: 1.3.0 Converts a geometry containing curves to a linear geometry.
- ST_LineToCurve - Availability: 1.3.0 Converts a linear geometry to a curved geometry.
- ST_SimplifyPreserveTopology - 1.3.3 ⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠⊠. Returns a simplified and valid representation of a geometry, using the Douglas-Peucker algorithm.

Chapter 14

Reporting Problems

14.1 Reporting Software Bugs

Reporting bugs effectively is a fundamental way to help PostGIS development. The most effective bug report is that enabling PostGIS developers to reproduce it, so it would ideally contain a script triggering it and every information regarding the environment in which it was detected. Good enough info can be extracted running `SELECT postgis_full_version()` [for PostGIS] and `SELECT version()` [for postgresql].

If you aren't using the latest release, it's worth taking a look at its release changelog first, to find out if your bug has already been fixed.

Using the PostGIS bug tracker will ensure your reports are not discarded, and will keep you informed on its handling process. Before reporting a new bug please query the database to see if it is a known one, and if it is please add any new information you have about it.

You might want to read Simon Tatham's paper about How to Report Bugs Effectively before filing a new report.

14.2 Reporting Documentation Issues

The documentation should accurately reflect the features and behavior of the software. If it doesn't, it could be because of a software bug or because the documentation is in error or deficient.

Documentation issues can also be reported to the PostGIS bug tracker.

If your revision is trivial, just describe it in a new bug tracker issue, being specific about its location in the documentation.

If your changes are more extensive, a patch is definitely preferred. This is a four step process on Unix (assuming you already have git installed):

1. Clone the PostGIS' git repository. On Unix, type:

   git clone https://git.osgeo.org/gitea/postgis/postgis.git

   This will be stored in the directory postgis

2. Make your changes to the documentation with your favorite text editor. On Unix, type (for example):

   vim doc/postgis.xml

   Note that the documentation is written in DocBook XML rather than HTML, so if you are not familiar with it please follow the example of the rest of the documentation.

3. Make a patch file containing the differences from the master copy of the documentation. On Unix, type:

   git diff doc/postgis.xml > doc.patch

4. Attach the patch to a new issue in bug tracker.

Appendix A

Appendix

A.1 PostGIS 3.5.1

2024/09/25

This version requires PostgreSQL 12-17, GEOS 3.8 or higher, and Proj 6.1+. To take advantage of all features, GEOS 3.12+ is needed. To take advantage of all SFCGAL features, SFCGAL 1.5.0+ is needed.

A.1.1 Breaking Changes

#5677, Retain SRID during unary union (Paul Ramsey)

#5792, [topology] Prevent topology corruption with TopoGeo_addPoint near almost collinear edges (Sandro Santilli)

#5795, [topology] Fix ST_NewEdgesSplit can cause invalid topology (Björn Harrtell)

#5794, [topology] Fix crash in TopoGeo_addPoint (Sandro Santilli)

#5785, [raster] ST_MapAlgebra segfaults when expression references a supernumerary rast argument (Dian M Fay)

#5787, Check that ST_ChangeEdgeGeom doesn't change winding of rings (Sandro Santilli)

#5791, Add legacy stubs for old transaction functions to allow pg_upgrade (Regina Obe)

#5800, PROJ compiled version reading the wrong minor and micro (Regina Obe)

#5790, Non-schema qualified calls causing issue with materialized views (Regina Obe)

#5812, Performance regression in ST_Within (Paul Ramsey)

#5815, Remove hash/merge promise from <> operator (Paul Ramsey)

#5823, Build support for Pg18 (Paul Ramsey)

A.1.2 Enhancements

#5782, Improve robustness of min distance calculation (Sandro Santilli)

[topology] Speedup topology building when closing large rings with many holes (Björn Harrtell)

#5810, Update tiger geocoder to handle TIGER 2024 data (Regina Obe)

A.1.3 Breaking Changes

#5799, make ST_TileEnvelope clip envelopes to tile plane extent (Paul Ramsey)

A.2 PostGIS 3.5.0

2024/09/25

This version requires PostgreSQL 12-17, GEOS 3.8 or higher, and Proj 6.1+. To take advantage of all features, GEOS 3.12+ is needed. To take advantage of all SFCGAL features, SFCGAL 1.5.0+ is needed.

Many thanks to our translation teams, in particular:

Dapeng Wang, Zuo Chenwei from HighGo (Chinese Team)

Teramoto Ikuhiro (Japanese Team)

Vincent Bre (French Team)

A.2.1 Breaking Changes

#5546, TopoGeometry <> TopoGeometry is now ambiguous, to get the old behaviour, assuming your TopoGeometry objects are named tg1 and tg2, use: (id(tg1) <> id(tg2) OR topology_id(tg1) <> topology_id(tg2) OR layer_id(tg1) <> layer_id(tg2) OR type(tg1) <> type(tg2)) (Sandro Santilli)

#5536, comments are not anymore included in PostGIS extensions (Sandro Santilli)

xmllint is now required to build comments (Sandro Santilli)

DocBook5 XSL is now required to build html (Sandro Santilli)

#5602, Drop support for GEOS 3.6 and 3.7 (Regina Obe)

#5571, Improve ST_GeneratePoints performance, but old seeded pseudo random points will need to be regenerated.

#5596, GH-749, Allow promoting column as an id in ST_AsGeoJson(record,..). Views and materialized views that use the ST_AsGeoJSON(record ..) will need rebuilding to upgrade to new signature (Jan Tojnar)

#5496, ST_Clip all variants replaced, will require rebuilding of materialized views that use them (funding from The National Institute for Agricultural and Food Research and Technology (INIA-CSIC)), Regina Obe

#5659, ST_DFullyWithin behaviour has changed to be ST_Contains(ST_Buffer(A, R), B) (Paul Ramsey)

Remove the WFS_locks extra package. (Paul Ramsey)

5747, GH-776, ST_Length: Return 0 for CurvePolygon (Dan Baston)

5770, support for GEOS 3.13 and RelateNG. Most functionality remains the same, but new GEOS predicate implementation has a few small changes.

Boundary Node Rule relate matrices might be different when using the ”multi-valent end point” rule.

Relate matrices for situations with invalid MultiPolygons with shared boundaries might be different. Run ST_MakeValid to get valid inputs to feed to the calculation.

Zero length LineStrings are treated as if they are the equivalent Point object.

A.2.2 Deprecated signatures

GH-761, ST_StraightSkeleton = > CG_StraightSkeleton (Loïc Bartoletti)

GH-189, All SFCGAL functions now use the prefix CG_, with the old ones using ST_ being deprecated. (Loïc Bartoletti)

A.2.3 New features

Improvements in the ’postgis’ script:

- new command list-enabled
- new command list-all
- command upgrade upgrades all databases that need to be
- command status reports status of all databases

(Sandro Santilli)

#5742, expose version of PROJ at compile time (Sandro Santilli)

#5721, postgis_topology: Allow sharing sequences between different topologies (Lars Opsahl)

#5667, postgis_topology: TopoGeo_LoadGeometry (Sandro Santilli)

#5055, add explicit <> geometry operator to prevent non-unique error with <> and != (Paul Ramsey)

Add ST_HasZ/ST_HasM (Loïc Bartoletti)

GT-123, postgis_sfcgal: CG_YMonotonePartition, CG_ApproxConvexPartition, CG_GreeneApproxConvexPar and CG_OptimalConvexPartition (Loïc Bartoletti)

GT-156, postgis_sfcgal: CG_Visibility (Loïc Bartoletti)

GT-157, postgis_sfcgal: Add ST_ExtrudeStraightSkeleton (Loïc Bartoletti)

#5496, postgis_raster: ST_Clip support for touched (Regina Obe)

GH-760, postgis_sfcgal: CG_Intersection, CG_3DIntersects, CG_Intersects, CG_Difference, CG_Union (and aggregate), CG_Triangulate, CG_Area, CG_3DDistance, CG_Distance (Loïc Bartoletti)

#5687, Don’t rely on search_path to determine postgis schema Fix for PG17 security change (Regina Obe)

#5705, GH-767, ST_RemoveIrrelevantPointsForView (Sam Peters)

#5706, GH-768, ST_RemoveSmallParts (Sam Peters)

A.2.4 Enhancements

5550, Fix upgrades from 2.x in sandboxed systems (Sandro Santilli)

#3587, postgis_topology: faster load of big lines in topologies (Sandro Santilli)

#5670, postgis_topology: faster ST_CreateTopoGeo (Sandro Santilli)

#5531, documentation format upgraded to DocBook 5 (Sandro Santilli)

#5543, allow building without documentation (Sandro Santilli)

#5596, GH-749, Allow promoting column as an id in ST_AsGeoJson(record,..). (Jan Tojnar)

GH-744, Don’t create docbook.css for the HTML manual, use style.css instead (Chris Mayo)

Faster implementation of point-in-poly cached index (Paul Ramsey)

Improve performance of ST_GeneratePoints (Paul Ramsey)

#5361, ST_CurveN, ST_NumCurves and consistency in accessors on curved geometry (Paul Ramsey)

GH-761, postgis_sfcgal: Add an optional parameter to CG_StraightSkeleton (was ST_StraightSkeleton) to use m as a distance in result (Hannes Janetzek, Loïc Bartoletti)