PostGIS 2.1.10dev Manual

SVN Revision (15812)

Contents

Abstract

PostGIS is an extension to the PostgreSQL object-relational database system which allows GIS (Geographic Information Systems) objects to be stored in the database. PostGIS includes support for GiST-based R-Tree spatial indexes, and functions for analysis and processing of GIS objects.

This is the manual for version 2.1.10dev

Chapter 1

Introduction

PostGIS was developed 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. We plan on supporting and developing PostGIS to support a range of important GIS functionality, including full OpenGIS support, advanced topological constructs (coverages, surfaces, networks), desktop user interface tools for viewing and editing GIS data, and web-based access tools.

PostGIS is an incubation project of the OSGeo Foundation. PostGIS is being continually improved and funded by many FOSS4G Developers as well as corporations all over the world that gain great benefit from its functionality and versatility.

1.1 Project Steering Committee

The PostGIS Project Steering Committee (PSC) coordinates the general direction, release cycles, documentation, and outreach efforts for the PostGIS project. In addition the PSC provides general user support, accepts and approves patches from the general PostGIS community and votes on miscellaneous issues involving PostGIS such as developer commit access, new PSC members or significant API changes.

Mark Cave-Ayland Coordinates bug fixing and maintenance effort, alignment of PostGIS with PostgreSQL releases, spatial index selectivity and binding, loader/dumper, and Shapefile GUI Loader, integration of new and new function enhancements.

Regina Obe Buildbot Maintenance, windows production and experimental builds, Documentation, general user support on PostGIS newsgroup, X3D support, Tiger Geocoder Support, management functions, and smoke testing new functionality or major code changes.

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

Paul Ramsey (Chair) 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, PointCloud (in development), GEOS functionality integration and alignment with GEOS releases, loader/dumper, and Shapefile GUI loader.

Sandro Santilli Bug fixes and maintenance and integration of new GEOS functionality and alignment with GEOS releases, Topology support, and Raster framework and low level api functions.

1.2 Core Contributors Present

Jorge Arévalo Raster development, GDAL driver support, loader

Nicklas Avén Distance function enhancements (including 3D distance and relationship functions) and additions, Tiny WKB output format (TWKB) (in development) and general user support

Olivier Courtin Input output XML (KML,GML)/GeoJSON functions, 3D support and bug fixes.

Pierre Racine Raster overall architecture, prototyping, programming support

David Zwarg Raster development (mostly map algebra analytic functions)

1.3 Core Contributors Past

Chris Hodgson Prior PSC Member. General development, site and buildbot maintenance, OSGeo incubation management

Kevin Neufeld Prior PSC Member. Documentation and documentation support tools, buildbot maintenance, advanced user support on PostGIS newsgroup, and PostGIS maintenance function enhancements.

Dave Blasby The original developer/Co-founder of PostGIS. Dave wrote the server side objects, index bindings, and many of the server side analytical functions.

Mateusz Loskot Raster loader, low level raster api functions

Jeff Lounsbury Original development of the Shape file loader/dumper. Current PostGIS Project Owner representative.

Mark Leslie Ongoing maintenance and development of core functions. Enhanced curve support. Shapefile GUI loader.

1.4 Other Contributors

Individual Contributors In alphabetical order: Alex Bodnaru, Alex Mayrhofer, Andrea Peri, Andreas Forø Tollefsen, Andreas Neumann, Anne Ghisla, Barbara Phillipot, Ben Jubb, Bernhard Reiter, Brian Hamlin, Bruce Rindahl, Bruno Wolff III, Bryce L. Nordgren, Carl Anderson, Charlie Savage, Dane Springmeyer, David Skea, David Techer, Eduin Carrillo, Even Rouault, Frank Warmerdam, George Silva, Gerald Fenoy, Gino Lucrezi, Guillaume Lelarge, IIDA Tetsushi, Ingvild Nystuen, Jason Smith, Jeff Adams, Jose Carlos Martinez Llari, Kashif Rasul, Klaus Foerster, Kris Jurka, Leo Hsu, Loic Dachary, Luca S. Percich, Maria Arias de Reyna, Mark Sondheim, Markus Schaber, Maxime Guillaud, Maxime van Noppen, Michael Fuhr, Nathan Wagner, Nathaniel Clay, Nikita Shulga, Norman Vine, Rafal Magda, Ralph Mason, Richard Greenwood, Silvio Grosso, Steffen Macke, Stephen Frost, Tom van Tilburg, Vincent Picavet

Corporate Sponsors These are corporate entities that have contributed developer time, hosting, or direct monetary funding to the PostGIS project

In alphabetical order: Arrival 3D, Associazione Italiana per l'Informazione Geografica Libera (GFOSS.it), AusVet, Avencia, Azavea, Cadcorp, CampToCamp, City of Boston (DND), Clever Elephant Solutions, Cooperativa Alveo, Deimos Space, Faunalia, Geographic Data BC, Hunter Systems Group, Lidwala Consulting Engineers, LisaSoft, Logical Tracking & Tracing International AG, Michigan Tech Research Institute, Natural Resources Canada, Norwegian Forest and Landscape Institute, OpenGeo, OSGeo, Oslandia, Palantir Technologies, Paragon Corporation, R3 GIS, Refractions Research, Regione Toscana-SIGTA, Safe Software, Sirius Corporation plc, Stadt Uster, UC Davis Center for Vectorborne Diseases, University of Laval, U.S Department of State (HIU), CartoDB, Zonar Systems

Crowd Funding Campaigns Crowd funding campaigns are campaigns we run to get badly wanted features funded that can service a large number of people. Each campaign is specifically focused on a particular feature or set of features. Each sponsor chips in a small fraction of the needed funding and with enough people/organizations contributing, we have the funds to pay for the work that will help many. If you have an idea for a feature you think many others would be willing to co-fund, please post to the PostGIS newsgroup your thoughts and together we can make it happen.

PostGIS 2.0.0 was the first release we tried this strategy. We used PledgeBank and we got two successful campaigns out of it.

postgistopology - 10 plus sponsors each contributed $250 USD to build toTopoGeometry function and beef up topology support in 2.0.0. It happened.

postgis64windows - 20 someodd sponsors each contributed $100 USD to pay for the work needed to work out PostGIS 64-bit issues on windows. It happened. We now have a 64-bit release for PostGIS 2.0.1 available on PostgreSQL stack builder.

Important Support Libraries The GEOS geometry operations library, and the algorithmic work of Martin Davis in making it all work, ongoing maintenance and support of Mateusz Loskot, Sandro Santilli (strk), Paul Ramsey and others.

The GDAL Geospatial Data Abstraction Library, by Frank Warmerdam and others is used to power much of the raster functionality introduced in PostGIS 2.0.0. In kind, improvements needed in GDAL to support PostGIS are contributed back to the GDAL project.

The Proj4 cartographic projection library, and the work of Gerald Evenden and Frank Warmerdam in creating and maintaining it.

Last but not least, the PostgreSQL DBMS, The giant that PostGIS stands on. Much of the speed and flexibility of PostGIS would not be possible without the extensibility, great query planner, GIST index, and plethora of SQL features provided by PostgreSQL.

1.5 More Information

- The latest software, documentation and news items are available at the PostGIS web site, http://postgis.net.
- More information about the GEOS geometry operations library is available athttp://trac.osgeo.org/geos/.
- More information about the Proj4 reprojection library is available at http://trac.osgeo.org/proj/.
- More information about the PostgreSQL database server is available at the PostgreSQL main site http://www.postgresql.org.
- More information about GiST indexing is available at the PostgreSQL GiST development site, http://www.sai.msu.su/~megera/-postgres/gist/.
- More information about MapServer internet map server is available at http://mapserver.org.
- The "Simple Features for Specification for SQL" is available at the OpenGIS Consortium web site: http://www.opengeospatial.org/-
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Chapter 2

PostGIS Installation

This chapter details the steps required to install PostGIS.

2.1 Short Version

To compile assuming you have all the dependencies in your search path:

```
tar xvfz postgis-2.1.10dev.tar.gz
cd postgis-2.1.10dev
./configure
make
make install
```

Once postgis is installed, it needs to be enabled in each individual database you want to use it in.

> **Note**
> The raster support is currently optional, but installed by default. For enabling using the PostgreSQL 9.1+ extensions model raster is required. Using the extension enable process is preferred and more user-friendly. To spatially enable your database:

```
psql -d yourdatabase -c "CREATE EXTENSION postgis;"
psql -d yourdatabase -c "CREATE EXTENSION postgis_topology;"
psql -d yourdatabase -c "CREATE EXTENSION postgis_tiger_geocoder;"
```

Please refer to Section 2.4.3 for more details about querying installed/available extensions and upgrading extensions, or switching from a non-extension install to an extension install.

For those running PostgreSQL 9.0 or who decided for some reason not to compile with raster support, or just are old-fashioned, here are longer more painful instructions for you:

All the .sql files once installed will be installed in share/contrib/postgis-2.1 folder of your PostgreSQL install

```
createdb yourdatabase
createlang plpgsql yourdatabase
psql -d yourdatabase -f postgis.sql
psql -d yourdatabase -f postgis_comments.sql
psql -d yourdatabase -f spatial_ref_sys.sql
psql -d yourdatabase -f rtpostgis.sql
psql -d yourdatabase -f raster_comments.sql
psql -d yourdatabase -f topology.sql
psql -d yourdatabase -f topology_comments.sql
```

The rest of this chapter goes into detail each of the above installation steps.

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.

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/`*`9.3`*`/`*`main`*`/environment` where 9.3 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.

2.2 Install Requirements

PostGIS has the following requirements for building and usage:

Required

- PostgreSQL 9.0 or higher. A complete installation of PostgreSQL (including server headers) is required. PostgreSQL is available from http://www.postgresql.org .

  For a full PostgreSQL / PostGIS support matrix and PostGIS/GEOS support matrix refer to http://trac.osgeo.org/postgis/wiki/-UsersWikiPostgreSQLPostGIS

- GNU C compiler (`gcc`). Some other ANSI C compilers can be used to compile PostGIS, but we find far fewer problems when compiling with `gcc`.

- GNU Make (`gmake` or `make`). For many systems, GNU `make` is the default version of make. Check the version by invoking `make -v`. Other versions of `make` may not process the PostGIS `Makefile` properly.

- Proj4 reprojection library, version 4.6.0 or greater. The Proj4 library is used to provide coordinate reprojection support within PostGIS. Proj4 is available for download from http://trac.osgeo.org/proj/ .

- GEOS geometry library, version 3.3 or greater, but GEOS 3.4+ is recommended to take full advantage of all the new functions and features. Without GEOS 3.4, you will be missing some major enhancements such as ST_Triangles and long-running function interruption, and improvements to geometry validation and making geometries valid such as ST_ValidDetail and ST_MakeValid. GEOS 3.3.2+ is also required for topology support. GEOS is available for download from http://trac.osgeo.org/-geos/ and 3.4+ is backward-compatible with older versions so fairly safe to upgrade.
- LibXML2, version 2.5.x or higher. LibXML2 is currently used in some imports functions (ST_GeomFromGML and ST_GeomFromKML). LibXML2 is available for download from http://xmlsoft.org/downloads.html.
- JSON-C, version 0.9 or higher. JSON-C is currently used to import GeoJSON via the function ST_GeomFromGeoJson. JSON-C is available for download from https://github.com/json-c/json-c/releases.
- GDAL, version 1.8 or higher (1.9 or higher is strongly recommended since some things will not work well or behavior differently with lower versions). This is required for raster support and to be able to install with `CREATE EXTENSION postgis` so highly recommended for those running 9.1+. http://trac.osgeo.org/gdal/wiki/DownloadSource.

Optional

- GDAL (pseudo optional) only if you don't want raster and don't care about installing with `CREATE EXTENSION postgis` can you leave it out. Keep in mind other extensions may have a requires postgis extension which will prevent you from installing them unless you install postgis as an extension. So it is highly recommended you compile with GDAL support.
- GTK (requires GTK+2.0, 2.8+) to compile the shp2pgsql-gui shape file loader. http://www.gtk.org/ .
- SFCGAL, version 0.2 (or higher) could be used to provide additional 2D and 3D advanced analysis functions to PostGIS cf Section 8.9. 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 0.2 require at least CGAL 4.1. https://github.com/Oslandia/SFCGAL.
- CUnit (`CUnit`). This is needed for regression testing. http://cunit.sourceforge.net/
- Apache Ant (`ant`) is required for building any of the drivers under the `java` directory. Ant is available from http://ant.apache.org .
- DocBook (`xsltproc`) is required for building the documentation. Docbook is available from http://www.docbook.org/ .
- DBLatex (`dblatex`) is required for building the documentation in PDF format. DBLatex is available from http://dblatex.sourceforge.net/ .
- ImageMagick (`convert`) is required to generate the images used in the documentation. ImageMagick is available from http://www.imagemagick.org/ .

2.3 Getting the Source

Retrieve the PostGIS source archive from the downloads website http://postgis.net/stuff/postgis-2.1.10dev.tar.gz

```
wget http://postgis.net/stuff/postgis-2.1.10dev.tar.gz
tar -xvzf postgis-2.1.10dev.tar.gz
```

This will create a directory called `postgis-2.1.10dev` in the current working directory.

Alternatively, checkout the source from the svn repository http://svn.osgeo.org/postgis/trunk/ .

```
svn checkout http://svn.osgeo.org/postgis/trunk/ postgis-2.1.10dev
```

Change into the newly created `postgis-2.1.10dev` directory to continue the installation.

2.4 Compiling and Install from Source: Detailed

Note

Many OS systems now include pre-built packages for PostgreSQL/PostGIS. In many cases compilation is only necessary if you want the most bleeding edge versions or you are a package maintainer.

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

If you are a windows user, you can get stable builds via Stackbuilder or PostGIS Windows download site We also have very bleeding-edge windows experimental builds that are built usually once or twice a week or whenever anything exciting happens. You can use these to experiment with the in progress releases of PostGIS

The PostGIS module is an extension to the PostgreSQL backend server. As such, PostGIS 2.1.10dev *requires* full PostgreSQL server headers access in order to compile. It can be built against PostgreSQL versions 9.0 or higher. Earlier versions of PostgreSQL are *not* supported.

Refer to the PostgreSQL installation guides if you haven't already installed PostgreSQL. http://www.postgresql.org .

Note

For GEOS functionality, when you install PostgresSQL you may need to explicitly link PostgreSQL against the standard C++ library:

```
LDFLAGS=-lstdc++ ./configure [YOUR OPTIONS HERE]
```

This is a workaround for bogus C++ exceptions interaction with older development tools. If you experience weird problems (backend unexpectedly closed or similar things) try this trick. This will require recompiling your PostgreSQL from scratch, of course.

The following steps outline the configuration and compilation of the PostGIS source. They are written for Linux users and will not work on Windows or Mac.

2.4.1 Configuration

As with most linux installations, the first step is to generate the Makefile that will be used to build the source code. This is done by running the shell script

./configure

With no additional parameters, this command will attempt to automatically locate the required components and libraries needed to build the PostGIS source code on your system. Although this is the most common usage of **./configure**, the script accepts several parameters for those who have the required libraries and programs in non-standard locations.

The following list shows only the most commonly used parameters. For a complete list, use the **--help** or **--help=short** parameters.

--prefix=PREFIX This is the location the PostGIS libraries and SQL scripts will be installed to. By default, this location is the same as the detected PostgreSQL installation.

Caution

This parameter is currently broken, as the package will only install into the PostgreSQL installation directory. Visit http://trac.osgeo.org/postgis/ticket/635 to track this bug.

--with-pgconfig=FILE PostgreSQL provides a utility called **pg_config** to enable extensions like PostGIS to locate the PostgreSQL installation directory. Use this parameter (**--with-pgconfig=/path/to/pg_config**) to manually specify a particular PostgreSQL installation that PostGIS will build against.

--with-gdalconfig=FILE GDAL, a required library, provides functionality needed for raster support **gdal-config** to enable software installations to locate the GDAL installation directory. Use this parameter (**--with-gdalconfig=/path/to/gdal-config**) to manually specify a particular GDAL installation that PostGIS will build against.

--with-geosconfig=FILE GEOS, a required geometry library, provides a utility called **geos-config** to enable software installations to locate the GEOS installation directory. Use this parameter (**--with-geosconfig=/path/to/geos-config**) to manually specify a particular GEOS installation that PostGIS will build against.

--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 is a reprojection library required by PostGIS. Use this parameter (**--with-projdir=/path/to/projdir**) to manually specify a particular Proj4 installation directory that PostGIS will build against.

--with-libiconv=DIR Directory where iconv is installed.

--with-jsondir=DIR JSON-C is an MIT-licensed JSON library required by PostGIS ST_GeomFromJSON support. Use this parameter (**--with-jsondir=/path/to/jsondir**) to manually specify a particular JSON-C installation directory that PostGIS will build against.

--with-gui Compile the data import GUI (requires GTK+2.0). This will create shp2pgsql-gui graphical interface to shp2pgsql.

--with-raster Compile with raster support. This will build rtpostgis-2.1.10dev library and rtpostgis.sql file. This may not be required in final release as plan is to build in raster support by default.

--with-topology Compile with topology support. This will build the topology.sql file. There is no corresponding library as all logic needed for topology is in postgis-2.1.10dev library.

--with-gettext=no By default PostGIS will try to detect gettext support and compile with it, however if you run into incompatibility issues that cause breakage of loader, you can disable it entirely with this command. Refer to ticket http://trac.osgeo.org/-postgis/ticket/748 for an example issue solved by configuring with this. NOTE: that you aren't missing much by turning this off. This is used for international help/label support for the GUI loader which is not yet documented and still experimental.

--with-sfcgal=PATH By default PostGIS will not install with sfcgal support without this switch. `PATH` is an optional argument that allows to specify an alternate PATH to sfcgal-config.

Note
If you obtained PostGIS from the SVN repository , the first step is really to run the script
./autogen.sh
This script will generate the **configure** script that in turn is used to customize the installation of PostGIS.
If you instead obtained PostGIS as a tarball, running **./autogen.sh** is not necessary as **configure** has already been generated.

2.4.2 Building

Once the Makefile has been generated, building PostGIS is as simple as running

make

The last line of the output should be "`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.

make comments

Introduced in PostGIS 2.0. This generates html cheat sheets suitable for quick reference or for student handouts. This requires xsltproc to build and will generate 4 files in doc folder `topology_cheatsheet.html`, `tiger_geocoder_cheatsheet.html`, `raster_cheatsheet.html`, `postgis_cheatsheet.html`

You can download some pre-built ones available in html and pdf from PostGIS / PostgreSQL Study Guides

make cheatsheets

2.4.3 Building PostGIS Extensions and Deploying them

The PostGIS extensions are built and installed automatically if you are using PostgreSQL 9.1+.

If you are building from source repository, you need to build the function descriptions first. These get built if you have docbook installed. You can also manually build with the statement:

make comments

Building the comments is not necessary if you are building from a release tar ball since these are packaged pre-built with the tar ball already.

If you are building against PostgreSQL 9.1, the extensions should automatically build as part of the make install process. You can if needed build from the extensions folders or copy files if you need them on a different server.

```
cd extensions
cd postgis
make clean
make
make install
cd ..
cd postgis_topology
make clean
make
make install
```

The extension files will always be the same for the same version of PostGIS regardless of OS, so it is fine to copy over the extension files from one OS to another as long as you have the PostGIS binaries already installed on your servers.

If you want to install the extensions manually on a separate server different from your development, You need to copy the following files from the extensions folder into the `PostgreSQL / share / extension` folder of your PostgreSQL install as well as the needed binaries for regular PostGIS if you don't have them already on the server.

- These are the control files that denote information such as the version of the extension to install if not specified. `postgis.control, postgis_topology.control`.
- All the files in the /sql folder of each extension. Note that these need to be copied to the root of the PostgreSQL share/extension folder `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.

If you are using psql, you can verify that the extensions are installed by running this query:

```
SELECT name, default_version,installed_version
FROM pg_available_extensions WHERE name LIKE 'postgis%' ;
      name       | default_version | installed_version
-----------------+-----------------+-------------------
postgis          | 2.1.10dev       | 2.1.10dev
postgis_topology | 2.1.10dev       |
```

If you have the extension installed in the database you are querying, you'll see mention in the `installed_version` column. If you get no records back, it means you don't have postgis extensions installed on the server at all. PgAdmin III 1.14+ will also provide this information in the `extensions` section of the database browser tree and will even allow upgrade or uninstall by right-clicking.

If you have the extensions available, you can install postgis extension in your database of choice by either using pgAdmin extension interface or running these sql commands:

```
CREATE EXTENSION postgis;
CREATE EXTENSION postgis_topology;
CREATE EXTENSION postgis_tiger_geocoder;
```

In psql you can use to see what versions you have installed and also what schema they are installed.

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

```
List of installed extensions
-[ RECORD 1 ]-------------------------------------------------
-
Name        | postgis
Version     | 2.1.10dev
Schema      | public
Description | PostGIS geometry, geography, and raster spat..
-[ RECORD 2 ]-------------------------------------------------
-
Name        | postgis_tiger_geocoder
Version     | 2.1.10dev
Schema      | tiger
Description | PostGIS tiger geocoder and reverse geocoder
-[ RECORD 3 ]-------------------------------------------------
-
Name        | postgis_topology
Version     | 2.1.10dev
Schema      | topology
Description | PostGIS topology spatial types and functions
```

Warning

Extension tables `spatial_ref_sys`, `layer`, `topology` can not be explicitly backed up. They can only be backed up when the respective `postgis` or `postgis_topology` extension is backed up, which only seems to happen when you backup the whole database. As of PostGIS 2.0.1, only srid records not packaged with PostGIS are backed up when the database is backed up so don't go around changing srids we package and expect your changes to be there. Put in a ticket if you find an issue. The structures of extension tables are never backed up since they are created with `CREATE EXTENSION` and assumed to be the same for a given version of an extension. These behaviors are built into the current PostgreSQL extension model, so nothing we can do about it.

If you installed 2.1.10dev, without using our wonderful extension system, you can change it to be extension based by first upgrading to the latest micro version running the upgrade scripts: `postgis_upgrade_21_minor.sql`,`raster_upgrade_21_minor.sql`,`topology_upgrade_21_minor.sql`.

If you installed postgis without raster support, you'll need to install raster support first (using the full `rtpostgis.sql`

Then you can run the below commands to package the functions in their respective extension.

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

2.4.4 Testing

If you wish to test the PostGIS build, run

make check

The above command will run through various checks and regression tests using the generated library against an actual PostgreSQL database.

> **Note**
> If you configured PostGIS using non-standard PostgreSQL, GEOS, or Proj4 locations, you may need to add their library locations to the LD_LIBRARY_PATH environment variable.

> **Caution**
> Currently, the **make check** relies on the `PATH` and `PGPORT` environment variables when performing the checks - it does *not* use the PostgreSQL version that may have been specified using the configuration parameter **--with-pgconfig**. So make sure to modify your PATH to match the detected PostgreSQL installation during configuration or be prepared to deal with the impending headaches.

If successful, the output of the test should be similar to the following:

```
     CUnit - A Unit testing framework for C - Version 2.1-0
     http://cunit.sourceforge.net/


Suite: print_suite
  Test: test_lwprint_default_format ... passed
  Test: test_lwprint_format_orders ... passed
  Test: test_lwprint_optional_format ... passed
  Test: test_lwprint_oddball_formats ... passed
  Test: test_lwprint_bad_formats ... passed
Suite: misc
  Test: test_misc_force_2d ... passed
  Test: test_misc_simplify ... passed
  Test: test_misc_count_vertices ... passed
  Test: test_misc_area ... passed
  Test: test_misc_wkb ... passed
Suite: ptarray
  Test: test_ptarray_append_point ... passed
  Test: test_ptarray_append_ptarray ... passed
  Test: test_ptarray_locate_point ... passed
  Test: test_ptarray_isccw ... passed
  Test: test_ptarray_signed_area ... passed
  Test: test_ptarray_desegmentize ... passed
  Test: test_ptarray_insert_point ... passed
  Test: test_ptarray_contains_point ... passed
  Test: test_ptarrayarc_contains_point ... passed
Suite: PostGIS Computational Geometry Suite
  Test: test_lw_segment_side ... passed
  Test: test_lw_segment_intersects ... passed
  Test: test_lwline_crossing_short_lines ... passed
  Test: test_lwline_crossing_long_lines ... passed
  Test: test_lwline_crossing_bugs ... passed
  Test: test_lwpoint_set_ordinate ... passed
  Test: test_lwpoint_get_ordinate ... passed
  Test: test_point_interpolate ... passed
  Test: test_lwline_clip ... passed
  Test: test_lwline_clip_big ... passed
```

```
  Test: test_lwmline_clip ... passed
  Test: test_geohash_point ... passed
  Test: test_geohash_precision ... passed
  Test: test_geohash ... passed
  Test: test_geohash_point_as_int ... passed
  Test: test_isclosed ... passed
Suite: buildarea
  Test: buildarea1 ... passed
  Test: buildarea2 ... passed
  Test: buildarea3 ... passed
  Test: buildarea4 ... passed
  Test: buildarea4b ... passed
  Test: buildarea5 ... passed
  Test: buildarea6 ... passed
  Test: buildarea7 ... passed
Suite: clean
  Test: test_lwgeom_make_valid ... passed
Suite: PostGIS Measures Suite
  Test: test_mindistance2d_tolerance ... passed
  Test: test_rect_tree_contains_point ... passed
  Test: test_rect_tree_intersects_tree ... passed
  Test: test_lwgeom_segmentize2d ... passed
  Test: test_lwgeom_locate_along ... passed
  Test: test_lw_dist2d_pt_arc ... passed
  Test: test_lw_dist2d_seg_arc ... passed
  Test: test_lw_dist2d_arc_arc ... passed
  Test: test_lw_arc_length ... passed
  Test: test_lw_dist2d_pt_ptarrayarc ... passed
  Test: test_lw_dist2d_ptarray_ptarrayarc ... passed
Suite: node
  Test: test_lwgeom_node ... passed
Suite: WKT Out Suite
  Test: test_wkt_out_point ... passed
  Test: test_wkt_out_linestring ... passed
  Test: test_wkt_out_polygon ... passed
  Test: test_wkt_out_multipoint ... passed
  Test: test_wkt_out_multilinestring ... passed
  Test: test_wkt_out_multipolygon ... passed
  Test: test_wkt_out_collection ... passed
  Test: test_wkt_out_circularstring ... passed
  Test: test_wkt_out_compoundcurve ... passed
  Test: test_wkt_out_curvpolygon ... passed
  Test: test_wkt_out_multicurve ... passed
  Test: test_wkt_out_multisurface ... passed
Suite: WKT In Suite
  Test: test_wkt_in_point ... passed
  Test: test_wkt_in_linestring ... passed
  Test: test_wkt_in_polygon ... passed
  Test: test_wkt_in_multipoint ... passed
  Test: test_wkt_in_multilinestring ... passed
  Test: test_wkt_in_multipolygon ... passed
  Test: test_wkt_in_collection ... passed
  Test: test_wkt_in_circularstring ... passed
  Test: test_wkt_in_compoundcurve ... passed
  Test: test_wkt_in_curvpolygon ... passed
  Test: test_wkt_in_multicurve ... passed
  Test: test_wkt_in_multisurface ... passed
  Test: test_wkt_in_tin ... passed
  Test: test_wkt_in_polyhedralsurface ... passed
  Test: test_wkt_in_errlocation ... passed
Suite: WKB Out Suite
  Test: test_wkb_out_point ... passed
```

```
  Test: test_wkb_out_linestring ... passed
  Test: test_wkb_out_polygon ... passed
  Test: test_wkb_out_multipoint ... passed
  Test: test_wkb_out_multilinestring ... passed
  Test: test_wkb_out_multipolygon ... passed
  Test: test_wkb_out_collection ... passed
  Test: test_wkb_out_circularstring ... passed
  Test: test_wkb_out_compoundcurve ... passed
  Test: test_wkb_out_curvpolygon ... passed
  Test: test_wkb_out_multicurve ... passed
  Test: test_wkb_out_multisurface ... passed
  Test: test_wkb_out_polyhedralsurface ... passed
:
Suite: Geodetic Suite
  Test: test_sphere_direction ... passed
  Test: test_sphere_project ... passed
  Test: test_lwgeom_area_sphere ... passed
  Test: test_signum ... passed
  Test: test_gbox_from_spherical_coordinates ... passed
:
  Test: test_geos_noop ... passed
Suite: Internal Spatial Trees
  Test: test_tree_circ_create ... passed
  Test: test_tree_circ_pip ... passed
  Test: test_tree_circ_pip2 ... passed
  Test: test_tree_circ_distance ... passed
Suite: triangulate
  Test: test_lwgeom_delaunay_triangulation ... passed
Suite: stringbuffer
  Test: test_stringbuffer_append ... passed
  Test: test_stringbuffer_aprintf ... passed
Suite: surface
  Test: triangle_parse ... passed
  Test: tin_parse ... passed
  Test: polyhedralsurface_parse ... passed
  Test: surface_dimension ... passed
Suite: homogenize
  Test: test_coll_point ... passed
  Test: test_coll_line ... passed
  Test: test_coll_poly ... passed
  Test: test_coll_coll ... passed
  Test: test_geom ... passed
  Test: test_coll_curve ... passed
Suite: force_sfs
  Test: test_sfs_11 ... passed
  Test: test_sfs_12 ... passed
  Test: test_sqlmm ... passed
Suite: out_gml
  Test: out_gml_test_precision ... passed
  Test: out_gml_test_srid ... passed
  Test: out_gml_test_dims ... passed
  Test: out_gml_test_geodetic ... passed
  Test: out_gml_test_geoms ... passed
  Test: out_gml_test_geoms_prefix ... passed
  Test: out_gml_test_geoms_nodims ... passed
  Test: out_gml2_extent ... passed
  Test: out_gml3_extent ... passed
Suite: KML Out Suite
  Test: out_kml_test_precision ... passed
  Test: out_kml_test_dims ... passed
  Test: out_kml_test_geoms ... passed
  Test: out_kml_test_prefix ... passed
```

```
Suite: GeoJson Out Suite
  Test: out_geojson_test_precision ... passed
  Test: out_geojson_test_dims ... passed
  Test: out_geojson_test_srid ... passed
  Test: out_geojson_test_bbox ... passed
  Test: out_geojson_test_geoms ... passed
Suite: SVG Out Suite
  Test: out_svg_test_precision ... passed
  Test: out_svg_test_dims ... passed
  Test: out_svg_test_relative ... passed
  Test: out_svg_test_geoms ... passed
  Test: out_svg_test_srid ... passed
Suite: X3D Out Suite
  Test: out_x3d3_test_precision ... passed
  Test: out_x3d3_test_geoms ... passed

--Run Summary: Type      Total     Ran  Passed  Failed
               suites       27      27     n/a       0
               tests       198     198     198       0
               asserts    1728    1728    1728       0

Creating database 'postgis_reg'
Loading PostGIS into 'postgis_reg'
PostgreSQL 9.3beta1 on x86_64-unknown-linux-gnu, compiled by gcc (Debian 4.4.5-8) 4.4.5,  ↩
    64-bit
  Postgis 2.1.0SVN - r11415 - 2013-05-11 02:48:21
  GEOS: 3.4.0dev-CAPI-1.8.0 r3797
  PROJ: Rel. 4.7.1, 23 September 2009

Running tests

 loader/Point .............. ok
 loader/PointM .............. ok
 loader/PointZ .............. ok
 loader/MultiPoint .............. ok
 loader/MultiPointM .............. ok
 loader/MultiPointZ .............. ok
 loader/Arc .............. ok
 loader/ArcM .............. ok
 loader/ArcZ .............. ok
 loader/Polygon .............. ok
 loader/PolygonM .............. ok
 loader/PolygonZ .............. ok
 loader/TSTPolygon ......... ok
 loader/TSIPolygon ......... ok
 loader/TSTIPolygon ......... ok
 loader/PointWithSchema ..... ok
 loader/NoTransPoint ......... ok
 loader/NotReallyMultiPoint ......... ok
 loader/MultiToSinglePoint ......... ok
 loader/ReprojectPts ........ ok
 loader/ReprojectPtsGeog ........ ok
 loader/Latin1 .... ok
 binary .. ok
 regress .. ok
 regress_index .. ok
 regress_index_nulls .. ok
 regress_selectivity .. ok
 lwgeom_regress .. ok
 regress_lrs .. ok
 removepoint .. ok
 setpoint .. ok
```

```
 simplify .. ok
 snaptogrid .. ok
 summary .. ok
 affine .. ok
 empty .. ok
 measures .. ok
 legacy .. ok
 long_xact .. ok
 ctors .. ok
 sql-mm-serialize .. ok
 sql-mm-circularstring .. ok
 sql-mm-compoundcurve .. ok
 sql-mm-curvepoly .. ok
 sql-mm-general .. ok
 sql-mm-multicurve .. ok
 sql-mm-multisurface .. ok
 polyhedralsurface .. ok
 polygonize .. ok
 postgis_type_name .. ok
 geography .. ok
 out_geometry .. ok
 out_geography .. ok
 in_geohash .. ok
 in_gml .. ok
 in_kml .. ok
 iscollection .. ok
 regress_ogc .. ok
 regress_ogc_cover .. ok
 regress_ogc_prep .. ok
 regress_bdpoly .. ok
 regress_proj .. ok
 regress_management .. ok
 dump .. ok
 dumppoints .. ok
 boundary .. ok
 wmsservers .. ok
 wkt .. ok
 wkb .. ok
 tickets .. ok
 typmod .. ok
 remove_repeated_points .. ok
 split .. ok
 relate .. ok
 bestsrid .. ok
 concave_hull .. ok
 hausdorff .. ok
 regress_buffer_params .. ok
 offsetcurve .. ok
 relatematch .. ok
 isvaliddetail .. ok
 sharedpaths .. ok
 snap .. ok
 node .. ok
 unaryunion .. ok
 clean .. ok
 relate_bnr .. ok
 delaunaytriangles .. ok
 in_geojson .. ok
 uninstall .. ok (4112)

Run tests: 90
```

2.4.5 Installation

To install PostGIS, type

make install

This will copy the PostGIS installation files into their appropriate subdirectory specified by the **--prefix** configuration parameter. In particular:

- The loader and dumper binaries are installed in `[prefix]/bin`.
- The SQL files, such as `postgis.sql`, are installed in `[prefix]/share/contrib`.
- The PostGIS libraries are installed in `[prefix]/lib`.

If you previously ran the **make comments** command to generate the `postgis_comments.sql`, `raster_comments.sql` file, install the sql file by running

make comments-install

> **Note**
> `postgis_comments.sql`, `raster_comments.sql`, `topology_comments.sql` was separated from the typical build and installation targets since with it comes the extra dependency of **xsltproc**.

2.5 Create a spatially-enabled database on PostgreSQL lower than 9.1

The first step in creating a PostGIS database is to create a simple PostgreSQL database.

createdb [yourdatabase]

Many of the PostGIS functions are written in the PL/pgSQL procedural language. As such, the next step to create a PostGIS database is to enable the PL/pgSQL language in your new database. This is accomplish by the command below command. For PostgreSQL 8.4+, this is generally already installed

createlang plpgsql [yourdatabase]

Now load the PostGIS object and function definitions into your database by loading the `postgis.sql` definitions file (located in `[prefix]/share/contrib` as specified during the configuration step).

psql -d [yourdatabase] -f postgis.sql

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.

psql -d [yourdatabase] -f spatial_ref_sys.sql

If you wish to add comments to the PostGIS functions, the final step is to load the `postgis_comments.sql` into your spatial database. The comments can be viewed by simply typing **\dd [function_name]** from a **psql** terminal window.

psql -d [yourdatabase] -f postgis_comments.sql

Install raster support

psql -d [yourdatabase] -f rtpostgis.sql

Install raster support comments. This will provide quick help info for each raster function using psql or PgAdmin or any other PostgreSQL tool that can show function comments

psql -d [yourdatabase] -f raster_comments.sql

Install topology support

psql -d [yourdatabase] -f topology/topology.sql

Install topology support comments. This will provide quick help info for each topology function / type using psql or PgAdmin or any other PostgreSQL tool that can show function comments

psql -d [yourdatabase] -f topology/topology_comments.sql

If you plan to restore an old backup from prior versions in this new db, run:

psql -d [yourdatabase] -f legacy.sql

> **Note**
> There is an alternative `legacy_minimal.sql` you can run instead which will install barebones needed to recover tables and work with apps like MapServer and GeoServer. If you have views that use things like distance / length etc, you'll need the full blown `legacy.sql`

You can later run `uninstall_legacy.sql` to get rid of the deprecated functions after you are done with restoring and cleanup.

2.6 Creating a spatial database using EXTENSIONS

If you are using PostgreSQL 9.1+ and have compiled and installed the extensions/ postgis modules, you can create a spatial database the new way.

createdb [yourdatabase]

The core postgis extension installs PostGIS geometry, geography, raster, spatial_ref_sys and all the functions and comments with a simple:

```
CREATE EXTENSION postgis;
```

command.

psql -d [yourdatabase] -c "CREATE EXTENSION postgis;"

Topology is packaged as a separate extension and installable with command:

psql -d [yourdatabase] -c "CREATE EXTENSION postgis_topology;"

If you plan to restore an old backup from prior versions in this new db, run:

psql -d [yourdatabase] -f legacy.sql

You can later run `uninstall_legacy.sql` to get rid of the deprecated functions after you are done with restoring and cleanup.

2.7 Installing, Upgrading Tiger Geocoder and loading data

Extras like Tiger geocoder may not be packaged in your PostGIS distribution, but will always be available in the postgis-2.1.10dev.tar.gz file. The instructions provided here are also available in the `extras/tiger_geocoder/tiger_2011/README`

If you are on Windows and you don't have tar installed, you can use http://www.7-zip.org/ to unzip the PostGIS tarball.

2.7.1 Tiger Geocoder Enabling your PostGIS database: Using Extension

If you are using PostgreSQL 9.1+ and PostGIS 2.1.0+, you can take advantage of the new extension model for installing tiger geocoder. To do so:

1. First get binaries for PostGIS 2.1.0 or compile and install as usual. This should install the necessary extension files as well for tiger geocoder.

2. Connect to your database via psql or pgAdmin or some other tool and run the following SQL commands. Note that if you are installing in a database that already has postgis, you don't need to do the first step. If you have `fuzzystrmatch` extension already installed, you don't need to do the second step either.

```
CREATE EXTENSION postgis;
CREATE EXTENSION fuzzystrmatch;
CREATE EXTENSION postgis_tiger_geocoder;
```

3. To confirm your install is working correctly, run this sql in your database:

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

Which should output

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

4. Create a new record in `tiger.loader_platform` table with the paths of your executables and server.

So for example to create a profile called debbie that follows `sh` convention. You would do:

```
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';
```

And then edit the paths in the *declare_sect* column to those that fit Debbie's pg, unzip,shp2pgsql, psql, etc path locations.

If you don't edit this `loader_platform` table, it will just contain common case locations of items and you'll have to edit the generated script after the script is generated.

5. Then run the Loader_Generate_Nation_Script and Loader_Generate_Script SQL functions make sure to use the name of your custom profile. So for example to do the nation load using our new profile we would:

```
SELECT Loader_Generate_Nation_Script('debbie');
```

2.7.1.1 Converting a Tiger Geocoder Regular Install to Extension Model

If you installed the tiger geocoder without using the extension model, you can convert to the extension model as follows:

1. Follow instructions in Section 2.7.4 for the non-extension model upgrade.

2. Connect to your database with psql or pgAdmin and run the following command:

```
CREATE EXTENSION postgis_tiger_geocoder FROM unpackaged;
```

2.7.1.2 Using PAGC address standardizer

One of the many complaints of folks is the address normalizer function Normalize_Address function that normalizes an address for prepping before geocoding. The normalizer is far from perfect and trying to patch its imperfectness takes a vast amount of resources. As such we have integrated with another project that has a much better address standardizer engine. This is currently a separate project, which is a subproject of PAGC. The source code for this PostgreSQL standardizer extension can be downloaded from PAGC PostgreSQL Address Standardizer. To use this new normalizer, you compile the pagc extension and install as an extension in your database.

The PAGC project and standardizer portion in particular, relies on PCRE which is usually already installed on most Nix systems, but you can download the latest at: http://www.pcre.org. It also requires Perl with the `Regexp::Assemble` installed

For Windows users, the PostGIS 2.1+ bundle will come packaged with the address_standardizer already so no need to compile and can move straight to `CREATE EXTENSION` step.

Installing Regex::Assemble

```
cpan Regexp::Assemble
```

or if you are on Ubuntu / Debian you might need to do

```
sudo perl -MCPAN -e "install Regexp::Assemble"
```

Compiling

```
svn co svn://svn.code.sf.net/p/pagc/code/branches/sew-refactor/postgresql  ↵
    address_standardizer
cd address_standardizer
make
#if you have in non-standard location pcre try
# make SHLIB_LINK="-L/path/pcre/lib -lpostgres -lpgport -lpcre" CPPFLAGS="-I.  -I/path/pcre ↵
    /include"
make install
```

Once you have installed, you can connect to your database and run the SQL:

```
CREATE EXTENSION address_standardizer;
```

Once you install this extension in the same database as you have installed `postgis_tiger_geocoder`, then the Pagc_Normalize_Ad can be used instead of Normalize_Address. The other nice thing about this extension is that its tiger agnostic, so can be used with other data sources such as international addresses.

2.7.2 Tiger Geocoder Enabling your PostGIS database: Not Using Extensions

First install PostGIS using the prior instructions.

If you don't have an extras folder, download http://postgis.net/stuff/postgis-2.1.10dev.tar.gz

tar xvfz postgis-2.1.10dev.tar.gz

cd postgis-2.1.10dev/extras/tiger_geocoder/tiger_2011

Edit the `tiger_loader_2012.sql` to the paths of your executables server etc or alternatively you can update the `loader_platform` table once installed. If you don't edit this file or the `loader_platform` table, it will just contain common case locations of items and you'll have to edit the generated script after the fact when you run the Loader_Generate_Nation_Script and Loader_Generate_Script SQL functions.

If you are installing Tiger geocoder for the first time edit either the `create_geocode.bat` script If you are on windows or the `create_geocode.sh` if you are on Linux/Unix/Mac OSX with your PostgreSQL specific settings and run the corresponding script from the commandline.

Verify that you now have a `tiger` schema in your database and that it is part of your database search_path. If it is not, add it with a command something along the line of:

```
ALTER DATABASE geocoder SET search_path=public, tiger;
```

The normalizing address functionality works more or less without any data except for tricky addresses. Run this test and verify things look like this:

```
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
```

2.7.3 Loading Tiger Data

The instructions for loading data are available in a more detailed form in the `extras/tiger_geocoder/tiger_2011/README`. This just includes the general steps.

The load process downloads data from the census website for the respective nation files, states requested, extracts the files, and then loads each state into its own separate set of state tables. Each state table inherits from the tables defined in `tiger` schema so that its sufficient to just query those tables to access all the data and drop a set of state tables at any time using the Drop_State_Tables_Generate_Script if you need to reload a state or just don't need a state anymore.

In order to be able to load data you'll need the following tools:

- A tool to unzip the zip files from census website.

  For Unix like systems: `unzip` executable which is usually already installed on most Unix like platforms.

  For Windows, 7-zip which is a free compress/uncompress tool you can download from http://www.7-zip.org/
- `shp2pgsql` commandline which is installed by default when you install PostGIS.
- `wget` which is a web grabber tool usually installed on most Unix/Linux systems.

  If you are on windows, you can get pre-compiled binaries from 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_Script. Before you load any state data, you need to load the nation wide data which you do with Loader_Generate_Nation_Script. Which will generate a loader script for you. Loader_Generate_Nation_Script is a one-time step that should be done for upgrading (from 2010) and for new installs.

To load state data refer to Loader_Generate_Script to generate a data load script for your platform for the states you desire. Note that you can install these piecemeal. You don't have to load all the states you want all at once. You can load them as you need them.

After the states you desire have been loaded, make sure to run the:

```
SELECT install_missing_indexes();
```

as described in Install_Missing_Indexes.

To test that things are working as they should, try to run a geocode on an address in your state using Geocode

2.7.4 Upgrading your Tiger Geocoder Install

If you have Tiger Geocoder packaged with 2.0+ already installed, you can upgrade the functions at any time even from an interim tar ball if there are fixes you badly need. This will only work for Tiger geocoder not installed with extensions.

If you don't have an extras folder, download http://postgis.net/stuff/postgis-2.1.10dev.tar.gz

tar xvfz postgis-2.1.10dev.tar.gz

cd postgis-2.1.10dev/extras/tiger_geocoder/tiger_2011

Locate the `upgrade_geocoder.bat` script If you are on windows or the `upgrade_geocoder.sh` if you are on Linux/Unix/Mac OSX. Edit the file to have your postgis database credentials.

If you are upgrading from 2010 or 2011, make sure to unremark out the loader script line so you get the latest script for loading 2012 data.

Then run th corresponding script from the commandline.

Next drop all nation tables and load up the new ones. Generate a drop script with this SQL statement as detailed in Drop_Nation_Tables_G

```
SELECT drop_nation_tables_generate_script();
```

Run the generated drop SQL statements.

Generate a nation load script with this SELECT statement as detailed in Loader_Generate_Nation_Script

For windows

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

For unix/linux

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

Refer to Section 2.7.3 for instructions on how to run the generate script. This only needs to be done once.

> **Note**
> You can have a mix of 2010/2011 state tables and can upgrade each state separately. Before you upgrade a state to 2011, you first need to drop the 2010 tables for that state using Drop_State_Tables_Generate_Script.

2.8 Create a spatially-enabled database from a template

Some packaged distributions of PostGIS (in particular the Win32 installers for PostGIS >= 1.1.5) load the PostGIS functions into a template database called `template_postgis`. If the `template_postgis` database exists in your PostgreSQL installation then it is possible for users and/or applications to create spatially-enabled databases using a single command. Note that in both cases, the database user must have been granted the privilege to create new databases.

From the shell:

```
# createdb -T template_postgis my_spatial_db
```

From SQL:

```
postgres=# CREATE DATABASE my_spatial_db TEMPLATE=template_postgis
```

2.9 Upgrading

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.

2.9.1 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, then you should upgrade using the sql script way. Please refer to the appropriate.

2.9.1.1 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 ... because postgis extension depends on it
```

After compiling you should find several `postgis_upgrade*.sql` files. Install the one for your version of PostGIS. For example `postgis_upgrade_20_to_21.sql` should be used if you are upgrading from PostGIS 2.0 to 2.1. If you are moving from PostGIS 1.* to PostGIS 2.* or from PostGIS 2.* prior to r7409, you need to do a HARD UPGRADE.

```
psql -f postgis_upgrade_21_minor.sql -d your_spatial_database
```

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

```
psql -f rtpostgis_upgrade_21_minor.sql -d your_spatial_database
```

```
psql -f topology_upgrade_21_minor.sql -d your_spatial_database
```

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.

2.9.1.2 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.

```
ALTER EXTENSION postgis UPDATE TO "2.1.10dev";
ALTER EXTENSION postgis_topology UPDATE TO "2.1.10dev";
```

If you get an error notice something like:

```
No migration path defined for ... to 2.1.10dev
```

Then you'll need to backup your database, create a fresh one as described in Section 2.6 and then restore your backup ontop of this new database.

If you get a notice message like:

```
Version "2.1.10dev" 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 SVN 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 "2.1.10devnext";
ALTER EXTENSION postgis_topology UPDATE TO "2.1.10devnext";
```

> **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.

2.9.2 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.pl 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 2.5 and Section 2.6 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.pl. Unexpected errors, if any, will be printed to the standard error stream by psql. Keep a log of those.

   ```
   perl utils/postgis_restore.pl "/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 loose 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));
```

2.10 Common Problems during installation

There are several things to check when your installation or upgrade doesn't go as you expected.

1. Check that you have installed PostgreSQL 9.0 or newer, and that you are compiling against the same version of the PostgreSQL source as the version of PostgreSQL that is running. Mix-ups can occur when your (Linux) distribution has already installed PostgreSQL, or you have otherwise installed PostgreSQL before and forgotten about it. PostGIS will only work with PostgreSQL 9.0 or newer, and strange, unexpected error messages will result if you use an older version. To check the version of PostgreSQL which is running, connect to the database using psql and run this query:

```
SELECT version();
```

   If you are running an RPM based distribution, you can check for the existence of pre-installed packages using the **rpm** command as follows: **rpm -qa | grep postgresql**

2. If your upgrade fails, make sure you are restoring into a database that already has PostGIS installed.

```
SELECT postgis_full_version();
```

Also check that configure has correctly detected the location and version of PostgreSQL, the Proj4 library and the GEOS library.

1. The output from configure is used to generate the `postgis_config.h` file. Check that the `POSTGIS_PGSQL_VERSION`, `POSTGIS_PROJ_VERSION` and `POSTGIS_GEOS_VERSION` variables have been set correctly.

2.11 JDBC

The JDBC extensions provide Java objects corresponding to the internal PostGIS types. These objects can be used to write Java clients which query the PostGIS database and draw or do calculations on the GIS data in PostGIS.

1. Enter the `java/jdbc` sub-directory of the PostGIS distribution.
2. Run the `ant` command. Copy the `postgis.jar` file to wherever you keep your java libraries.

The JDBC extensions require a PostgreSQL JDBC driver to be present in the current CLASSPATH during the build process. If the PostgreSQL JDBC driver is located elsewhere, you may pass the location of the JDBC driver JAR separately using the -D parameter like this:

```
# ant -Dclasspath=/path/to/postgresql-jdbc.jar
```

PostgreSQL JDBC drivers can be downloaded from http://jdbc.postgresql.org .

2.12 Loader/Dumper

The data loader and dumper are built and installed automatically as part of the PostGIS build. To build and install them manually:

```
# cd postgis-2.1.10dev/loader
# make
# make install
```

The loader is called `shp2pgsql` and converts ESRI Shape files into SQL suitable for loading in PostGIS/PostgreSQL. The dumper is called `pgsql2shp` and converts PostGIS tables (or queries) into ESRI Shape files. For more verbose documentation, see the online help, and the manual pages.

Chapter 3

PostGIS Frequently Asked Questions

1. *Where can I find tutorials, guides and workshops on working with PostGIS*

   OpenGeo has a step by step tutorial guide workshop Introduction to PostGIS. It includes packaged data as well as intro to working with OpenGeo Suite. It is probably the best tutorial on PostGIS.BostonGIS also has a PostGIS almost idiot's guide on getting started. That one is more focused on the windows user.

2. *My applications and desktop tools worked with PostGIS 1.5,but they don't work with PostGIS 2.0. How do I fix this?*

   A lot of deprecated functions were removed from the PostGIS code base in PostGIS 2.0. This has affected applications in addition to third-party tools such as Geoserver, MapServer, QuantumGIS, and OpenJump to name a few. There are a couple of ways to resolve this. For the third-party apps, you can try to upgrade to the latest versions of these which have many of these issues fixed. For your own code, you can change your code to not use the functions removed. Most of these functions are non ST_ aliases of ST_Union, ST_Length etc. and as a last resort, install the whole of `legacy.sql` or just the portions of `legacy.sql` you need.The `legacy.sql` file is located in the same folder as postgis.sql. You can install this file after you have installed postgis.sql and spatial_ref_sys.sql to get back all the 200 some-odd old functions we removed.

3. *When I load OpenStreetMap data with osm2pgsql, I'm getting an error failed: ERROR: operator class "gist_geometry_ops" does not exist for access method "gist" Error occurred. This worked fine in PostGIS 1.5.*

   In PostGIS 2, the default geometry operator class gist_geometry_ops was changed to gist_geometry_ops_2d and the gist_geometry_ops was completely removed. This was done because PostGIS 2 also introduced Nd spatial indexes for 3D support and the old name was deemed confusing and a misnomer.Some older applications that as part of the process create tables and indexes, explicitly referenced the operator class name. This was unnecessary if you want the default 2D index. So if you manage said good, change index creation from:BAD:

   ```
   CREATE INDEX idx_my_table_geom ON my_table USING gist(geom gist_geometry_ops);
   ```

   To GOOD:

   ```
   CREATE INDEX idx_my_table_geom ON my_table USING gist(geom);
   ```

   The only case where you WILL need to specify the operator class is if you want a 3D spatial index as follows:

   ```
   CREATE INDEX idx_my_super3d_geom ON my_super3d USING gist(geom gist_geometry_ops_nd);
   ```

   If you are unfortunate to be stuck with compiled code you can't change that has the old gist_geometry_ops hard-coded, then you can create the old class using the `legacy_gist.sql` packaged in PostGIS 2.0.2+. However if you use this fix, you are advised to at a later point drop the index and recreate it without the operator class. This will save you grief in the future when you need to upgrade again.

4. *I'm running PostgreSQL 9.0 and I can no longer read/view geometries in OpenJump, Safe FME, and some other tools?*

   In PostgreSQL 9.0+, the default encoding for bytea data has been changed to hex and older JDBC drivers still assume escape format. This has affected some applications such as Java applications using older JDBC drivers or .NET applications that use the older npgsql driver that expect the old behavior of ST_AsBinary. There are two approaches to getting this to work again.You can upgrade your JDBC driver to the latest PostgreSQL 9.0 version which you can get from http://jdbc.postgresql.org/download.htmlIf you are running a .NET app, you can use Npgsql 2.0.11 or higher which you can download from http://pgfoundry.org/frs/?group_id=1000140 and as described on Francisco Figueiredo's NpgSQL 2.0.11 released blog entryIf upgrading your PostgreSQL driver is not an option, then you can set the default back to the old behavior with the following change:

```
ALTER DATABASE mypostgisdb SET bytea_output='escape';
```

5. *I tried to use PgAdmin to view my geometry column and it is blank, what gives?*

   PgAdmin doesn't show anything for large geometries. The best ways to verify you do have data in your geometry columns are?

```
-- this should return no records if all your geom fields are filled in
SELECT somefield FROM mytable WHERE geom IS NULL;
```

```
-- To tell just how large your geometry is do a query of the form
--which will tell you the most number of points you have in any of your geometry ↩
    columns
SELECT MAX(ST_NPoints(geom)) FROM sometable;
```

6. *What kind of geometric objects can I store?*

   You can store Points, Linestrings, Polygons, CircularStrings, CompoundCurves, CurvePolygons, Triangles, Polyhedral-Surfaces, TINs, Rasters, and collections of all the above. The most commonly used types used are Points, Linestrings and Polygons, and their collections.Points, Linestrings and Polygons can be stored either as "geometry" or "geography". "Geometry" are cartesian representations of features in a 2D space. The shortest distance between two "geometry" points is a straight line. "Geography" are representations of objects on a spherical surface. The shortest distance between two "geography" points is a great circle.The "raster" type has a distinct set of functions for manipulation and analysis. Refer to Chapter 10 and Chapter 9 for more details.

7. *I'm all confused. Which data store should I use geometry or geography?*

   Short Answer: geography is a new data type that supports long range distances measurements, but most computations on it are currently slower than they are on geometry. If you use geography -- you don't need to learn much about planar coordinate systems. Geography is generally best if all you care about is measuring distances and lengths and you have data from all over the world. Geometry data type is an older data type that has many more functions supporting it, enjoys greater support from third party tools, and operations on it are generally faster -- sometimes as much as 10 fold faster for larger geometries. Geometry is best if you are pretty comfortable with spatial reference systems or you are dealing with localized data where all your data fits in a single spatial reference system (SRID), or you need to do a lot of spatial processing. Note: It is fairly easy to do one-off conversions between the two types to gain the benefits of each. Refer to Section 13.10 to see what is currently supported and what is not. Long Answer: Refer to our more lengthy discussion in the Section 4.2.2 and function type matrix.

8. *I have more intense questions about geography, such as how big of a geographic region can I stuff in a geography column and still get reasonable answers. Are there limitations such as poles, everything in the field must fit in a hemisphere (like SQL Server 2008 has), speed etc?*

   Your questions are too deep and complex to be adequately answered in this section. Please refer to our Section 4.2.3.

9. *How do I insert a GIS object into the database?*

   First, you need to create a table with a column of type "geometry" or "geography" to hold your GIS data. Storing geography type data is a little different than storing geometry. Refer to Section 4.2.1 for details on storing geography. For geometry: Connect to your database with `psql` and try the following SQL:

```
CREATE TABLE gtest ( gid serial primary key, name varchar(20)
        , geom geometry(LINESTRING) );
```

   If the geometry column definition fails, you probably have not loaded the PostGIS functions and objects into this database or are using a pre-2.0 version of PostGIS. See the Section 2.4.Then, you can insert a geometry into the table using a SQL insert statement. The GIS object itself is formatted using the OpenGIS Consortium "well-known text" format:

```
INSERT INTO gtest (ID, NAME, GEOM)
VALUES (
  1,
  'First Geometry',
  ST_GeomFromText('LINESTRING(2 3,4 5,6 5,7 8)')
);
```

For more information about other GIS objects, see the object reference.To view your GIS data in the table:

```
SELECT id, name, ST_AsText(geom) AS geom FROM gtest;
```

The return value should look something like this:

```
 id | name             | geom
----+------------------+-----------------------------
  1 | First Geometry | LINESTRING(2 3,4 5,6 5,7 8)
(1 row)
```

10. *How do I construct a spatial query?*

    The same way you construct any other database query, as an SQL combination of return values, functions, and boolean tests.For spatial queries, there are two issues that are important to keep in mind while constructing your query: is there a spatial index you can make use of; and, are you doing expensive calculations on a large number of geometries.In general, you will want to use the "intersects operator" (&&) which tests whether the bounding boxes of features intersect. The reason the && operator is useful is because if a spatial index is available to speed up the test, the && operator will make use of this. This can make queries much much faster.You will also make use of spatial functions, such as Distance(), ST_Intersects(), ST_Contains() and ST_Within(), among others, to narrow down the results of your search. Most spatial queries include both an indexed test and a spatial function test. The index test serves to limit the number of return tuples to only tuples that *might* meet the condition of interest. The spatial functions are then use to test the condition exactly.

```
SELECT id, the_geom
FROM thetable
WHERE
  ST_Contains(the_geom,'POLYGON((0 0, 0 10, 10 10, 10 0, 0 0))');
```

11. *How do I speed up spatial queries on large tables?*

    Fast queries on large tables is the *raison d'etre* of spatial databases (along with transaction support) so having a good index is important.To build a spatial index on a table with a `geometry` column, use the "CREATE INDEX" function as follows:

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

The "USING GIST" option tells the server to use a GiST (Generalized Search Tree) index.

Note
GiST indexes are assumed to be lossy. Lossy indexes uses a proxy object (in the spatial case, a bounding box) for building the index.

You should also ensure that the PostgreSQL query planner has enough information about your index to make rational decisions about when to use it. To do this, you have to "gather statistics" on your geometry tables.For PostgreSQL 8.0.x and greater, just run the **VACUUM ANALYZE** command.For PostgreSQL 7.4.x and below, run the **SELECT UPDATE_GEOMETRY_STATS()** command.

12. *Why aren't PostgreSQL R-Tree indexes supported?*

    Early versions of PostGIS used the PostgreSQL R-Tree indexes. However, PostgreSQL R-Trees have been completely discarded since version 0.6, and spatial indexing is provided with an R-Tree-over-GiST scheme.Our tests have shown search speed for native R-Tree and GiST to be comparable. Native PostgreSQL R-Trees have two limitations which make them undesirable for use with GIS features (note that these limitations are due to the current PostgreSQL native R-Tree implementation, not the R-Tree concept in general):

- R-Tree indexes in PostgreSQL cannot handle features which are larger than 8K in size. GiST indexes can, using the "lossy" trick of substituting the bounding box for the feature itself.
- R-Tree indexes in PostgreSQL are not "null safe", so building an index on a geometry column which contains null geometries will fail.

13. *Why should I use the `AddGeometryColumn()` function and all the other OpenGIS stuff?*

    If you do not want to use the OpenGIS support functions, you do not have to. Simply create tables as in older versions, defining your geometry columns in the CREATE statement. All your geometries will have SRIDs of -1, and the OpenGIS meta-data tables will *not* be filled in properly. However, this will cause most applications based on PostGIS to fail, and it is generally suggested that you do use `AddGeometryColumn()` to create geometry tables.MapServer is one application which makes use of the `geometry_columns` meta-data. Specifically, MapServer can use the SRID of the geometry column to do on-the-fly reprojection of features into the correct map projection.

14. *What is the best way to find all objects within a radius of another object?*

    To use the database most efficiently, it is best to do radius queries which combine the radius test with a bounding box test: the bounding box test uses the spatial index, giving fast access to a subset of data which the radius test is then applied to.The `ST_DWithin(geometry, geometry, distance)` function is a handy way of performing an indexed distance search. It works by creating a search rectangle large enough to enclose the distance radius, then performing an exact distance search on the indexed subset of results.For example, to find all objects with 100 meters of POINT(1000 1000) the following query would work well:

    ```
    SELECT * FROM geotable
    WHERE ST_DWithin(geocolumn, 'POINT(1000 1000)', 100.0);
    ```

15. *How do I perform a coordinate reprojection as part of a query?*

    To perform a reprojection, both the source and destination coordinate systems must be defined in the SPATIAL_REF_SYS table, and the geometries being reprojected must already have an SRID set on them. Once that is done, a reprojection is as simple as referring to the desired destination SRID. The below projects a geometry to NAD 83 long lat. The below will only work if the srid of the_geom is not -1 (not undefined spatial ref)

    ```
    SELECT ST_Transform(the_geom,4269) FROM geotable;
    ```

16. *I did an ST_AsEWKT and ST_AsText on my rather large geometry and it returned blank field. What gives?*

    You are probably using PgAdmin or some other tool that doesn't output large text. If your geometry is big enough, it will appear blank in these tools. Use PSQL if you really need to see it or output it in WKT.

    ```
            --To check number of geometries are really blank
            SELECT count(gid) FROM geotable WHERE the_geom IS NULL;
    ```

17. *When I do an ST_Intersects, it says my two geometries don't intersect when I KNOW THEY DO. What gives?*

    This generally happens in two common cases. Your geometry is invalid -- check ST_IsValid or you are assuming they intersect because ST_AsText truncates the numbers and you have lots of decimals after it is not showing you.

18. *I am releasing software that uses PostGIS, does that mean my software has to be licensed using the GPL like PostGIS? Will I have to publish all my code if I use PostGIS?*

    Almost certainly not. As an example, consider Oracle database running on Linux. Linux is GPL, Oracle is not, does Oracle running on Linux have to be distributed using the GPL? No. So your software can use a PostgreSQL/PostGIS database as much as it wants and be under any license you like.The only exception would be if you made changes to the PostGIS source code, and distributed your changed version of PostGIS. In that case you would have to share the code of your changed PostGIS (but not the code of applications running on top of it). Even in this limited case, you would still only have to distribute source code to people you distributed binaries to. The GPL does not require that you *publish* your source code, only that you share it with people you give binaries to.

Chapter 4

Using PostGIS: Data Management and Queries

4.1 GIS Objects

The GIS objects supported by PostGIS are all the vector types defined in the "Simple Features for SQL 1.2.1" standard defined by the OpenGIS Consortium (OGC), and the ISO "SQL/MM Part 3: Spatial" document. In addition, PostGIS supports a raster type (no standards exist to follow), and a topology model (following an early draft ISO standard for topology that has not been published as yet).

The OGC and ISO standards define 2D (x/y), 3D (x/y/z, x/y/m) and 4D (x/y/z/m) variants of points, lines, polygons, curved features, polyhedra, and TINS.

4.1.1 Well-Known Binary (WKB) and Well-Known Text (WKT) Representations

The OGC and ISO specifications define both text and binary representations for geometry objects, WKT and WKB. Both representations include information about the type of the object and the coordinates that form the object.

Examples of the text representations (WKT) of the spatial objects of the features are as follows:

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

The OpenGIS specification also requires that the internal storage format of spatial objects include a spatial referencing system identifier (SRID). The SRID is required when creating spatial objects for insertion into the database.

Input/Output of these formats are available using the following interfaces:

```
bytea WKB = ST_AsBinary(geometry);
text WKT = ST_AsText(geometry);
geometry = ST_GeomFromWKB(bytea WKB, SRID);
geometry = ST_GeometryFromText(text WKT, SRID);
```

For example, a valid insert statement to create and insert an OGC spatial object would be:

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

4.1.2 PostGIS EWKB, EWKT and Canonical Forms

OGC formats only support 2d geometries, and the associated SRID is *never* embedded in the input/output representations.

PostGIS extended formats are currently superset of OGC one (every valid WKB/WKT is a valid EWKB/EWKT) but this might vary in the future, specifically if OGC comes out with a new format conflicting with our extensions. Thus you SHOULD NOT rely on this feature!

PostGIS EWKB/EWKT add 3dm,3dz,4d coordinates support and embedded SRID information.

Examples of the text representations (EWKT) of the extended spatial objects of the features are as follows. The * ones are new in this version of PostGIS:

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

Input/Output of these formats are available using the following interfaces:

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

For example, a valid insert statement to create and insert a PostGIS spatial object would be:

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

The "canonical forms" of a PostgreSQL type are the representations you get with a simple query (without any function call) and the one which is guaranteed to be accepted with a simple insert, update or copy. For the postgis 'geometry' type these are:

```
- Output
  - binary: EWKB
  ascii: HEXEWKB (EWKB in hex form)
- Input
  - binary: EWKB
  ascii: HEXEWKB|EWKT
```

For example this statement reads EWKT and returns HEXEWKB in the process of canonical ascii input/output:

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

geometry
----------------------------------------------------
01010000200400000000000000000000000000000000000000
(1 row)
```

4.1.3 SQL-MM Part 3

The SQL Multimedia Applications Spatial specification extends the simple features for SQL spec by defining a number of circularly interpolated curves.

The SQL-MM definitions include 3dm, 3dz and 4d coordinates, but do not allow the embedding of SRID information.

The well-known text extensions are not yet fully supported. Examples of some simple curved geometries are shown below:

- CIRCULARSTRING(0 0, 1 1, 1 0)

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

  The CIRCULARSTRING is the basic curve type, similar to a LINESTRING in the linear world. A single segment required three points, the start and end points (first and third) and any other point on the arc. The exception to this is for a closed circle, where the start and end points are the same. In this case the second point MUST be the center of the arc, ie the opposite side of the circle. To chain arcs together, the last point of the previous arc becomes the first point of the next arc, just like in LINESTRING. This means that a valid circular string must have an odd number of points greated than 1.

- COMPOUNDCURVE(CIRCULARSTRING(0 0, 1 1, 1 0),(1 0, 0 1))

  A compound curve is a single, continuous curve that has both curved (circular) segments and linear segments. That means that in addition to having well-formed components, the end point of every component (except the last) must be coincident with the start point of the following component.

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

  Example compound curve in a curve polygon: 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))

  A CURVEPOLYGON is just like a polygon, with an outer ring and zero or more inner rings. The difference is that a ring can take the form of a circular string, linear string or compound string.

  As of PostGIS 1.4 PostGIS supports compound curves in a curve polygon.

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

  The MULTICURVE is a collection of curves, which can include linear strings, circular strings or compound strings.

- 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)))

  This is a collection of surfaces, which can be (linear) polygons or curve polygons.

Note
PostGIS prior to 1.4 does not support compound curves in a curve polygon, but PostGIS 1.4 and above do support the use of Compound Curves in a Curve Polygon.

Note
All floating point comparisons within the SQL-MM implementation are performed to a specified tolerance, currently 1E-8.

4.2 PostGIS Geography Type

The geography type provides native support for spatial features represented on "geographic" coordinates (sometimes called "geodetic" coordinates, or "lat/lon", or "lon/lat"). Geographic coordinates are spherical coordinates expressed in angular units (degrees).

The basis for the PostGIS geometry type is a plane. The shortest path between two points on the plane is a straight line. That means calculations on geometries (areas, distances, lengths, intersections, etc) can be calculated using cartesian mathematics and straight line vectors.

The basis for the PostGIS geographic type is a sphere. The shortest path between two points on the sphere is a great circle arc. That means that calculations on geographies (areas, distances, lengths, intersections, etc) must be calculated on the sphere, using more complicated mathematics. For more accurate measurements, the calculations must take the actual spheroidal shape of the world into account, and the mathematics becomes very complicated indeed.

Because the underlying mathematics is much more complicated, there are fewer functions defined for the geography type than for the geometry type. Over time, as new algorithms are added, the capabilities of the geography type will expand.

One restriction is that it only supports WGS 84 long lat (SRID:4326). It uses a new data type called geography. None of the GEOS functions support this new type. As a workaround one can convert back and forth between geometry and geography types.

The new geography type uses the PostgreSQL 8.3+ typmod definition format so that a table with a geography field can be added in a single step. All the standard OGC formats except for curves are supported.

4.2.1 Geography Basics

The geography type only supports the simplest of simple features. Standard geometry type data will autocast to geography if it is of SRID 4326. You can also use the EWKT and EWKB conventions to insert data.

- POINT: Creating a table with 2d point geometry:

  ```
  CREATE TABLE testgeog(gid serial PRIMARY KEY, the_geog geography(POINT,4326) );
  ```

  Creating a table with z coordinate point

  ```
  CREATE TABLE testgeog(gid serial PRIMARY KEY, the_geog geography(POINTZ,4326) );
  ```

- LINESTRING
- POLYGON
- MULTIPOINT
- MULTILINESTRING
- MULTIPOLYGON
- GEOMETRYCOLLECTION

The new geography fields don't get registered in the `geometry_columns`. They get registered in a new view called geography_columns which is a view against the system catalogs so is always automatically kept up to date without need for an AddGeom... like function.

Now, check the "geography_columns" view and see that your table is listed.

You can create a new table with a GEOGRAPHY column using the CREATE TABLE syntax. Unlike GEOMETRY, there is no need to run a separate AddGeometryColumns() process to register the column in metadata.

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

Note that the location column has type GEOGRAPHY and that geography type supports two optional modifier: a type modifier that restricts the kind of shapes and dimensions allowed in the column; an SRID modifier that restricts the coordinate reference identifier to a particular number.

Allowable values for the type modifier are: POINT, LINESTRING, POLYGON, MULTIPOINT, MULTILINESTRING, MULTIPOLYGON. The modifier also supports dimensionality restrictions through suffixes: Z, M and ZM. So, for example a modifier of 'LINESTRINGM' would only allow line strings with three dimensions in, and would treat the third dimension as a measure. Similarly, 'POINTZM' would expect four dimensional data.

The SRID modifier is currently of limited use: only 4326 (WGS84) is allowed as a value. If you do not specify an SRID, the a value 0 (undefined spheroid) will be used, and all calculations will proceed using WGS84 anyways.

In the future, alternate SRIDs will allow calculations on spheroids other than WGS84.

Once you have created your table, you can see it in the GEOGRAPHY_COLUMNS table:

```
-- See the contents of the metadata view
SELECT * FROM geography_columns;
```

You can insert data into the table the same as you would if it was using a GEOMETRY column:

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

Creating an index works the same as GEOMETRY. PostGIS will note that the column type is GEOGRAPHY and create an appropriate sphere-based index instead of the usual planar index used for GEOMETRY.

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

Query and measurement functions use units of meters. So distance parameters should be expressed in meters, and return values should be expected in meters (or square meters for areas).

```
-- Show a distance query and note, London is outside the 1000km tolerance
  SELECT name FROM global_points WHERE ST_DWithin(location, ST_GeographyFromText('SRID ↩
     =4326;POINT(-110 29)'), 1000000);
```

You can see the power of GEOGRAPHY in action by calculating the how close a plane flying from Seattle to London (LINESTRING(-122.33 47.606, 0.0 51.5)) comes to Reykjavik (POINT(-21.96 64.15)).

```
-- Distance calculation using GEOGRAPHY (122.2km)
  SELECT ST_Distance('LINESTRING(-122.33 47.606, 0.0 51.5)'::geography, 'POINT(-21.96  ↩
     64.15)':: geography);
```

```
-- Distance calculation using GEOMETRY (13.3 "degrees")
  SELECT ST_Distance('LINESTRING(-122.33 47.606, 0.0 51.5)'::geometry, 'POINT(-21.96 64.15) ↩
     ':: geometry);
```

The GEOGRAPHY type calculates the true shortest distance over the sphere between Reykjavik and the great circle flight path between Seattle and London.

Great Circle mapper The GEOMETRY type calculates a meaningless cartesian distance between Reykjavik and the straight line path from Seattle to London plotted on a flat map of the world. The nominal units of the result might be called "degrees", but the result doesn't correspond to any true angular difference between the points, so even calling them "degrees" is inaccurate.

4.2.2 When to use Geography Data type over Geometry data type

The new GEOGRAPHY type allows you to store data in longitude/latitude coordinates, but at a cost: there are fewer functions defined on GEOGRAPHY than there are on GEOMETRY; those functions that are defined take more CPU time to execute.

The type you choose should be conditioned on the expected working area of the application you are building. Will your data span the globe or a large continental area, or is it local to a state, county or municipality?

- If your data is contained in a small area, you might find that choosing an appropriate projection and using GEOMETRY is the best solution, in terms of performance and functionality available.
- If your data is global or covers a continental region, you may find that GEOGRAPHY allows you to build a system without having to worry about projection details. You store your data in longitude/latitude, and use the functions that have been defined on GEOGRAPHY.
- If you don't understand projections, and you don't want to learn about them, and you're prepared to accept the limitations in functionality available in GEOGRAPHY, then it might be easier for you to use GEOGRAPHY than GEOMETRY. Simply load your data up as longitude/latitude and go from there.

Refer to Section 13.10 for compare between what is supported for Geography vs. Geometry. For a brief listing and description of Geography functions, refer to Section 13.3

4.2.3 Geography Advanced FAQ

1. *Do you calculate on the sphere or the spheroid?*

   By default, all distance and area calculations are done on the spheroid. You should find that the results of calculations in local areas match up will with local planar results in good local projections. Over larger areas, the spheroidal calculations will be more accurate than any calculation done on a projected plane. All the geography functions have the option of using a sphere calculation, by setting a final boolean parameter to 'FALSE'. This will somewhat speed up calculations, particularly for cases where the geometries are very simple.

2. *What about the date-line and the poles?*

   All the calculations have no conception of date-line or poles, the coordinates are spherical (longitude/latitude) so a shape that crosses the dateline is, from a calculation point of view, no different from any other shape.

3. *What is the longest arc you can process?*

   We use great circle arcs as the "interpolation line" between two points. That means any two points are actually joined up two ways, depending on which direction you travel along the great circle. All our code assumes that the points are joined by the *shorter* of the two paths along the great circle. As a consequence, shapes that have arcs of more than 180 degrees will not be correctly modelled.

4. *Why is it so slow to calculate the area of Europe / Russia / insert big geographic region here ?*

   Because the polygon is so darned huge! Big areas are bad for two reasons: their bounds are huge, so the index tends to pull the feature no matter what query you run; the number of vertices is huge, and tests (distance, containment) have to traverse the vertex list at least once and sometimes N times (with N being the number of vertices in the other candidate feature). As with GEOMETRY, we recommend that when you have very large polygons, but are doing queries in small areas, you "denormalize" your geometric data into smaller chunks so that the index can effectively subquery parts of the object and so queries don't have to pull out the whole object every time. Just because you *can* store all of Europe in one polygon doesn't mean you *should*.

4.3 Using OpenGIS Standards

The OpenGIS "Simple Features Specification for SQL" defines standard GIS object types, the functions required to manipulate them, and a set of meta-data tables. In order to ensure that meta-data remain consistent, operations such as creating and removing a spatial column are carried out through special procedures defined by OpenGIS.

There are two OpenGIS meta-data tables: `SPATIAL_REF_SYS` and `GEOMETRY_COLUMNS`. The `SPATIAL_REF_SYS` table holds the numeric IDs and textual descriptions of coordinate systems used in the spatial database.

4.3.1 The SPATIAL_REF_SYS Table and Spatial Reference Systems

The spatial_ref_sys table is a PostGIS included and OGC compliant database table that lists over 3000 known spatial reference systems and details needed to transform/reproject between them.

Although the PostGIS spatial_ref_sys table contains over 3000 of the more commonly used spatial reference system definitions that can be handled by the proj library, it does not contain all known to man and you can even define your own custom projection if you are familiar with proj4 constructs. Keep in mind that most spatial reference systems are regional and have no meaning when used outside of the bounds they were intended for.

An excellent resource for finding spatial reference systems not defined in the core set is http://spatialreference.org/

Some of the more commonly used spatial reference systems are: 4326 - WGS 84 Long Lat, 4269 - NAD 83 Long Lat, 3395 - WGS 84 World Mercator, 2163 - US National Atlas Equal Area, Spatial reference systems for each NAD 83, WGS 84 UTM zone - UTM zones are one of the most ideal for measurement, but only cover 6-degree regions.

Various US state plane spatial reference systems (meter or feet based) - usually one or 2 exists per US state. Most of the meter ones are in the core set, but many of the feet based ones or ESRI created ones you will need to pull from spatialreference.org.

For details on determining which UTM zone to use for your area of interest, check out the utmzone PostGIS plpgsql helper function.

The `SPATIAL_REF_SYS` table definition is as follows:

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

The `SPATIAL_REF_SYS` columns are as follows:

SRID An integer value that uniquely identifies the Spatial Referencing System (SRS) within the database.

AUTH_NAME The name of the standard or standards body that is being cited for this reference system. For example, "EPSG" would be a valid `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 where the EPSG projection code would go.

SRTEXT The Well-Known Text representation of the Spatial Reference System. An example of a WKT SRS representation is:

```
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 listing of EPSG projection codes and their corresponding WKT representations, see http://www.opengeospatial.org/. For a discussion of WKT in general, see the OpenGIS "Coordinate Transformation Services Implementation Specification" at http://www.opengeospatial.org/standards. For information on the European Petroleum Survey Group (EPSG) and their database of spatial reference systems, see http://www.epsg.org.

PROJ4TEXT PostGIS uses the Proj4 library to provide coordinate transformation capabilities. The PROJ4TEXT column contains the Proj4 coordinate definition string for a particular SRID. For example:

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

For more information about, see the Proj4 web site at http://trac.osgeo.org/proj/. The spatial_ref_sys.sql file contains both SRTEXT and PROJ4TEXT definitions for all EPSG projections.

4.3.2 The GEOMETRY_COLUMNS VIEW

In versions of PostGIS prior to 2.0.0, geometry_columns was a table that could be directly edited, and sometimes got out of synch with the actual definition of the geometry columns. In PostGIS 2.0.0, GEOMETRY_COLUMNS became a view with the same front-facing structure as prior versions, but reading from database system catalogs Its structure is as follows:

```
\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)  |
```

The column meanings have not changed from prior versions and are:

F_TABLE_CATALOG, F_TABLE_SCHEMA, F_TABLE_NAME The fully qualified name of the feature table containing the geometry column. Note that the terms "catalog" and "schema" are Oracle-ish. There is not PostgreSQL analogue of "catalog" so that column is left blank -- for "schema" the PostgreSQL schema name is used (public is the default).

F_GEOMETRY_COLUMN The name of the geometry column in the feature table.

COORD_DIMENSION The spatial dimension (2, 3 or 4 dimensional) of the column.

SRID The ID of the spatial reference system used for the coordinate geometry in this table. It is a foreign key reference to the SPATIAL_REF_SYS.

TYPE The type of the spatial object. To restrict the spatial column to a single type, use one of: POINT, LINESTRING, POLYGON, MULTIPOINT, MULTILINESTRING, MULTIPOLYGON, GEOMETRYCOLLECTION or corresponding XYM versions POINTM, LINESTRINGM, POLYGONM, MULTIPOINTM, MULTILINESTRINGM, MULTIPOLYGONM, GEOMETRYCOLLECTIONM. For heterogeneous (mixed-type) collections, you can use "GEOMETRY" as the type.

> **Note**
> This attribute is (probably) not part of the OpenGIS specification, but is required for ensuring type homogeneity.

4.3.3 Creating a Spatial Table

Creating a table with spatial data, can be done in one step. As shown in the following example which creates a roads table with a 2D linestring geometry column in WGS84 long lat

```
CREATE TABLE ROADS ( ID int4
      , ROAD_NAME varchar(25), geom geometry(LINESTRING,4326) );
```

We can add additional columns using standard ALTER TABLE command as we do in this next example where we add a 3-D linestring.

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

For backwards compability, you can still create a spatial table in two stages using the management functions.

- Create a normal non-spatial table.

  For example: **CREATE TABLE ROADS (ID int4, ROAD_NAME varchar(25))**

- Add a spatial column to the table using the OpenGIS "AddGeometryColumn" function. Refer to AddGeometryColumn for more details.

  The syntax is:

  ```
  AddGeometryColumn(
    <schema_name>,
    <table_name>,
    <column_name>,
    <srid>,
    <type>,
    <dimension>
  )
  ```

  Or, using current schema:

  ```
  AddGeometryColumn(
    <table_name>,
    <column_name>,
    <srid>,
    <type>,
    <dimension>
  )
  ```

  Example1: **SELECT AddGeometryColumn('public', 'roads', 'geom', 423, 'LINESTRING', 2)**

  Example2: **SELECT AddGeometryColumn('roads', 'geom', 423, 'LINESTRING', 2)**

Here is an example of SQL used to create a table and add a spatial column (assuming that an SRID of 128 exists already):

```
CREATE TABLE parks (
  park_id    INTEGER,
  park_name  VARCHAR,
  park_date  DATE,
  park_type  VARCHAR
);
SELECT AddGeometryColumn('parks', 'park_geom', 128, 'MULTIPOLYGON', 2 );
```

Here is another example, using the generic "geometry" type and the undefined SRID value of 0:

```
CREATE TABLE roads (
  road_id INTEGER,
  road_name VARCHAR
);
SELECT AddGeometryColumn( 'roads', 'roads_geom', 0, 'GEOMETRY', 3 );
```

4.3.4 Manually Registering Geometry Columns in geometry_columns

The AddGeometryColumn() approach creates a geometry column and also registers the new column in the geometry_columns table. If your software utilizes geometry_columns, then any geometry columns you need to query by must be registered in this view. Starting with PostGIS 2.0, geometry_columns is no longer editable and all geometry columns are autoregistered.

However they may be registered as a generic geometry column if the column was not defined as a specific type during creation.

Two of the cases where this may happen, but you can't use AddGeometryColumn, is in the case of SQL Views and bulk inserts. For these cases, you can correct the registration in the geometry_columns table by constraining the column. Note in PostGIS 2.0+ if your column is typmod based, the creation process would register it correctly, so no need to do anything.

```
--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 in PostGIS 2.0+
-- 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
-- like so
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 that this approach will work for both PostGIS 2.0+ and PostGIS 1.4+
-- For PostGIS 2.0 it will also change the underlying structure of the table to
-- to make the column typmod based.
-- For PostGIS prior to 2.0, this technique can also be used to register views
SELECT populate_geometry_columns('myschema.my_special_pois'::regclass);

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

Although the old-constraint based method is still supported, a constraint-based geomentry column used directly in a view, will not register correctly in geometry_columns, as will a typmod one. In this example we define a column using typmod and another using constraints.

```
CREATE TABLE pois_ny(gid SERIAL PRIMARY KEY
   , poi_name text, cat varchar(20)
   , geom geometry(POINT,4326) );
SELECT AddGeometryColumn('pois_ny', 'geom_2160', 2160, 'POINT', 2, false);
```

If we run in psql

```
\d pois_ny;
```

We observe they are defined differently -- one is typmod, one is constraint

```
                                  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)
```

In geometry_columns, they both register correctly

```
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
```

However -- if we were to create a view like this

```
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';
```

The typmod based geom view column registers correctly, but the constraint based one does not.

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

This may change in future versions of PostGIS, but for now To force the constraint based view column to register correctly, we need to do this:

```
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
```

4.3.5 Ensuring OpenGIS compliancy of geometries

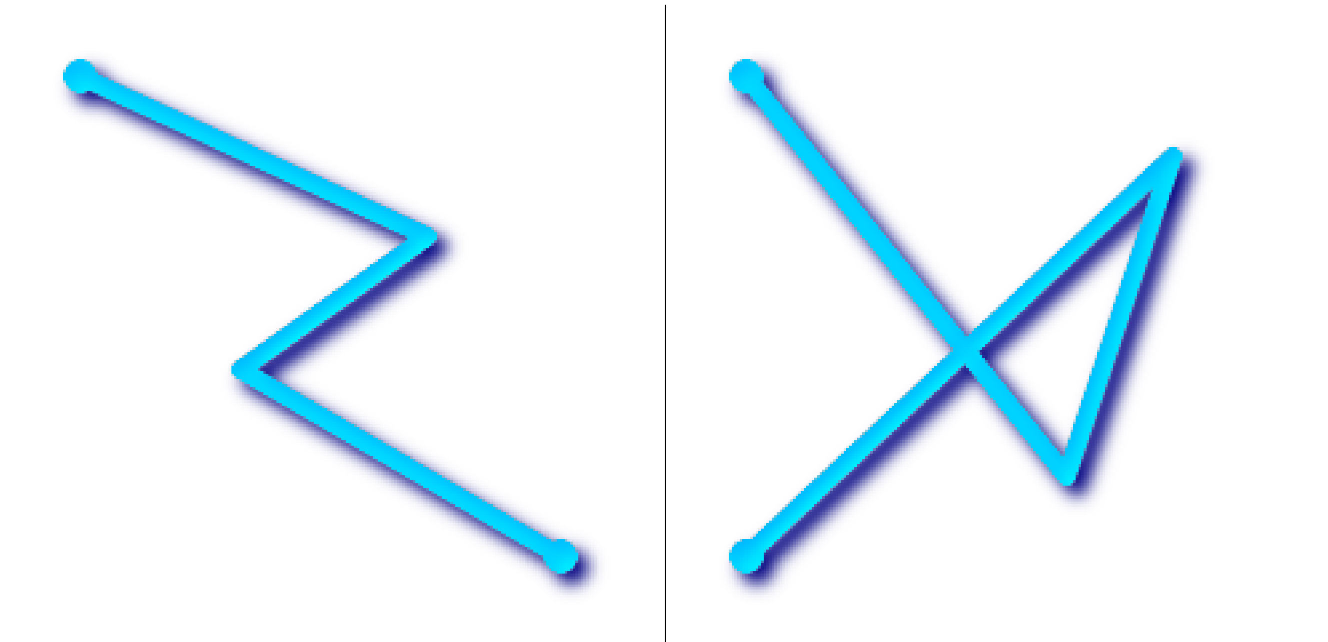
PostGIS is compliant with the Open Geospatial Consortium's (OGC) OpenGIS Specifications. As such, many PostGIS methods require, or more accurately, assume that geometries that are operated on are both simple and valid. For example, it does not make sense to calculate the area of a polygon that has a hole defined outside of the polygon, or to construct a polygon from a non-simple boundary line.

According to the OGC Specifications, a *simple* geometry is one that has no anomalous geometric points, such as self intersection or self tangency and primarily refers to 0 or 1-dimensional geometries (i.e. `[MULTI]POINT, [MULTI]LINESTRING`). Geometry validity, on the other hand, primarily refers to 2-dimensional geometries (i.e. `[MULTI]POLYGON)` and defines the set of assertions that characterizes a valid polygon. The description of each geometric class includes specific conditions that further detail geometric simplicity and validity.

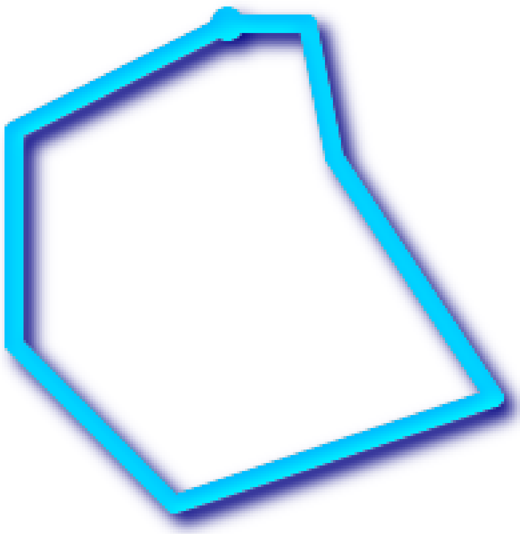
A `POINT` is inheritably *simple* as a 0-dimensional geometry object.

`MULTIPOINT`s are *simple* if no two coordinates (`POINT`s) are equal (have identical coordinate values).

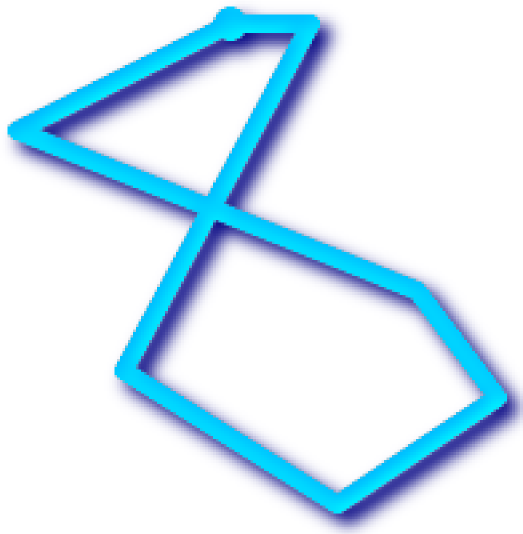
A `LINESTRING` is *simple* if it does not pass through the same `POINT` twice (except for the endpoints, in which case it is referred to as a linear ring and additionally considered closed).



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



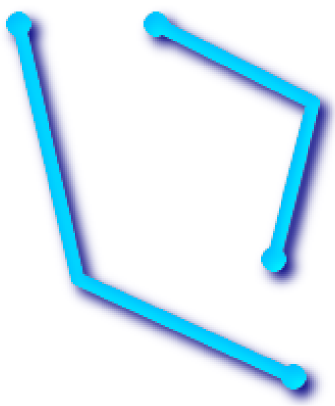
(c)



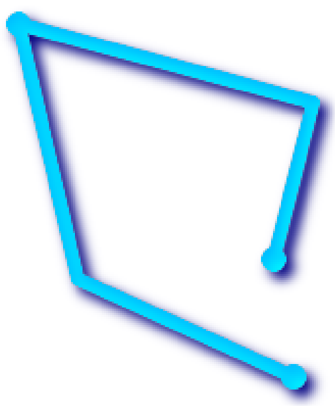
(d)

(a) and **(c)** are simple `LINESTRING`s, **(b)** and **(d)** are not.

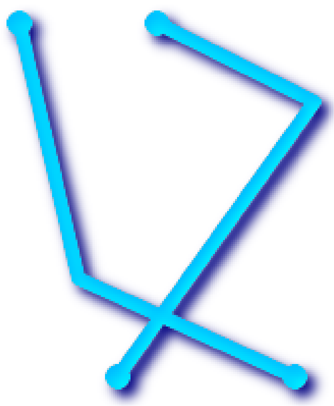
A `MULTILINESTRING` is *simple* only if all of its elements are simple and the only intersection between any two elements occurs at `POINT`s that are on the boundaries of both elements.



(e)



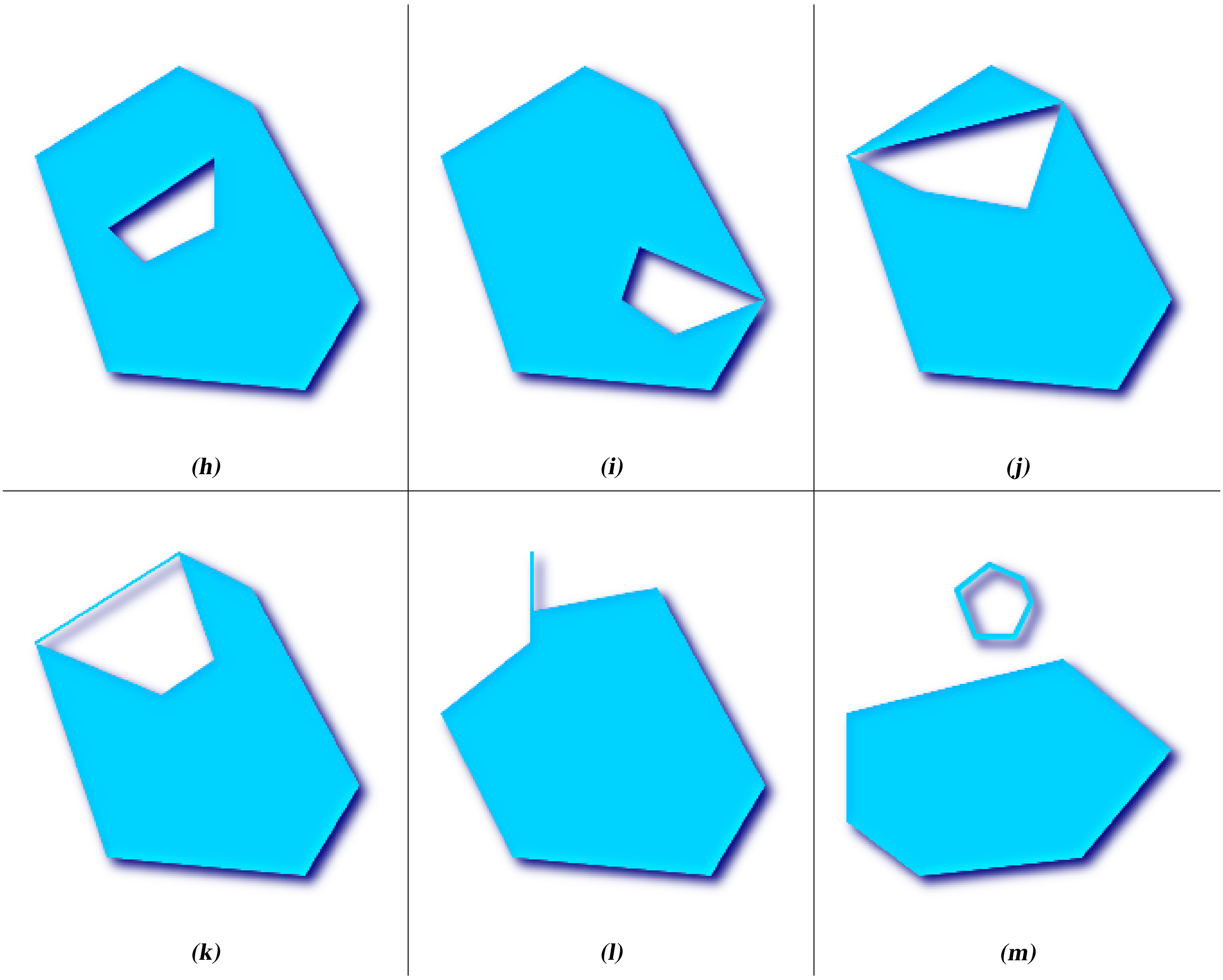
(f)



(g)

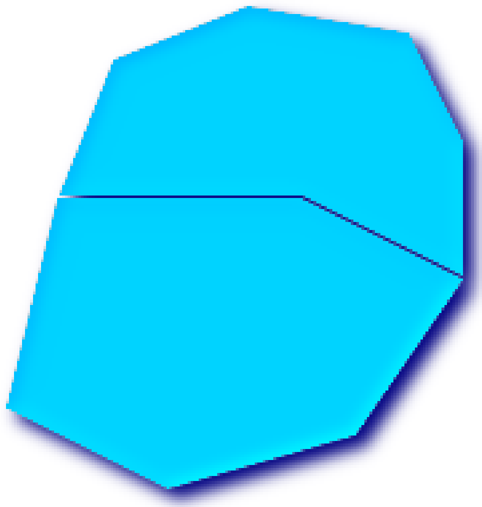
(e) and **(f)** are simple `MULTILINESTRING`s, **(g)** is not.

By definition, a `POLYGON` is always *simple*. It is *valid* if no two rings in the boundary (made up of an exterior ring and interior rings) cross. The boundary of a `POLYGON` may intersect at a `POINT` but only as a tangent (i.e. not on a line). A `POLYGON` may not have cut lines or spikes and the interior rings must be contained entirely within the exterior ring.

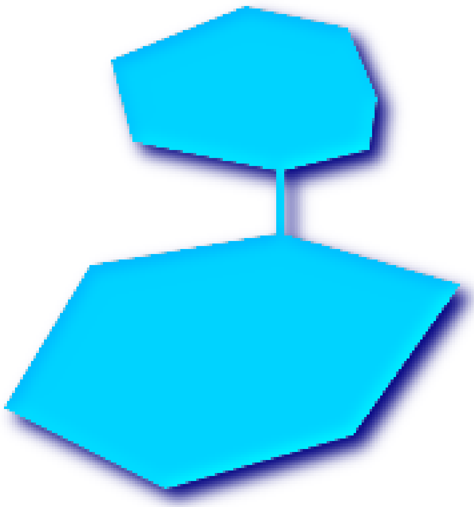


(h) and **(i)** are valid `POLYGON`s, **(j-m)** cannot be represented as single `POLYGON`s, but **(j)** and **(m)** could be represented as a valid `MULTIPOLYGON`.

A `MULTIPOLYGON` is *valid* if and only if all of its elements are valid and the interiors of no two elements intersect. The boundaries of any two elements may touch, but only at a finite number of `POINT`s.



(n)



(o)

(n) and **(o)** are not valid `MULTIPOLYGON`s. **(p)**, however, is valid.

Most of the functions implemented by the GEOS library rely on the assumption that your geometries are valid as specified by the OpenGIS Simple Feature Specification. To check simplicity or validity of geometries you can use the ST_IsSimple() and ST_IsValid()

```
-- Typically, it doesn't make sense to check
-- for validity on linear features since it will always return TRUE.
-- But in this example, PostGIS extends the definition of the OGC IsValid
-- by returning false if a LineString has less than 2 *distinct* vertices.
gisdb=# SELECT
   ST_IsValid('LINESTRING(0 0, 1 1)'),
   ST_IsValid('LINESTRING(0 0, 0 0, 0 0)');

 st_isvalid | st_isvalid
------------+-----------
      t     |     f
```

By default, PostGIS does not apply this validity check on geometry input, because testing for validity needs lots of CPU time for complex geometries, especially polygons. If you do not trust your data sources, you can manually enforce such a check to your tables by adding a check constraint:

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

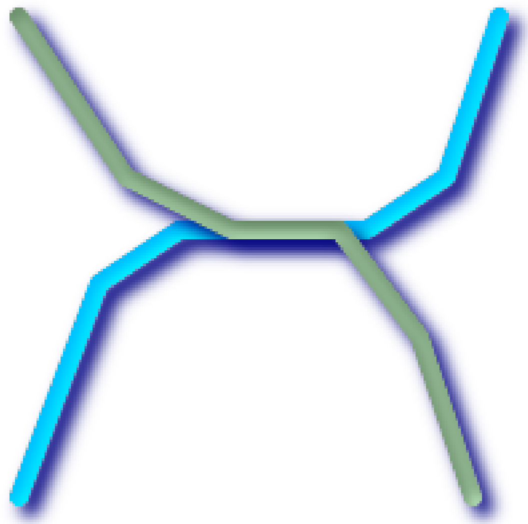
If you encounter any strange error messages such as "GEOS Intersection() threw an error!" or "JTS Intersection() threw an error!" when calling PostGIS functions with valid input geometries, you likely found an error in either PostGIS or one of the libraries it uses, and you should contact the PostGIS developers. The same is true if a PostGIS function returns an invalid geometry for valid input.

Note

Strictly compliant OGC geometries cannot have Z or M values. The ST_IsValid() function won't consider higher dimensioned geometries invalid! Invocations of AddGeometryColumn() will add a constraint checking geometry dimensions, so it is enough to specify 2 there.

4.3.6 Dimensionally Extended 9 Intersection Model (DE-9IM)

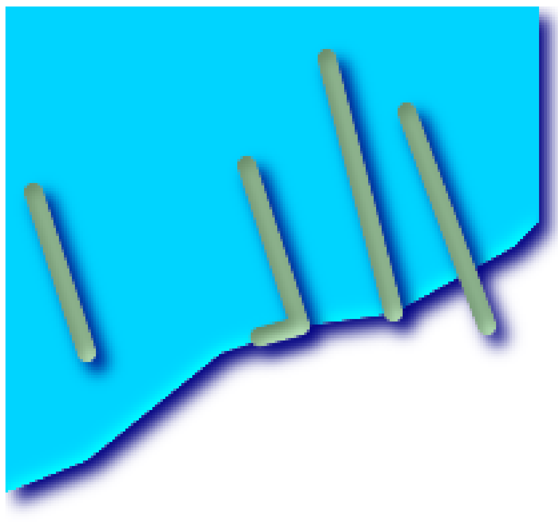
It is sometimes the case that the typical spatial predicates (ST_Contains, ST_Crosses, ST_Intersects, ST_Touches, ...) are insufficient in and of themselves to adequately provide that desired spatial filter.



For example, consider a linear dataset representing a road network. It may be the task of a GIS analyst to identify all road segments that cross each other, not at a point, but on a line, perhaps invalidating some business rule. In this case, ST_Crosses does not adequately provide the necessary spatial filter since, for linear features, it returns `true` only where they cross at a point.

One two-step solution might be to first perform the actual intersection (ST_Intersection) of pairs of road segments that spatially intersect (ST_Intersects), and then compare the intersection's ST_GeometryType with 'LINESTRING' (properly dealing with cases that return GEOMETRYCOLLECTIONs of [MULTI]POINTs, [MULTI]LINESTRINGs, etc.).

A more elegant / faster solution may indeed be desirable.



A second [theoretical] example may be that of a GIS analyst trying to locate all wharfs or docks that intersect a lake's boundary on a line and where only one end of the wharf is up on shore. In other words, where a wharf is within, but not completely within a lake, intersecting the boundary of a lake on a line, and where the wharf's endpoints are both completely within and on the boundary of the lake. The analyst may need to use a combination of spatial predicates to isolate the sought after 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

  ... (needless to say, this could get quite complicated)

So enters the Dimensionally Extended 9 Intersection Model, or DE-9IM for short.

4.3.6.1 Theory

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."

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` are the two endpoints. For `POLYGON`s, the boundary is the linework that make up the exterior and interior rings.

Interior

The interior of a geometry are those points of a geometry that are left when the boundary is removed. For `POINT`s, the interior is the `POINT` itself. The interior of a `LINESTRING` are the set of real points between the endpoints. For `POLYGON`s, the interior is the areal surface inside the polygon.

Exterior

The exterior of a geometry is the universe, an areal surface, not on the interior or boundary of the geometry.

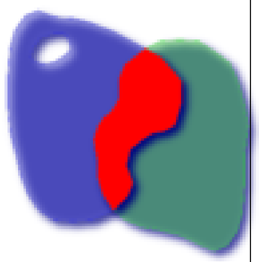
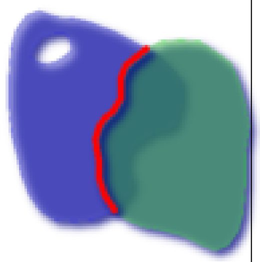
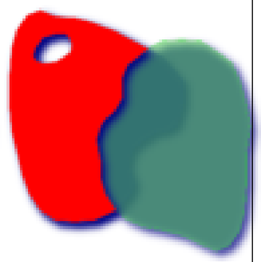
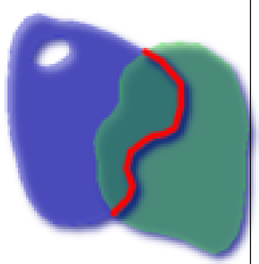
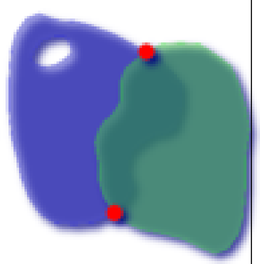
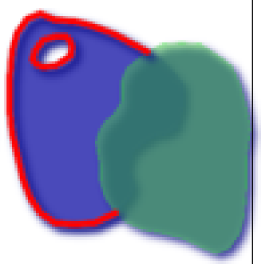
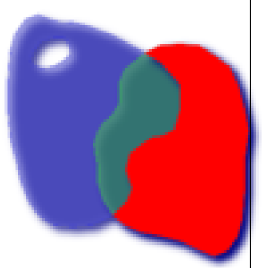
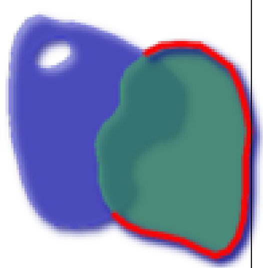
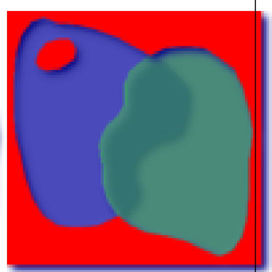
Given geometry *a*, where the *I(a)*, *B(a)*, and *E(a)* are the *Interior*, *Boundary*, and *Exterior* of a, the mathematical representation of the matrix is:

	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))*

Where *dim(a)* is the dimension of *a* as specified by ST_Dimension but has the domain of `{0,1,2,T,F,*}`

- `0` => point
- `1` => line
- `2` => area
- `T` => `{0,1,2}`
- `F` => empty set
- `*` => don't care

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

	Interior	Boundary	Exterior
Interior	 *dim(...)* = **2**	 *dim(...)* = **1**	 *dim(...)* = **2**
Boundary	 *dim(...)* = **1**	 *dim(...)* = **0**	 *dim(...)* = **1**
Exterior	 *dim(...)* = **2**	 *dim(...)* = **1**	 *dim(...)* = **2**

Read from left to right and from top to bottom, the dimensional matrix is represented, '**212101212**'.

A relate matrix that would therefore represent our first example of two lines that intersect on a line would be: '**1*1***1****'

```
-- Identify road segments that cross on 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**');
```

A relate matrix that represents the second example of wharfs partly on the lake's shoreline would be '**102101FF2**'

```
-- Identify wharfs 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');
```

For more information or reading, see:

- OpenGIS Simple Features Implementation Specification for SQL (version 1.1, section 2.1.13.2)
- Dimensionally Extended Nine-Intersection Model (DE-9IM) by Christian Strobl
- GeoTools: Point Set Theory and the DE-9IM Matrix
- *Encyclopedia of GIS* By Hui Xiong

4.4 Loading GIS (Vector) Data

Once you have created a spatial table, you are ready to upload GIS data to the database. Currently, there are two ways to get data into a PostGIS/PostgreSQL database: using formatted SQL statements or using the Shape file loader/dumper.

4.4.1 Loading Data Using SQL

If you can convert your data to a text representation, then using formatted SQL might be the easiest way to get your data into PostGIS. As with Oracle and other SQL databases, data can be bulk loaded by piping a large text file full of SQL "INSERT" statements into the SQL terminal monitor.

A data upload file (`roads.sql` for example) might look like this:

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

The data file can be piped into PostgreSQL very easily using the "psql" SQL terminal monitor:

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

4.4.2 shp2pgsql: Using the ESRI Shapefile Loader

The `shp2pgsql` data loader converts ESRI Shape files into SQL suitable for insertion into a PostGIS/PostgreSQL database either in geometry or geography format. The loader has several operating modes distinguished by command line flags:

In addition to the shp2pgsql command-line loader, there is an `shp2pgsql-gui` graphical interface with most of the options as the command-line loader, but may be easier to use for one-off non-scripted loading or if you are new to PostGIS. It can also be configured as a plugin to PgAdminIII.

(c|a|d|p) These are mutually exclusive options:

-c Creates a new table and populates it from the shapefile. *This is the default mode.*

-a Appends data from the Shape file into the database table. Note that to use this option to load multiple files, the files must have the same attributes and same data types.

-d Drops the database table before creating a new table with the data in the Shape file.

-p Only produces the table creation SQL code, without adding any actual data. This can be used if you need to completely separate the table creation and data loading steps.

-? Display help screen.

-D Use the PostgreSQL "dump" format for the output data. This can be combined with -a, -c and -d. It is much faster to load than the default "insert" SQL format. Use this for very large data sets.

-s [<FROM_SRID%gt;:]<SRID> Creates and populates the geometry tables with the specified SRID. Optionally specifies that the input shapefile uses the given FROM_SRID, in which case the geometries will be reprojected to the target SRID. FROM_SRID cannot be specified with -D.

-k Keep identifiers' case (column, schema and attributes). Note that attributes in Shapefile are all UPPERCASE.

-i Coerce all integers to standard 32-bit integers, do not create 64-bit bigints, even if the DBF header signature appears to warrant it.

-I Create a GiST index on the geometry column.

-S Generate simple geometries instead of MULTI geometries. Will only succeed if all the geometries are actually single (I.E. a MULTIPOLYGON with a single shell, or or a MULTIPOINT with a single vertex).

-t <dimensionality> Force the output geometry to have the specified dimensionality. Use the following strings to indicate the dimensionality: 2D, 3DZ, 3DM, 4D.

If the input has fewer dimensions that specified, the output will have those dimensions filled in with zeroes. If the input has more dimensions that specified, the unwanted dimensions will be stripped.

-w Output WKT format, instead of WKB. Note that this can introduce coordinate drifts due to loss of precision.

-e Execute each statement on its own, without using a transaction. This allows loading of the majority of good data when there are some bad geometries that generate errors. Note that this cannot be used with the -D flag as the "dump" format always uses a transaction.

-W <encoding> Specify encoding of the input data (dbf file). When used, all attributes of the dbf are converted from the specified encoding to UTF8. The resulting SQL output will contain a `SET CLIENT_ENCODING to UTF8` command, so that the backend will be able to reconvert from UTF8 to whatever encoding the database is configured to use internally.

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

-n -n Only import DBF file. If your data has no corresponding shapefile, it will automatically switch to this mode and load just the dbf. So setting this flag is only needed if you have a full shapefile set, and you only want the attribute data and no geometry.

-G Use geography type instead of geometry (requires lon/lat data) in WGS84 long lat (SRID=4326)

-T <tablespace> Specify the tablespace for the new table. Indexes will still use the default tablespace unless the -X parameter is also used. The PostgreSQL documentation has a good description on when to use custom tablespaces.

-X <tablespace> Specify the tablespace for the new table's indexes. This applies to the primary key index, and the GIST spatial index if -I is also used.

An example session using the loader to create an input file and uploading it might look like this:

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

A conversion and upload can be done all in one step using UNIX pipes:

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

4.5 Retrieving GIS Data

Data can be extracted from the database using either SQL or the Shape file loader/dumper. In the section on SQL we will discuss some of the operators available to do comparisons and queries on spatial tables.

4.5.1 Using SQL to Retrieve Data

The most straightforward means of pulling data out of the database is to use a SQL select query to reduce the number of RECORDS and COLUMNS returned and dump the resulting columns into a parsable text file:

```
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)
```

However, there will be times when some kind of restriction is necessary to cut down the number of fields returned. In the case of attribute-based restrictions, just use the same SQL syntax as normal with a non-spatial table. In the case of spatial restrictions, the following operators are available/useful:

&& This operator tells whether the bounding box of one geometry intersects the bounding box of another.

ST_OrderingEquals This tests whether two geometries are geometrically identical. For example, if 'POLYGON((0 0,1 1,1 0,0 0))' is the same as 'POLYGON((0 0,1 1,1 0,0 0))' (it is).

= This operator is a little more naive, it only tests whether the bounding boxes of two geometries are the same.

Next, you can use these operators in queries. Note that when specifying geometries and boxes on the SQL command line, you must explicitly turn the string representations into geometries by using the "ST_GeomFromText()" function. The 312 is a fictitious spatial reference system that matches our data. So, for example:

```
SELECT road_id, road_name
  FROM roads
  WHERE ST_OrderingEquals(roads_geom , ST_GeomFromText('LINESTRING(191232 243118,191108  ↩
      243242)',312) ) ;
```

The above query would return the single record from the "ROADS_GEOM" table in which the geometry was equal to that value.

When using the "&&" operator, you can specify either a BOX3D as the comparison feature or a GEOMETRY. When you specify a GEOMETRY, however, its bounding box will be used for the comparison.

```
SELECT road_id, road_name
FROM roads
WHERE roads_geom && ST_GeomFromText('POLYGON((...))',312);
```

The above query will use the bounding box of the polygon for comparison purposes.

The most common spatial query will probably be a "frame-based" query, used by client software, like data browsers and web mappers, to grab a "map frame" worth of data for display. 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);
```

Note the use of the SRID 312, to specify the projection of the envelope.

4.5.2 Using the Dumper

The `pgsql2shp` table dumper connects directly to the database and converts a table (possibly defined by a query) into a shape file. The basic syntax is:

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

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

The commandline options are:

-f <filename> Write the output to a particular filename.

-h <host> The database host to connect to.

-p <port> The port to connect to on the database host.

-P <password> The password to use when connecting to the database.

-u <user> The username to use when connecting to the database.

-g <geometry column> In the case of tables with multiple geometry columns, the geometry column to use when writing the shape file.

-b Use a binary cursor. This will make the operation faster, but will not work if any NON-geometry attribute in the table lacks a cast to text.

-r Raw mode. Do not drop the `gid` field, or escape column names.

-d For backward compatibility: write a 3-dimensional shape file when dumping from old (pre-1.0.0) postgis databases (the default is to write a 2-dimensional shape file in that case). Starting from postgis-1.0.0+, dimensions are fully encoded.

-m `filename` Remap identifiers to ten character names. The content of the file is lines of two symbols separated by a single white space and no trailing or leading space: VERYLONGSYMBOL SHORTONE ANOTHERVERYLONGSYMBOL SHORTER etc.

4.6 Building Indexes

Indexes are what make using a spatial database for large data sets possible. Without indexing, any search for a feature would require a "sequential scan" of every record in the database. Indexing speeds up searching by organizing the data into a search tree which can be quickly traversed to find a particular record. PostgreSQL supports three kinds of indexes by default: B-Tree indexes, R-Tree indexes, and GiST indexes.

- B-Trees are used for data which can be sorted along one axis; for example, numbers, letters, dates. GIS data cannot be rationally sorted along one axis (which is greater, (0,0) or (0,1) or (1,0)?) so B-Tree indexing is of no use for us.
- R-Trees break up data into rectangles, and sub-rectangles, and sub-sub rectangles, etc. R-Trees are used by some spatial databases to index GIS data, but the PostgreSQL R-Tree implementation is not as robust as the GiST implementation.
- GiST (Generalized Search Trees) indexes break up data into "things to one side", "things which overlap", "things which are inside" and can be used on a wide range of data-types, including GIS data. PostGIS uses an R-Tree index implemented on top of GiST to index GIS data.

4.6.1 GiST Indexes

GiST stands for "Generalized Search Tree" and is a generic form of indexing. In addition to GIS indexing, GiST is used to speed up searches on all kinds of irregular data structures (integer arrays, spectral data, etc) which are not amenable to normal B-Tree indexing.

Once a GIS data table exceeds a few thousand rows, you will want to build an index to speed up spatial searches of the data (unless all your searches are based on attributes, in which case you'll want to build a normal index on the attribute fields).

The syntax for building a GiST index on a "geometry" column is as follows:

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

The above syntax will always build a 2D-index. To get the an n-dimensional index supported in PostGIS 2.0+ for the geometry type, you can create one using this syntax

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

Building a spatial index is a computationally intensive exercise: on tables of around 1 million rows, on a 300MHz Solaris machine, we have found building a GiST index takes about 1 hour. After building an index, it is important to force PostgreSQL to collect table statistics, which are used to optimize query plans:

```
VACUUM ANALYZE [table_name] [(column_name)];
-- This is only needed for PostgreSQL 7.4 installations and below
SELECT UPDATE_GEOMETRY_STATS([table_name], [column_name]);
```

GiST indexes have two advantages over R-Tree indexes in PostgreSQL. Firstly, GiST indexes are "null safe", meaning they can index columns which include null values. Secondly, GiST indexes support the concept of "lossiness" which is important when dealing with GIS objects larger than the PostgreSQL 8K page size. Lossiness allows PostgreSQL to store only the "important" part of an object in an index -- in the case of GIS objects, just the bounding box. GIS objects larger than 8K will cause R-Tree indexes to fail in the process of being built.

4.6.2 Using Indexes

Ordinarily, indexes invisibly speed up data access: once the index is built, the query planner transparently decides when to use index information to speed up a query plan. Unfortunately, the PostgreSQL query planner does not optimize the use of GiST indexes well, so sometimes searches which should use a spatial index instead default to a sequence scan of the whole table.

If you find your spatial indexes are not being used (or your attribute indexes, for that matter) there are a couple things you can do:

- Firstly, 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. For PostgreSQL 7.4 installations and below this is done by running **update_geometry_stats([table_name, column_name])** (compute distribution) and **VACUUM ANALYZE [table_name] [column_name]** (compute number of values). Starting with PostgreSQL 8.0 running **VACUUM ANALYZE** will do both operations. You should regularly vacuum your databases anyways -- many PostgreSQL DBAs have **VACUUM** run as an off-peak cron job on a regular basis.
- If vacuuming does not work, you can force the planner to use the index information by using the **SET ENABLE_SEQSCAN=OFF** command. You should only use this command sparingly, and only on spatially indexed queries: generally speaking, the planner knows better than you do about when to use normal B-Tree indexes. Once you have run your query, you should consider setting `ENABLE_SEQSCAN` back on, so that other queries will utilize the planner as normal.

> **Note**
> As of version 0.6, it should not be necessary to force the planner to use the index with `ENABLE_SEQSCAN`.

- If you find the planner wrong about the cost of sequential vs index scans try reducing the value of random_page_cost in postgresql.conf or using SET random_page_cost=#. Default value for the parameter is 4, try setting it to 1 or 2. Decrementing the value makes the planner more inclined of using Index scans.

4.7 Complex Queries

The *raison d'etre* of spatial database functionality is performing queries inside the database which would ordinarily require desktop GIS functionality. Using PostGIS effectively requires knowing what spatial functions are available, and ensuring that appropriate indexes are in place to provide good performance. The SRID of 312 used in these examples is purely for demonstration. You should be using a REAL SRID listed in the the spatial_ref_sys table and one that matches the projection of your data. If your data has no spatial reference system specified, you should be THINKING very thoughtfully why it doesn't and maybe it should. If your reason is because you are modeling something that doesn't have a geographic spatial reference system defined such as the internals of a molecule or a good location on Mars to transport the human race in the event of a nuclear holocaust, then simply leave out the SRID or make one up and insert it in the `spatial_ref_sys` table.

4.7.1 Taking Advantage of Indexes

When constructing a query it is important to remember that only the bounding-box-based operators such as && can take advantage of the GiST spatial index. Functions such as `ST_Distance()` cannot use the index to optimize their operation. For example, the following query would be quite slow on a large table:

```
SELECT the_geom
FROM geom_table
WHERE ST_Distance(the_geom, ST_GeomFromText('POINT(100000 200000)', 312)) < 100
```

This query is selecting 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 our specified point, ie. one `ST_Distance()` calculation for each row in the table. We can avoid this by using the && operator to reduce the number of distance calculations required:

```
SELECT the_geom
FROM geom_table
WHERE ST_DWithin(the_geom,  ST_MakeEnvelope(90900, 190900, 100100, 200100,312), 100)
```

This query selects the same geometries, but it does it in a more efficient way. Assuming there is a GiST index on the_geom, the query planner will recognize that it can use the index to reduce the number of rows before calculating the result of the `ST_distance()` function. Notice that the `ST_MakeEnvelope` geometry which is used in the && operation is a 200 unit square box centered on the original point - this is our "query box". The && operator uses the index to quickly reduce the result set down to only those geometries which have bounding boxes that overlap the "query box". Assuming that our query box is much smaller than the extents of the entire geometry table, this will drastically reduce the number of distance calculations that need to be done.

Change in Behavior

As of PostGIS 1.3.0, most of the Geometry Relationship Functions, with the notable exceptions of ST_Disjoint and ST_Relate, include implicit bounding box overlap operators.

4.7.2 Examples of Spatial SQL

The examples in this section will make use of two tables, a table of linear roads, and a table of polygonal municipality boundaries. The table definitions for the `bc_roads` table is:

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

The table definition for the `bc_municipality` table is:

```
Column     | Type              | Description
-----------+-------------------+-------------------
gid        | integer           | Unique ID
code       | integer           | Unique ID
name       | character varying | City / Town Name
the_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(the_geom))/1000 AS km_roads FROM bc_roads;

   km_roads
   ------------------
   70842.1243039643
   (1 row)
   ```

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 area):

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

   hectares
   ------------------
   32657.9103824927
   (1 row)
   ```

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

   This query brings a spatial measurement into the query condition. There are several ways of approaching this problem, but the most efficient is below:

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

   name           | hectares
   ---------------+-----------------
   TUMBLER RIDGE  | 155020.02556131
   (1 row)
   ```

   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 we could separately index for performance. By ordering the results in a descending direction, and them using the PostgreSQL "LIMIT" command we can easily pick off 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", because we are bringing together data from two tables (doing a join) but using a spatial interaction condition ("contained") as the join condition rather than the usual relational approach of joining on a common key:

```
SELECT
  m.name,
  sum(ST_Length(r.the_geom))/1000 as roads_km
FROM
  bc_roads AS r,
  bc_municipality AS m
WHERE
  ST_Contains(m.the_geom,r.the_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 our particular example table). For smaller overlays (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 actually 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.the_geom, m.the_geom) AS intersection_geom,
  ST_Length(r.the_geom) AS rd_orig_length,
  r.*
FROM
  bc_roads AS r,
  bc_municipality AS m
WHERE  m.name = 'PRINCE GEORGE' AND ST_Intersects(r.the_geom, m.the_geom);
```

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

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

kilometers
------------------
4.89151904172838
(1 row)
```

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

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

```
gid  | name         | area
-----+--------------+------------------
12   | SPALLUMCHEEN | 257374619.430216
(1 row)
```

Chapter 5

Raster Data Management, Queries, and Applications

5.1 Loading and Creating Rasters

For most use cases, you will create PostGIS rasters by loading existing raster files using the packaged `raster2pgsql` raster loader.

5.1.1 Using raster2pgsql to load rasters

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. These should be the same as those provided by your PostGIS install documented here ST_GDALDrivers if you are using the same gdal library for both.

Note
The older version of this tool was a python script. The executable has replaced the python script. If you still find the need for the Python script Examples of the python one can be found at GDAL PostGIS Raster Driver Usage. Please note that the raster2pgsql python script may not work with future versions of PostGIS raster and is no longer supported.

Note
When creating overviews of a specific factor from a set of rasters that are aligned, it is possible for the overviews to not align. Visit http://trac.osgeo.org/postgis/ticket/1764 for an example where the overviews do not align.

EXAMPLE USAGE:

```
raster2pgsql raster_options_go_here raster_file someschema.sometable > out.sql
```

-? Display help screen. Help will also display if you don't pass in any arguments.

-G Print the supported raster formats.

(c|a|d|p) These are mutually exclusive options:

-c Create new table and populate it with raster(s), *this is the default mode*

-a Append raster(s) to an existing table.

-d Drop table, create new one and populate it with raster(s)

-p Prepare mode, only create the table.

Raster processing: Applying constraints for proper registering in raster catalogs

-C Apply raster constraints -- srid, pixelsize etc. to ensure raster is properly registered in `raster_columns` view.

-x Disable setting the max extent constraint. Only applied if -C flag is also used.

-r Set the constraints (spatially unique and coverage tile) for regular blocking. Only applied if -C flag is also used.

Raster processing: Optional parameters used to manipulate input raster dataset

-s <SRID> Assign output raster with specified SRID. If not provided or is zero, raster's metadata will be checked to determine an appropriate SRID.

-b BAND Index (1-based) of band to extract from raster. For more than one band index, separate with comma (,). If unspecified, all bands of raster will be extracted.

-t TILE_SIZE Cut raster into tiles to be inserted one per table row. `TILE_SIZE` is expressed as WIDTHxHEIGHT or set to the value "auto" to allow the loader to compute an appropriate tile size using the first raster and applied to all rasters.

-R, --register Register the raster as a filesystem (out-db) raster.
Only the metadata of the raster and path location to the raster is stored in the database (not the pixels).

-l `OVERVIEW_FACTOR` Create overview of the raster. For more than one factor, separate with comma(,). Overview table name follows the pattern o_`overview factor_table`, where `overview factor` is a placeholder for numerical overview factor and `table` is replaced with the base table name. Created overview is stored in the database and is not affected by -R. Note that your generated sql file will contain both the main table and overview tables.

-N `NODATA` NODATA value to use on bands without a NODATA value.

Optional parameters used to manipulate database objects

-q Wrap PostgreSQL identifiers in quotes

-f COLUMN Specify name of destination raster column, default is 'rast'

-F Add a column with the name of the file

-I Create a GiST index on the raster column.

-M Vacuum analyze the raster table.

-T `tablespace` Specify the tablespace for the new table. Note that indices (including the primary key) will still use the default tablespace unless the -X flag is also used.

-X `tablespace` Specify the tablespace for the table's new index. This applies to the primary key and the spatial index if the -I flag is used.

-Y Use copy statements instead of insert statements.

-e Execute each statement individually, do not use a transaction.

-E ENDIAN Control endianness of generated binary output of raster; specify 0 for XDR and 1 for NDR (default); only NDR output is supported now

-V `version` Specify version of output format. Default is 0. Only 0 is supported at this time.

An example session using the loader to create an input file and uploading it chunked in 100x100 tiles might look like this:

> **Note**
> You can leave the schema name out e.g `demelevation` instead of `public.demelevation` and the raster table will be created in the default schema of the database or user

```
raster2pgsql -s 4236 -I -C -M *.tif -F -t 100x100 public.demelevation > elev.sql
psql -d gisdb -f elev.sql
```

A conversion and upload can be done all in one step using UNIX pipes:

```
raster2pgsql -s 4236 -I -C -M *.tif -F -t 100x100 public.demelevation | psql -d gisdb
```

Load rasters Massachusetts state plane meters aerial tiles into a schema called `aerial` and create a full view, 2 and 4 level overview tables, use copy mode for inserting (no intermediary file just straight to db), and -e don't force everything in a transaction (good if you want to see data in tables right away without waiting). Break up the rasters into 128x128 pixel tiles and apply raster constraints. Use copy mode instead of table insert. (-F) Include a field called filename to hold the name of the file the tiles were cut from.

```
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
```

The -G commands outputs a list something like

```
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
  JAXA PALSAR Product Reader (Level 1.1/1.5)
  Ground-based SAR Applications Testbed File Format (.gff)
  ELAS
  Arc/Info Binary Grid
  Arc/Info ASCII Grid
  GRASS ASCII Grid
  SDTS Raster
  DTED Elevation Raster
  Portable Network Graphics
  JPEG JFIF
  In Memory Raster
  Japanese DEM (.mem)
  Graphics Interchange Format (.gif)
  Graphics Interchange Format (.gif)
  Envisat Image Format
  Maptech BSB Nautical Charts
  X11 PixMap Format
  MS Windows Device Independent Bitmap
  SPOT DIMAP
  AirSAR Polarimetric Image
  RadarSat 2 XML Product
  PCIDSK Database File
  PCRaster Raster File
  ILWIS Raster Map
  SGI Image File Format 1.0
  SRTMHGT File Format
  Leveller heightfield
  Terragen heightfield
  USGS Astrogeology ISIS cube (Version 3)
  USGS Astrogeology ISIS cube (Version 2)
```

```
NASA Planetary Data System
EarthWatch .TIL
ERMapper .ers Labelled
NOAA Polar Orbiter Level 1b Data Set
FIT Image
GRIdded Binary (.grb)
Raster Matrix Format
EUMETSAT Archive native (.nat)
Idrisi Raster A.1
Intergraph Raster
Golden Software ASCII Grid (.grd)
Golden Software Binary Grid (.grd)
Golden Software 7 Binary Grid (.grd)
COSAR Annotated Binary Matrix (TerraSAR-X)
TerraSAR-X Product
DRDC COASP SAR Processor Raster
R Object Data Store
Portable Pixmap Format (netpbm)
USGS DOQ (Old Style)
USGS DOQ (New Style)
ENVI .hdr Labelled
ESRI .hdr Labelled
Generic Binary (.hdr Labelled)
PCI .aux Labelled
Vexcel MFF Raster
Vexcel MFF2 (HKV) Raster
Fuji BAS Scanner Image
GSC Geogrid
EOSAT FAST Format
VTP .bt (Binary Terrain) 1.3 Format
Erdas .LAN/.GIS
Convair PolGASP
Image Data and Analysis
NLAPS Data Format
Erdas Imagine Raw
DIPEx
FARSITE v.4 Landscape File (.lcp)
NOAA Vertical Datum .GTX
NADCON .los/.las Datum Grid Shift
NTv2 Datum Grid Shift
ACE2
Snow Data Assimilation System
Swedish Grid RIK (.rik)
USGS Optional ASCII DEM (and CDED)
GeoSoft Grid Exchange Format
Northwood Numeric Grid Format .grd/.tab
Northwood Classified Grid Format .grc/.tab
ARC Digitized Raster Graphics
Standard Raster Product (ASRP/USRP)
Magellan topo (.blx)
SAGA GIS Binary Grid (.sdat)
Kml Super Overlay
ASCII Gridded XYZ
HF2/HFZ heightfield raster
OziExplorer Image File
USGS LULC Composite Theme Grid
Arc/Info Export E00 GRID
ZMap Plus Grid
NOAA NGS Geoid Height Grids
```

5.1.2 Creating rasters using PostGIS raster functions

On many occasions, you'll want to create rasters and raster tables right in the database. There are a plethora of functions to do that. The general steps to follow.

1. Create a table with a raster column to hold the new raster records which can be accomplished with:

```
CREATE TABLE myrasters(rid serial primary key, rast raster);
```

2. There are many functions to help with that goal. If you are creating rasters not as a derivative of other rasters, you will want to start with: ST_MakeEmptyRaster, followed by ST_AddBand

   You can also create rasters from geometries. To achieve that you'll want to use ST_AsRaster perhaps accompanied with other functions such as ST_Union or ST_MapAlgebraFct or any of the family of other map algebra functions.

   There are even many more options for creating new raster tables from existing tables. For example you can create a raster table in a different projection from an existing one using ST_Transform

3. Once you are done populating your table initially, you'll want to create a spatial index on the raster column with something like:

```
CREATE INDEX myrasters_rast_st_convexhull_idx ON myrasters USING gist( ST_ConvexHull( ↩
    rast) );
```

   Note the use of ST_ConvexHull since most raster operators are based on the convex hull of the rasters.

> **Note**
> Pre-2.0 versions of PostGIS raster were based on the envelope rather than the convex hull. For the spatial indexes to work properly you'll need to drop those and replace with convex hull based index.

4. Apply raster constraints using AddRasterConstraints

5.2 Raster Catalogs

There are two raster catalog views that come packaged with PostGIS. Both views utilize information embedded in the constraints of the raster tables. As a result the catalog views are always consistent with the raster data in the tables since the constraints are enforced.

1. `raster_columns` this view catalogs all the raster table columns in your database.
2. `raster_overviews` this view catalogs all the raster table columns in your database that serve as overviews for a finer grained table. Tables of this type are generated when you use the `-l` switch during load.

5.2.1 Raster Columns Catalog

The `raster_columns` is a catalog of all raster table columns in your database that are of type raster. It is a view utilizing the constraints on the tables so the information is always consistent even if you restore one raster table from a backup of another database. The following columns exist in the `raster_columns` catalog.

If you created your tables not with the loader or forgot to specify the `-C` flag during load, you can enforce the constraints after the fact using AddRasterConstraints so that the `raster_columns` catalog registers the common information about your raster tiles.

- `r_table_catalog` The database the table is in. This will always read the current database.
- `r_table_schema` The database schema the raster table belongs to.

- r_table_name raster table
- r_raster_column the column in the r_table_name table that is of type raster. There is nothing in PostGIS preventing you from having multiple raster columns per table so its possible to have a raster table listed multiple times with a different raster column for each.
- srid The spatial reference identifier of the raster. Should be an entry in the Section 4.3.1.
- scale_x The scaling between geometric spatial coordinates and pixel. This is only available if all tiles in the raster column have the same scale_x and this constraint is applied. Refer to ST_ScaleX for more details.
- scale_y The scaling between geometric spatial coordinates and pixel. This is only available if all tiles in the raster column have the same scale_y and the scale_y constraint is applied. Refer to ST_ScaleY for more details.
- blocksize_x The width (number of pixels across) of each raster tile . Refer to ST_Width for more details.
- blocksize_y The width (number of pixels down) of each raster tile . Refer to ST_Height for more details.
- same_alignment A boolean that is true if all the raster tiles have the same alignment . Refer to ST_SameAlignment for more details.
- regular_blocking If the raster column has the spatially unique and coverage tile constraints, the value with be TRUE. Otherwise, it will be FALSE.
- num_bands The number of bands in each tile of your raster set. This is the same information as what is provided by ST_NumBands
- pixel_types An array defining the pixel type for each band. You will have the same number of elements in this array as you have number of bands. The pixel_types are one of the following defined in ST_BandPixelType.
- nodata_values An array of double precision numbers denoting the nodata_value for each band. You will have the same number of elements in this array as you have number of bands. These numbers define the pixel value for each band that should be ignored for most operations. This is similar information provided by ST_BandNoDataValue.
- extent This is the extent of all the raster rows in your raster set. If you plan to load more data that will change the extent of the set, you'll want to run the DropRasterConstraints function before load and then reapply constraints with AddRasterConstraints after load.

5.2.2 Raster Overviews

raster_overviews catalogs information about raster table columns used for overviews and additional information about them that is useful to know when utilizing overviews. Overview tables are cataloged in both raster_columns and raster_overviews because they are rasters in their own right but also serve an additional special purpose of being a lower resolution caricature of a higher resolution table. These are generated along-side the main raster table when you use the -l switch in raster loading or can be generated manually using AddOverviewConstraints.

Overview tables contain the same constraints as other raster tables as well as additional informational only constraints specific to overviews.

Note

The information in raster_overviews does not duplicate the information in raster_columns. If you need the information about an overview table present in raster_columns you can join the raster_overviews and raster_columns together to get the full set of information you need.

Two main reasons for overviews are:

1. Low resolution representation of the core tables commonly used for fast mapping zoom-out.

2. Computations are generally faster to do on them than their higher resolution parents because there are fewer records and each pixel covers more territory. Though the computations are not as accurate as the high-res tables they support, they can be sufficient in many rule-of-thumb computations.

The `raster_overviews` catalog contains the following columns of information.

- `o_table_catalog` The database the overview table is in. This will always read the current database.
- `o_table_schema` The database schema the overview raster table belongs to.
- `o_table_name` raster overview table name
- `o_raster_column` the raster column in the overview table.
- `r_table_catalog` The database the raster table that this overview services is in. This will always read the current database.
- `r_table_schema` The database schema the raster table that this overview services belongs to.
- `r_table_name` raster table that this overview services.
- `r_raster_column` the raster column that this overview column services.
- `overview_factor` - this is the pyramid level of the overview table. The higher the number the lower the resolution of the table. raster2pgsql if given a folder of images, will compute overview of each image file and load separately. Level 1 is assumed and always the original file. Level 2 is will have each tile represent 4 of the original. So for example if you have a folder of 5000x5000 pixel image files that you chose to chunk 125x125, for each image file your base table will have (5000*5000)/(125*125) records = 1600, your (l=2) `o_2` table will have ceiling(1600/Power(2,2)) = 400 rows, your (l=3) `o_3` will have ceiling(1600/Power(2,3)) = 200 rows. If your pixels aren't divisible by the size of your tiles, you'll get some scrap tiles (tiles not completely filled). Note that each overview tile generated by raster2pgsql has the same number of pixels as its parent, but is of a lower resolution where each pixel of it represents (Power(2,overview_factor) pixels of the original).

5.3 Building Custom Applications with PostGIS Raster

The fact that PostGIS raster provides you with SQL functions to render rasters in known image formats gives you a lot of optoins 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.

5.3.1 PHP Example Outputting using ST_AsPNG in concert with other raster functions

In this section, we'll demonstrate how to use the PHP PostgreSQL driver and the ST_AsGDALRaster family of functions to output band 1,2,3 of a raster to a PHP request stream that can then be embedded in an img src html tag.

The sample query demonstrates how to combine a whole bunch of raster functions together to grab all tiles that intersect a particular wgs 84 bounding box and then unions with ST_Union the intersecting tiles together returning all bands, transforms to user specified projection using ST_Transform, and then outputs the results as a png using ST_AsPNG.

You would call the below using

```
http://mywebserver/test_raster.php?srid=2249
```

to get the raster image in Massachusetts state plane feet.

```
<?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'] ) && 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]);
?>
```

5.3.2 ASP.NET C# Example Outputting using ST_AsPNG in concert with other raster functions

In this section, we'll demonstrate how to use Npgsql PostgreSQL .NET driver and the ST_AsGDALRaster family of functions to output band 1,2,3 of a raster to a PHP request stream that can then be embedded in an img src html tag.

You will need the npgsql .NET PostgreSQL driver for this exercise which you can get the latest of from http://npgsql.projects.postgresql.o . Just download the latest and drop into your ASP.NET bin folder and you'll be good to go.

The sample query demonstrates how to combine a whole bunch of raster functions together to grab all tiles that intersect a particular wgs 84 bounding box and then unions with ST_Union the intersecting tiles together returning all bands, transforms to user specified projection using ST_Transform, and then outputs the results as a png using ST_AsPNG.

This is same example as Section 5.3.1 except implemented in C#.

You would call the below using

```
http://mywebserver/TestRaster.ashx?srid=2249
```

to get the raster image in Massachusetts state plane feet.

```
 -- 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;
  }
}
```

5.3.3 Java console app that outputs raster query as Image file

This is a simple java console app that takes a query that returns one image and outputs to specified file.

You can download the latest PostgreSQL JDBC drivers from http://jdbc.postgresql.org/download.html

You can compile the following code using a command something like:

```
set env CLASSPATH .:..\postgresql-9.0-801.jdbc4.jar
```

```
javac SaveQueryImage.java
jar cfm SaveQueryImage.jar Manifest.txt *.class
```

And call it from the command-line with something like

```
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);
      }
  }
}
```

5.3.4 Use PLPython to dump out images via SQL

This is a plpython stored function that creates a file in the server directory for each record. plpython postgresql stored proc. Requires you have plpython installed. Should work fine with both plpythonu and plpython3u.

```
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
```

5.3.5 Outputting Rasters with PSQL

Sadly PSQL doesn't have easy to use built-in functionality for outputting binaries. This is a bit of a hack and based on one of the suggestions outlined in Clever Trick Challenge -- Outputting bytea with psql that piggy backs on PostgreSQL somewhat legacy large object support. To use first launch your psql commandline connected to your database.

Unlike the python approach, this approach creates the file on your local computer.

```
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 6

Using PostGIS Geometry: Building Applications

6.1 Using MapServer

The Minnesota MapServer is an internet web-mapping server which conforms to the OpenGIS Web Mapping Server specification.

- The MapServer homepage is at http://mapserver.org.
- The OpenGIS Web Map Specification is at http://www.opengeospatial.org/standards/wms.

6.1.1 Basic Usage

To use PostGIS with MapServer, you will need to know about how to configure MapServer, which is beyond the scope of this documentation. This section will cover specific PostGIS issues and configuration details.

To use PostGIS with MapServer, you will need:

- Version 0.6 or newer of PostGIS.
- Version 3.5 or newer of MapServer.

MapServer accesses PostGIS/PostgreSQL data like any other PostgreSQL client -- using the `libpq` interface. This means that MapServer can be installed on any machine with network access to the PostGIS server, and use PostGIS as a source of data. The faster the connection between the systems, the better.

1. Compile and install MapServer, with whatever options you desire, including the "--with-postgis" configuration option.
2. In your MapServer map file, add a PostGIS layer. For example:

```
LAYER
  CONNECTIONTYPE postgis
  NAME "widehighways"
  # Connect to a remote spatial database
  CONNECTION "user=dbuser dbname=gisdatabase host=bigserver"
  PROCESSING "CLOSE_CONNECTION=DEFER"
  # Get the lines from the 'geom' column of the 'roads' table
  DATA "geom from roads using srid=4326 using unique gid"
  STATUS ON
  TYPE LINE
  # Of the lines in the extents, only render the wide highways
  FILTER "type = 'highway' and numlanes >= 4"
  CLASS
    # Make the superhighways brighter and 2 pixels wide
```

```
    EXPRESSION ([numlanes] >= 6)
    STYLE
      COLOR 255 22 22
      WIDTH 2
    END
  END
  CLASS
    # All the rest are darker and only 1 pixel wide
    EXPRESSION ([numlanes] < 6)
    STYLE
      COLOR 205 92 82
    END
  END
END
```

In the example above, the PostGIS-specific directives are as follows:

CONNECTIONTYPE For PostGIS layers, this is always "postgis".

CONNECTION The database connection is governed by the a 'connection string' which is a standard set of keys and values like this (with the default values in <>):

user=<username> password=<password> dbname=<username> hostname=<server> port=<5432>

An empty connection string is still valid, and any of the key/value pairs can be omitted. At a minimum you will generally supply the database name and username to connect with.

DATA The form of this parameter is "<geocolumn> from <tablename> using srid=<srid> using unique <primary key>" where the column is the spatial column to be rendered to the map, the SRID is SRID used by the column and the primary key is the table primary key (or any other uniquely-valued column with an index).

You can omit the "using srid" and "using unique" clauses and MapServer will automatically determine the correct values if possible, but at the cost of running a few extra queries on the server for each map draw.

PROCESSING Putting in a CLOSE_CONNECTION=DEFER if you have multiple layers reuses existing connections instead of closing them. This improves speed. Refer to for MapServer PostGIS Performance Tips for a more detailed explanation.

FILTER The filter must be a valid SQL string corresponding to the logic normally following the "WHERE" keyword in a SQL query. So, for example, to render only roads with 6 or more lanes, use a filter of "num_lanes >= 6".

3. In your spatial database, ensure you have spatial (GiST) indexes built for any the layers you will be drawing.

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

4. If you will be querying your layers using MapServer you will also need to use the "using unique" clause in your DATA statement.

   MapServer requires unique identifiers for each spatial record when doing queries, and the PostGIS module of MapServer uses the unique value you specify in order to provide these unique identifiers. Using the table primary key is the best practice.

6.1.2 Frequently Asked Questions

1. *When I use an `EXPRESSION` in my map file, the condition never returns as true, even though I know the values exist in my table.*

   Unlike shape files, PostGIS field names have to be referenced in EXPRESSIONS using *lower case*.

```
EXPRESSION ([numlanes] >= 6)
```

2. *The FILTER I use for my Shape files is not working for my PostGIS table of the same data.*

   Unlike shape files, filters for PostGIS layers use SQL syntax (they are appended to the SQL statement the PostGIS connector generates for drawing layers in MapServer).

```
FILTER "type = 'highway' and numlanes >= 4"
```

3. *My PostGIS layer draws much slower than my Shape file layer, is this normal?*

   In general, the more features you are drawing into a given map, the more likely it is that PostGIS will be slower than Shape files. For maps with relatively few features (100s), PostGIS will often be faster. For maps with high feature density (1000s), PostGIS will always be slower. If you are finding substantial draw performance problems, it is possible that you have not built a spatial index on your table.

   ```
   postgis# CREATE INDEX geotable_gix ON geotable USING GIST ( geocolumn );
   postgis# VACUUM ANALYZE;
   ```

4. *My PostGIS layer draws fine, but queries are really slow. What is wrong?*

   For queries to be fast, you must have a unique key for your spatial table and you must have an index on that unique key.You can specify what unique key for mapserver to use with the `USING UNIQUE` clause in your `DATA` line:

   ```
   DATA "geom FROM geotable USING UNIQUE gid"
   ```

5. *Can I use "geography" columns (new in PostGIS 1.5) as a source for MapServer layers?*

   Yes! MapServer understands geography columns as being the same as geometry columns, but always using an SRID of 4326. Just make sure to include a "using srid=4326" clause in your `DATA` statement. Everything else works exactly the same as with geometry.

   ```
   DATA "geog FROM geogtable USING SRID=4326 USING UNIQUE gid"
   ```

6.1.3 Advanced Usage

The `USING` pseudo-SQL clause is used to add some information to help mapserver understand the results of more complex queries. More specifically, when either a view or a subselect is used as the source table (the thing to the right of "FROM" in a `DATA` definition) it is more difficult for mapserver to automatically determine a unique identifier for each row and also the SRID for the table. The `USING` clause can provide mapserver with these two pieces of information as follows:

```
DATA "geom FROM (
  SELECT
    table1.geom AS geom,
    table1.gid AS gid,
    table2.data AS data
  FROM table1
  LEFT JOIN table2
  ON table1.id = table2.id
) AS new_table USING UNIQUE gid USING SRID=4326"
```

USING UNIQUE <uniqueid> MapServer requires a unique id for each row in order to identify the row when doing map queries. Normally it identifies the primary key from the system tables. However, views and subselects don't automatically have an known unique column. If you want to use MapServer's query functionality, you need to ensure your view or subselect includes a uniquely valued column, and declare it with `USING UNIQUE`. For example, you could explicitly select nee of the table's primary key values for this purpose, or any other column which is guaranteed to be unique for the result set.

> **Note**
> "Querying a Map" is the action of clicking on a map to ask for information about the map features in that location. Don't confuse "map queries" with the SQL query in a `DATA` definition.

USING SRID=<srid> PostGIS needs to know which spatial referencing system is being used by the geometries in order to return the correct data back to MapServer. Normally it is possible to find this information in the "geometry_columns" table in the PostGIS database, however, this is not possible for tables which are created on the fly such as subselects and views. So the `USING SRID=` option allows the correct SRID to be specified in the `DATA` definition.

6.1.4 Examples

Lets start with a simple example and work our way up. Consider the following MapServer layer definition:

```
LAYER
  CONNECTIONTYPE postgis
  NAME "roads"
  CONNECTION "user=theuser password=thepass dbname=thedb host=theserver"
  DATA "geom from roads"
  STATUS ON
  TYPE LINE
  CLASS
    STYLE
      COLOR 0 0 0
    END
  END
END
```

This layer will display all the road geometries in the roads table as black lines.

Now lets say we want to show only the highways until we get zoomed in to at least a 1:100000 scale - the next two layers will achieve this effect:

```
LAYER
  CONNECTIONTYPE postgis
  CONNECTION "user=theuser password=thepass dbname=thedb host=theserver"
  PROCESSING "CLOSE_CONNECTION=DEFER"
  DATA "geom from roads"
  MINSCALE 100000
  STATUS ON
  TYPE LINE
  FILTER "road_type = 'highway'"
  CLASS
    COLOR 0 0 0
  END
END
LAYER
  CONNECTIONTYPE postgis
  CONNECTION "user=theuser password=thepass dbname=thedb host=theserver"
  PROCESSING "CLOSE_CONNECTION=DEFER"
  DATA "geom from roads"
  MAXSCALE 100000
  STATUS ON
  TYPE LINE
  CLASSITEM road_type
  CLASS
    EXPRESSION "highway"
    STYLE
      WIDTH 2
      COLOR 255 0 0
    END
  END
  CLASS
    STYLE
      COLOR 0 0 0
    END
  END
END
```

The first layer is used when the scale is greater than 1:100000, and displays only the roads of type "highway" as black lines. The `FILTER` option causes only roads of type "highway" to be displayed.

The second layer is used when the scale is less than 1:100000, and will display highways as double-thick red lines, and other roads as regular black lines.

So, we have done a couple of interesting things using only MapServer functionality, but our `DATA` SQL statement has remained simple. Suppose that the name of the road is stored in another table (for whatever reason) and we need to do a join to get it and label our roads.

```
LAYER
  CONNECTIONTYPE postgis
  CONNECTION "user=theuser password=thepass dbname=thedb host=theserver"
  DATA "geom FROM (SELECT roads.gid AS gid, roads.geom AS geom,
        road_names.name as name FROM roads LEFT JOIN road_names ON
        roads.road_name_id = road_names.road_name_id)
        AS named_roads USING UNIQUE gid USING SRID=4326"
  MAXSCALE 20000
  STATUS ON
  TYPE ANNOTATION
  LABELITEM name
  CLASS
    LABEL
      ANGLE auto
      SIZE 8
      COLOR 0 192 0
      TYPE truetype
      FONT arial
    END
  END
END
```

This annotation layer adds green labels to all the roads when the scale gets down to 1:20000 or less. It also demonstrates how to use an SQL join in a `DATA` definition.

6.2 Java Clients (JDBC)

Java clients can access PostGIS "geometry" objects in the PostgreSQL database either directly as text representations or using the JDBC extension objects bundled with PostGIS. In order to use the extension objects, the "postgis.jar" file must be in your CLASSPATH along with the "postgresql.jar" JDBC driver package.

```
import java.sql.*;
import java.util.*;
import java.lang.*;
import org.postgis.*;

public class JavaGIS {

public static void main(String[] args) {

  java.sql.Connection conn;

  try {
    /*
    * Load the JDBC driver and establish a connection.
    */
    Class.forName("org.postgresql.Driver");
    String url = "jdbc:postgresql://localhost:5432/database";
    conn = DriverManager.getConnection(url, "postgres", "");
    /*
    * Add the geometry types to the connection. Note that you
    * must cast the connection to the pgsql-specific connection
    * implementation before calling the addDataType() method.
```

```
    */
    ((org.postgresql.PGConnection)conn).addDataType("geometry",Class.forName("org.postgis. ↩
        PGgeometry"));
    ((org.postgresql.PGConnection)conn).addDataType("box3d",Class.forName("org.postgis. ↩
        PGbox3d"));
    /*
    * Create a statement and execute a select query.
    */
    Statement s = conn.createStatement();
    ResultSet r = s.executeQuery("select geom,id from geomtable");
    while( r.next() ) {
      /*
      * Retrieve the geometry as an object then cast it to the geometry type.
      * Print things out.
      */
      PGgeometry geom = (PGgeometry)r.getObject(1);
      int id = r.getInt(2);
      System.out.println("Row " + id + ":");
      System.out.println(geom.toString());
    }
    s.close();
    conn.close();
  }
catch( Exception e ) {
  e.printStackTrace();
  }
}
}
```

The "PGgeometry" object is a wrapper object which contains a specific topological geometry object (subclasses of the abstract class "Geometry") depending on the type: Point, LineString, Polygon, MultiPoint, MultiLineString, MultiPolygon.

```
PGgeometry geom = (PGgeometry)r.getObject(1);
if( geom.getType() == Geometry.POLYGON ) {
  Polygon pl = (Polygon)geom.getGeometry();
  for( int r = 0; r < pl.numRings(); r++) {
    LinearRing rng = pl.getRing(r);
    System.out.println("Ring: " + r);
    for( int p = 0; p < rng.numPoints(); p++ ) {
      Point pt = rng.getPoint(p);
      System.out.println("Point: " + p);
      System.out.println(pt.toString());
    }
  }
}
```

The JavaDoc for the extension objects provides a reference for the various data accessor functions in the geometric objects.

6.3 C Clients (libpq)

...

6.3.1 Text Cursors

...

6.3.2 Binary Cursors

...

Chapter 7

Performance tips

7.1 Small tables of large geometries

7.1.1 Problem description

Current PostgreSQL versions (including 8.0) suffer from a query optimizer weakness regarding TOAST tables. TOAST tables are a kind of "extension room" used to store large (in the sense of data size) values that do not fit into normal data pages (like long texts, images or complex geometries with lots of vertices), see the PostgreSQL Documentation for TOAST for more information).

The problem appears if you happen to have a table with rather large geometries, but not too much rows of them (like a table containing the boundaries of all European countries in high resolution). Then the table itself is small, but it uses lots of TOAST space. In our example case, the table itself had about 80 rows and used only 3 data pages, but the TOAST table used 8225 pages.

Now issue a query where you use the geometry operator && to search for a bounding box that matches only very few of those rows. Now the query optimizer sees that the table has only 3 pages and 80 rows. He estimates that a sequential scan on such a small table is much faster than using an index. And so he decides to ignore the GIST index. Usually, this estimation is correct. But in our case, the && operator has to fetch every geometry from disk to compare the bounding boxes, thus reading all TOAST pages, too.

To see whether your suffer from this bug, use the "EXPLAIN ANALYZE" postgresql command. For more information and the technical details, you can read the thread on the postgres performance mailing list: http://archives.postgresql.org/pgsql-performance/2005-02/msg00030.php

7.1.2 Workarounds

The PostgreSQL people are trying to solve this issue by making the query estimation TOAST-aware. For now, here are two workarounds:

The first workaround is to force the query planner to use the index. Send "SET enable_seqscan TO off;" to the server before issuing the query. This basically forces the query planner to avoid sequential scans whenever possible. So it uses the GIST index as usual. But this flag has to be set on every connection, and it causes the query planner to make misestimations in other cases, so you should "SET enable_seqscan TO on;" after the query.

The second workaround is to make the sequential scan as fast as the query planner thinks. This can be achieved by creating an additional column that "caches" the bbox, and matching against this. In our example, the commands are like:

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

Now change your query to use the && operator against bbox instead of geom_column, like:

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

Of course, if you change or add rows to mytable, you have to keep the bbox "in sync". The most transparent way to do this would be triggers, but you also can modify your application to keep the bbox column current or run the UPDATE query above after every modification.

7.2 CLUSTERing on geometry indices

For tables that are mostly read-only, and where a single index is used for the majority of queries, PostgreSQL offers the CLUSTER command. This command physically reorders all the data rows in the same order as the index criteria, yielding two performance advantages: First, for index range scans, the number of seeks on the data table is drastically reduced. Second, if your working set concentrates to some small intervals on the indices, you have a more efficient caching because the data rows are spread along fewer data pages. (Feel invited to read the CLUSTER command documentation from the PostgreSQL manual at this point.)

However, currently PostgreSQL does not allow clustering on PostGIS GIST indices because GIST indices simply ignores NULL values, you get an error message like:

```
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 "the_geom" NOT NULL.
```

As the HINT message tells you, one can work around this deficiency by adding a "not null" constraint to the table:

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

Of course, this will not work if you in fact need NULL values in your geometry column. Additionally, you must use the above method to add the constraint, using a CHECK constraint like "ALTER TABLE blubb ADD CHECK (geometry is not null);" will not work.

7.3 Avoiding dimension conversion

Sometimes, you happen to have 3D or 4D data in your table, but always access it using OpenGIS compliant ST_AsText() or ST_AsBinary() functions that only output 2D geometries. They do this by internally calling the ST_Force2D() function, which introduces a significant overhead for large geometries. To avoid this overhead, it may be feasible to pre-drop those additional dimensions once and forever:

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

Note that if you added your geometry column using AddGeometryColumn() there'll be a constraint on geometry dimension. To bypass it you will need to drop the constraint. Remember to update the entry in the geometry_columns table and recreate the constraint afterwards.

In case of large tables, it may be wise to divide this UPDATE into smaller portions by constraining the UPDATE to a part of the table via a WHERE clause and your primary key or another feasible criteria, and running a simple "VACUUM;" between your UPDATEs. This drastically reduces the need for temporary disk space. Additionally, if you have mixed dimension geometries, restricting the UPDATE by "WHERE dimension(the_geom)>2" skips re-writing of geometries that already are in 2D.

7.4 Tuning your configuration

These tips are taken from Kevin Neufeld's presentation "Tips for the PostGIS Power User" at the FOSS4G 2007 conference. Depending on your use of PostGIS (for example, static data and complex analysis vs frequently updated data and lots of users) these changes can provide significant speedups to your queries.

For a more tips (and better formatting), the original presentation is at http://2007.foss4g.org/presentations/view.php?abstract_id=117.

7.4.1 Startup

These settings are configured in postgresql.conf:

checkpoint_segments

- Maximum number of log file segments between automatic WAL checkpoints (each segment is normally 16MB); default is 3
- Set to at least 10 or 30 for databases with heavy write activity, or more for large database loads. Another article on the topic worth reading Greg Smith: Checkpoint and Background writer
- Possibly store the xlog on a separate disk device

constraint_exclusion

- Default: off (prior to PostgreSQL 8.4 and for PostgreSQL 8.4+ is set to partition)
- This is generally used for table partitioning. If you are running PostgreSQL versions below 8.4, set to "on" to ensure the query planner will optimize as desired. As of PostgreSQL 8.4, 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: ~32MB
- Set to about 1/3 to 3/4 of available RAM

7.4.2 Runtime

work_mem (the memory used for sort operations and complex queries)

- Default: 1MB
- 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 1200000;
```

maintenance_work_mem (used for VACUUM, CREATE INDEX, etc.)

- Default: 16MB
- Generally too low - ties up I/O, locks objects while swapping memory
- Recommend 32MB to 256MB on production servers w/lots of RAM, but depends on the # of concurrent users. If you have lots of RAM and few developers:

```
SET maintainence_work_mem TO 1200000;
```

Chapter 8

PostGIS Reference

The functions given below are the ones which a user of PostGIS is likely to need. There are other functions which are required support functions to the PostGIS objects which are not of use to a general user.

> **Note**
> PostGIS has begun a transition from the existing naming convention to an SQL-MM-centric convention. As a result, most of the functions that you know and love have been renamed using the standard spatial type (ST) prefix. Previous functions are still available, though are not listed in this document where updated functions are equivalent. The non ST_ functions not listed in this documentation are deprecated and will be removed in a future release so STOP USING THEM.

8.1 PostgreSQL PostGIS Geometry/Geography/Box Types

8.1.1 box2d

box2d — A box composed of x min, ymin, xmax, ymax. Often used to return the 2d enclosing box of a geometry.

Description

box2d is a spatial data type used to represent the enclosing box of a geometry or set of geometries. ST_Extent in earlier versions prior to PostGIS 1.4 would return a box2d.

8.1.2 box3d

box3d — A box composed of x min, ymin, zmin, xmax, ymax, zmax. Often used to return the 3d extent of a geometry or collection of geometries.

Description

box3d is a postgis spatial data type used to represent the enclosing box of a geometry or set of geometries. ST_3DExtent returns a box3d object.

Casting Behavior

This section lists the automatic as well as explicit casts allowed for this data type

Cast To	Behavior
box	automatic
box2d	automatic
geometry	automatic

8.1.3 geometry

geometry — Planar spatial data type.

Description

geometry is a fundamental postgis spatial data type used to represent a feature in the Euclidean coordinate system.

Casting Behavior

This section lists the automatic as well as explicit casts allowed for this data type

Cast To	Behavior
box	automatic
box2d	automatic
box3d	automatic
bytea	automatic
geography	automatic
text	automatic

See Also

Section 4.1

8.1.4 geometry_dump

geometry_dump — A spatial datatype with two fields - geom (holding a geometry object) and path[] (a 1-d array holding the position of the geometry within the dumped object.)

Description

geometry_dump is a compound data type consisting of a geometry object referenced by the .geom field and path[] a 1-dimensional integer array (starting at 1 e.g. path[1] to get first element) array that defines the navigation path within the dumped geometry to find this element. It is used by the ST_Dump* family of functions as an output type to explode a more complex geometry into its constituent parts and location of parts.

See Also

Section 13.5

8.1.5 geography

geography — Ellipsoidal spatial data type.

Description

geography is a spatial data type used to represent a feature in the round-earth coordinate system.

Casting Behavior

This section lists the automatic as well as explicit casts allowed for this data type

Cast To	Behavior
geometry	explicit

See Also

Section 13.3, Section 4.2

8.2 Management Functions

8.2.1 AddGeometryColumn

AddGeometryColumn — Adds a geometry column to an existing table of attributes. By default uses type modifier to define rather than constraints. Pass in false for use_typmod to get old check constraint based behavior

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);

Description

Adds a geometry column to an existing table of attributes. The `schema_name` is the name of the table schema. The `srid` must be an integer value reference to an entry in the SPATIAL_REF_SYS table. The `type` must be a string corresponding to the geometry type, eg, 'POLYGON' or 'MULTILINESTRING' . An error is thrown if the schemaname doesn't exist (or not visible in the current search_path) or the specified SRID, geometry type, or dimension is invalid.

> **Note**
> Changed: 2.0.0 This function no longer updates geometry_columns since geometry_columns is a view that reads from system catalogs. It by default also does not create constraints, but instead uses the built in type modifier behavior of PostgreSQL. So for example building a wgs84 POINT column with this function is now equivalent to: `ALTER TABLE some_table ADD COLUMN geom geometry(Point,4326);`
> Changed: 2.0.0 If you require the old behavior of constraints use the default `use_typmod`, but set it to false.

> **Note**
> Changed: 2.0.0 Views can no longer be manually registered in geometry_columns, however views built against geometry typmod tables geometries and used without wrapper functions will register themselves correctly because they inherit the typmod behavior of their parent table column. Views that use geometry functions that output other geometries will need to be cast to typmod geometries for these view geometry columns to be registered correctly in geometry_columns. Refer to Section 4.3.4.

This method implements the OpenGIS 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

Enhanced: 2.0.0 use_typmod argument introduced. Defaults to creating typmod geometry column instead of constraint-based.

Examples

```
-- 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
```

See Also

DropGeometryColumn, DropGeometryTable, Section 4.3.2, Section 4.3.4

8.2.2 DropGeometryColumn

DropGeometryColumn — Removes a geometry column from a spatial table.

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);

Description

Removes a geometry column from a spatial table. Note that schema_name will need to match the f_table_schema field of the table's row in the geometry_columns table.

This method implements the OpenGIS 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
Changed: 2.0.0 This function is provided for backward compatibility. Now that since geometry_columns is now a view against the system catalogs, you can drop a geometry column like any other table column using `ALTER TABLE`

Examples

```
      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;
```

See Also

AddGeometryColumn, DropGeometryTable, Section 4.3.2

8.2.3 DropGeometryTable

DropGeometryTable — Drops a table and all its references in 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);

Description

Drops a table and all its references in geometry_columns. Note: uses current_schema() on schema-aware pgsql installations if schema is not provided.

> **Note**
> Changed: 2.0.0 This function is provided for backward compatibility. Now that since geometry_columns is now a view against the system catalogs, you can drop a table with geometry columns like any other table using `DROP TABLE`

Examples

```
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;
```

See Also

AddGeometryColumn, DropGeometryColumn, Section 4.3.2

8.2.4 PostGIS_Full_Version

PostGIS_Full_Version — Reports full postgis version and build configuration infos.

Synopsis

text **PostGIS_Full_Version**();

Description

Reports full postgis version and build configuration infos. Also informs about synchronization between libraries and scripts suggesting upgrades as needed.

Examples

```
SELECT PostGIS_Full_Version();
                 postgis_full_version
----------------------------------------------------------------------------------
 POSTGIS="1.3.3" GEOS="3.1.0-CAPI-1.5.0" PROJ="Rel. 4.4.9, 29 Oct 2004" USE_STATS
(1 row)
```

See Also

Section 2.9, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version, PostGIS_Version

8.2.5 PostGIS_GEOS_Version

PostGIS_GEOS_Version — Returns the version number of the GEOS library.

Synopsis

text **PostGIS_GEOS_Version**();

Description

Returns the version number of the GEOS library, or `NULL` if GEOS support is not enabled.

Examples

```
SELECT PostGIS_GEOS_Version();
 postgis_geos_version
----------------------
 3.1.0-CAPI-1.5.0
(1 row)
```

See Also

PostGIS_Full_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version, PostGIS_Version

8.2.6 PostGIS_LibXML_Version

PostGIS_LibXML_Version — Returns the version number of the libxml2 library.

Synopsis

text **PostGIS_LibXML_Version**();

Description

Returns the version number of the LibXML2 library.

Availability: 1.5

Examples

```
SELECT PostGIS_LibXML_Version();
 postgis_libxml_version
----------------------
 2.7.6
(1 row)
```

See Also

PostGIS_Full_Version, PostGIS_Lib_Version, PostGIS_PROJ_Version, PostGIS_GEOS_Version, PostGIS_Version

8.2.7 PostGIS_Lib_Build_Date

PostGIS_Lib_Build_Date — Returns build date of the PostGIS library.

Synopsis

text **PostGIS_Lib_Build_Date**();

Description

Returns build date of the PostGIS library.

Examples

```
SELECT PostGIS_Lib_Build_Date();
 postgis_lib_build_date
------------------------
 2008-06-21 17:53:21
(1 row)
```

8.2.8 PostGIS_Lib_Version

PostGIS_Lib_Version — Returns the version number of the PostGIS library.

Synopsis

text **PostGIS_Lib_Version**();

Description

Returns the version number of the PostGIS library.

Examples

```
SELECT PostGIS_Lib_Version();
 postgis_lib_version
---------------------
 1.3.3
(1 row)
```

See Also

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version, PostGIS_Version

8.2.9 PostGIS_PROJ_Version

PostGIS_PROJ_Version — Returns the version number of the PROJ4 library.

Synopsis

text **PostGIS_PROJ_Version**();

Description

Returns the version number of the PROJ4 library, or `NULL` if PROJ4 support is not enabled.

Examples

```
SELECT PostGIS_PROJ_Version();
  postgis_proj_version
-------------------------
 Rel. 4.4.9, 29 Oct 2004
(1 row)
```

See Also

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_Version

8.2.10 PostGIS_Scripts_Build_Date

PostGIS_Scripts_Build_Date — Returns build date of the PostGIS scripts.

Synopsis

text **PostGIS_Scripts_Build_Date**();

Description

Returns build date of the PostGIS scripts.

Availability: 1.0.0RC1

Examples

```
SELECT PostGIS_Scripts_Build_Date();
  postgis_scripts_build_date
-------------------------
 2007-08-18 09:09:26
(1 row)
```

See Also

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_Version

8.2.11 PostGIS_Scripts_Installed

PostGIS_Scripts_Installed — Returns version of the postgis scripts installed in this database.

Synopsis

text **PostGIS_Scripts_Installed**();

Description

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

Examples

```
SELECT PostGIS_Scripts_Installed();
  postgis_scripts_installed
-------------------------
 1.5.0SVN
(1 row)
```

See Also

PostGIS_Full_Version, PostGIS_Scripts_Released, PostGIS_Version

8.2.12 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**();

Description

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

Examples

```
SELECT PostGIS_Scripts_Released();
  postgis_scripts_released
-------------------------
 1.3.4SVN
(1 row)
```

See Also

PostGIS_Full_Version, PostGIS_Scripts_Installed, PostGIS_Lib_Version

8.2.13 PostGIS_Version

PostGIS_Version — Returns PostGIS version number and compile-time options.

Synopsis

text **PostGIS_Version**();

Description

Returns PostGIS version number and compile-time options.

Examples

```
SELECT PostGIS_Version();
      postgis_version
---------------------------------------
 1.3 USE_GEOS=1 USE_PROJ=1 USE_STATS=1
(1 row)
```

See Also

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_LibXML_Version, PostGIS_PROJ_Version

8.2.14 Populate_Geometry_Columns

Populate_Geometry_Columns — Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints This ensures they will be registered correctly in `geometry_columns` view. By default will convert all geometry columns with no type modifier to ones with type modifiers. To get old behavior set `use_typmod=false`

Synopsis

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

Description

Ensures geometry columns have appropriate type modifiers or spatial constraints to ensure they are registered correctly in `geometry_columns` table.

For backwards compatibility and for spatial needs such as tble inheritance where each child table may have different geometry type, the old check constraint behavior is still supported. If you need the old behavior, you need to pass in the new optional argument as false `use_typmod=false`. When this is done geometry columns will be created with no type modifiers but will have 3 constraints defined. In particular, this means that every geometry column belonging to a table has at least three constraints:

- `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)

If a table `oid` is provided, this function tries to determine the srid, dimension, and geometry type of all geometry columns in the table, adding constraints as necessary. If successful, an appropriate row is inserted into the geometry_columns table, otherwise, the exception is caught and an error notice is raised describing the problem.

If the `oid` of a view is provided, as with a table oid, this function tries to determine the srid, dimension, and type of all the geometries in the view, inserting appropriate entries into the `geometry_columns` table, but nothing is done to enforce constraints.

The parameterless variant is a simple wrapper for the parameterized variant that first truncates and repopulates the geometry_columns table for every spatial table and view in the database, adding spatial constraints to tables where appropriate. It returns a summary of the number of geometry columns detected in the database and the number that were inserted into the `geometry_columns` table. The parameterized version simply returns the number of rows inserted into the `geometry_columns` table.

Availability: 1.4.0

Changed: 2.0.0 By default, now uses type modifiers instead of check constraints to constrain geometry types. You can still use check constraint behavior instead by using the new `use_typmod` and setting it to false.

Enhanced: 2.0.0 `use_typmod` optional argument was introduced that allows controlling if columns are created with typmodifiers or with check constraints.

Examples

```
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)
```

8.2.15 UpdateGeometrySRID

UpdateGeometrySRID — Updates the SRID of all features in a geometry column, geometry_columns metadata and srid. If it was enforced with constraints, the constraints will be updated with new srid constraint. If the old was enforced by type definition, the type definition will be changed.

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);

Description

Updates the SRID of all features in a geometry column, updating constraints and reference in geometry_columns. Note: uses current_schema() on schema-aware pgsql installations if schema is not provided.

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

This method supports Circular Strings and Curves

Examples

This will change the srid of the roads table to 4326 from whatever it was before

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

The prior example is equivalent to this DDL statement

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

If you got the projection wrong (or brought it in as unknown) in load and you wanted to transform to web mercator all in one shot You can do this with DDL but there is no equivalent PostGIS management function to do so in one go.

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

See Also

ST_SetSRID , ST_Transform

8.3 Geometry Constructors

8.3.1 ST_BdPolyFromText

ST_BdPolyFromText — Construct a Polygon given an arbitrary collection of closed linestrings as a MultiLineString Well-Known text representation.

Synopsis

geometry **ST_BdPolyFromText**(text WKT, integer srid);

Description

Construct a Polygon given an arbitrary collection of closed linestrings as a MultiLineString Well-Known text representation.

Note
Throws an error if WKT is not a MULTILINESTRING. Throws an error if output is a MULTIPOLYGON; use ST_BdMPolyFromText in that case, or see ST_BuildArea() for a postgis-specific approach.

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

Availability: 1.1.0 - requires GEOS >= 2.1.0.

Examples

```
Forthcoming
```

See Also

ST_BuildArea, ST_BdMPolyFromText

8.3.2 ST_BdMPolyFromText

ST_BdMPolyFromText — Construct a MultiPolygon given an arbitrary collection of closed linestrings as a MultiLineString text representation Well-Known text representation.

Synopsis

geometry **ST_BdMPolyFromText**(text WKT, integer srid);

Description

Construct a Polygon given an arbitrary collection of closed linestrings, polygons, MultiLineStrings as Well-Known text representation.

> **Note**
> Throws an error if WKT is not a MULTILINESTRING. Forces MULTIPOLYGON output even when result is really only composed by a single POLYGON; use ST_BdPolyFromText if you're sure a single POLYGON will result from operation, or see ST_BuildArea() for a postgis-specific approach.

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

Availability: 1.1.0 - requires GEOS >= 2.1.0.

Examples

```
Forthcoming
```

See Also

ST_BuildArea, ST_BdPolyFromText

8.3.3 ST_Box2dFromGeoHash

ST_Box2dFromGeoHash — Return a BOX2D from a GeoHash string.

Synopsis

box2d **ST_Box2dFromGeoHash**(text geohash, integer precision=full_precision_of_geohash);

Description

Return a BOX2D from a GeoHash string.

If no `precision` is specficified ST_Box2dFromGeoHash returns a BOX2D based on full precision of the input GeoHash string.

If `precision` is specified ST_Box2dFromGeoHash will use that many characters from the GeoHash to create the BOX2D. Lower precision values results in larger BOX2Ds and larger values increase the precision.

Availability: 2.1.0

Examples

```
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)
```

See Also

ST_GeoHash, ST_GeomFromGeoHash, ST_PointFromGeoHash

8.3.4 ST_GeogFromText

ST_GeogFromText — Return a specified geography value from Well-Known Text representation or extended (WKT).

Synopsis

geography **ST_GeogFromText**(text EWKT);

Description

Returns a geography object from the well-known text or extended well-known representation. SRID 4326 is assumed. This is an alias for ST_GeographyFromText. Points are always expressed in long lat form.

Examples

```
--- 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 || ')') ↩
    ;
```

See Also

ST_AsText, ST_GeographyFromText

8.3.5 ST_GeographyFromText

ST_GeographyFromText — Return a specified geography value from Well-Known Text representation or extended (WKT).

Synopsis

geography **ST_GeographyFromText**(text EWKT);

Description

Returns a geography object from the well-known text representation. SRID 4326 is assumed.

See Also

ST_GeogFromText, ST_AsText

8.3.6 ST_GeogFromWKB

ST_GeogFromWKB — Creates a geography instance from a Well-Known Binary geometry representation (WKB) or extended Well Known Binary (EWKB).

Synopsis

geography **ST_GeogFromWKB**(bytea geom);

Description

The `ST_GeogFromWKB` function, takes a well-known binary representation (WKB) of a geometry or PostGIS Extended WKB and creates an instance of the appropriate geography type. This function plays the role of the Geometry Factory in SQL.

If SRID is not specified, it defaults to 4326 (WGS 84 long lat).

✓ This method supports Circular Strings and Curves

Examples

```
--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)
```

See Also

ST_GeogFromText, ST_AsBinary

8.3.7 ST_GeomCollFromText

ST_GeomCollFromText — Makes a collection Geometry from collection WKT with the given SRID. If SRID is not give, it defaults to 0.

Synopsis

geometry **ST_GeomCollFromText**(text WKT, integer srid);
geometry **ST_GeomCollFromText**(text WKT);

Description

Makes a collection Geometry from the Well-Known-Text (WKT) representation with the given SRID. If SRID is not give, it defaults to 0.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Returns null if the WKT is not a GEOMETRYCOLLECTION

> **Note**
> If you are absolutely sure all your WKT geometries are collections, don't use this function. It is slower than ST_GeomFromText since it adds an additional validation step.

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s3.2.6.2

This method implements the SQL/MM specification.

Examples

```
SELECT ST_GeomCollFromText('GEOMETRYCOLLECTION(POINT(1 2),LINESTRING(1 2, 3 4))');
```

See Also

ST_GeomFromText, ST_SRID

8.3.8 ST_GeomFromEWKB

ST_GeomFromEWKB — Return a specified ST_Geometry value from Extended Well-Known Binary representation (EWKB).

Synopsis

geometry **ST_GeomFromEWKB**(bytea EWKB);

Description

Constructs a PostGIS ST_Geometry object from the OGC Extended Well-Known binary (EWKT) representation.

> **Note**
> The EWKB format is not an OGC standard, but a PostGIS specific format that includes the spatial reference system (SRID) identifier

Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.

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).

Examples

line string binary rep 0f LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144 42.25932) in NAD 83 long lat (4269).

Note
NOTE: Even though byte arrays are delimited with \ and may have ', we need to escape both out with \ and '' if standard_conforming_strings is off. So it does not look exactly like its AsEWKB representation.

```
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 on. 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')
```

See Also

ST_AsBinary, ST_AsEWKB, ST_GeomFromWKB

8.3.9 ST_GeomFromEWKT

ST_GeomFromEWKT — Return a specified ST_Geometry value from Extended Well-Known Text representation (EWKT).

Synopsis

geometry **ST_GeomFromEWKT**(text EWKT);

Description

Constructs a PostGIS ST_Geometry object from the OGC Extended Well-Known text (EWKT) representation.

> **Note**
> The EWKT format is not an OGC standard, but an PostGIS specific format that includes the spatial reference system (SRID) identifier

Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.

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).

Examples

```
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))
)');
```

See Also

ST_AsEWKT, ST_GeomFromText, ST_GeomFromEWKT

8.3.10 ST_GeometryFromText

ST_GeometryFromText — Return a specified ST_Geometry value from Well-Known Text representation (WKT). This is an alias name for ST_GeomFromText

Synopsis

geometry **ST_GeometryFromText**(text WKT);
geometry **ST_GeometryFromText**(text WKT, integer srid);

Description

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

This method implements the SQL/MM specification. SQL-MM 3: 5.1.40

See Also

ST_GeomFromText

8.3.11 ST_GeomFromGeoHash

ST_GeomFromGeoHash — Return a geometry from a GeoHash string.

Synopsis

geometry **ST_GeomFromGeoHash**(text geohash, integer precision=full_precision_of_geohash);

Description

Return a geometry from a GeoHash string. The geometry will be a polygon representing the GeoHash bounds.

If no `precision` is specficified ST_GeomFromGeoHash returns a polygon based on full precision of the input GeoHash string.

If `precision` is specified ST_GeomFromGeoHash will use that many characters from the GeoHash to create the polygon.

Availability: 2.1.0

Examples

```
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))
```

See Also

ST_GeoHash,ST_Box2dFromGeoHash, ST_PointFromGeoHash

8.3.12 ST_GeomFromGML

ST_GeomFromGML — Takes as input GML representation of geometry and outputs a PostGIS geometry object

Synopsis

geometry **ST_GeomFromGML**(text geomgml);
geometry **ST_GeomFromGML**(text geomgml, integer srid);

Description

Constructs a PostGIS ST_Geometry object from the OGC GML representation.

ST_GeomFromGML works only for GML Geometry fragments. It throws an error if you try to use it on a whole GML document.

OGC GML versions supported:

- GML 3.2.1 Namespace
- GML 3.1.1 Simple Features profile SF-2 (with GML 3.1.0 and 3.0.0 backward compatibility)
- GML 2.1.2

OGC GML standards, cf: http://www.opengeospatial.org/standards/gml:

Availability: 1.5, requires libxml2 1.6+

Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.

Enhanced: 2.0.0 default srid optional parameter added.

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 allow mixed dimensions (2D and 3D inside the same MultiGeometry for instance). As PostGIS geometries don't, ST_GeomFromGML convert the whole geometry to 2D if a missing Z dimension is found once.

GML support mixed SRS inside the same MultiGeometry. As PostGIS geometries don't, ST_GeomFromGML, in this case, reproject all subgeometries to the SRS root node. If no srsName attribute available for the GML root node, the function throw an error.

ST_GeomFromGML function is not pedantic about an explicit GML namespace. You could avoid to mention it explicitly for common usages. But you need it if you want to use XLink feature inside GML.

Note
ST_GeomFromGML function not support SQL/MM curves geometries.

Examples - A single geometry with srsName

```
SELECT ST_GeomFromGML('
    <gml:LineString srsName="EPSG:4269">
      <gml:coordinates>
        -71.16028,42.258729 -71.160837,42.259112 -71.161143,42.25932
      </gml:coordinates>
    </gml:LineString>');
```

Examples - XLink usage

```
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>'););
```

Examples - Polyhedral Surface

```
SELECT ST_AsEWKT(ST_GeomFromGML('
<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>'));

-- 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)))
```

See Also

Section 2.4.1, ST_AsGML, ST_GMLToSQL

8.3.13 ST_GeomFromGeoJSON

ST_GeomFromGeoJSON — Takes as input a geojson representation of a geometry and outputs a PostGIS geometry object

Synopsis

geometry **ST_GeomFromGeoJSON**(text geomjson);

Description

Constructs a PostGIS geometry object from the GeoJSON representation.

ST_GeomFromGeoJSON works only for JSON Geometry fragments. It throws an error if you try to use it on a whole JSON document.

Availability: 2.0.0 requires - JSON-C >= 0.9

> **Note**
> If you do not have JSON-C enabled, support you will get an error notice instead of seeing an output. To enable JSON-C, run configure --with-jsondir=/path/to/json-c. See Section 2.4.1 for details.

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

Examples

```
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)
```

See Also

ST_AsText, ST_AsGeoJSON, Section 2.4.1

8.3.14 ST_GeomFromKML

ST_GeomFromKML — Takes as input KML representation of geometry and outputs a PostGIS geometry object

Synopsis

geometry **ST_GeomFromKML**(text geomkml);

Description

Constructs a PostGIS ST_Geometry object from the OGC KML representation.

ST_GeomFromKML works only for KML Geometry fragments. It throws an error if you try to use it on a whole KML document.

OGC KML versions supported:

- KML 2.2.0 Namespace

OGC KML standards, cf: http://www.opengeospatial.org/standards/kml:

Availability: 1.5,libxml2 2.6+

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

Note
ST_GeomFromKML function not support SQL/MM curves geometries.

Examples - A single geometry with srsName

```
SELECT ST_GeomFromKML('
    <LineString>
      <coordinates>-71.1663,42.2614
        -71.1667,42.2616</coordinates>
    </LineString>');
```

See Also

Section 2.4.1, ST_AsKML

8.3.15 ST_GMLToSQL

ST_GMLToSQL — Return a specified ST_Geometry value from GML representation. This is an alias name for ST_GeomFromGML

Synopsis

geometry **ST_GMLToSQL**(text geomgml);
geometry **ST_GMLToSQL**(text geomgml, integer srid);

Description

This method implements the SQL/MM specification. SQL-MM 3: 5.1.50 (except for curves support).

Availability: 1.5, requires libxml2 1.6+

Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.

Enhanced: 2.0.0 default srid optional parameter added.

See Also

Section 2.4.1, ST_GeomFromGML, ST_AsGML

8.3.16 ST_GeomFromText

ST_GeomFromText — Return a specified ST_Geometry value from Well-Known Text representation (WKT).

Synopsis

geometry **ST_GeomFromText**(text WKT);
geometry **ST_GeomFromText**(text WKT, integer srid);

Description

Constructs a PostGIS ST_Geometry object from the OGC Well-Known text representation.

> **Note**
> There are 2 variants of ST_GeomFromText function, the first takes no SRID and returns a geometry with no defined spatial reference system. The second takes a spatial reference id as the second argument and returns an ST_Geometry that includes this srid as part of its meta-data. The srid must be defined in the spatial_ref_sys table.

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s3.2.6.2 - option SRID is from the conformance suite.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.40

This method supports Circular Strings and Curves

> **Warning**
> Changed: 2.0.0 In prior versions of PostGIS ST_GeomFromText('GEOMETRYCOLLECTION(EMPTY)') was allowed. This is now illegal in PostGIS 2.0.0 to better conform with SQL/MM standards. This should now be written as ST_GeomFromText('GEOMETRYCOLLECTION EMPTY')

Examples

```
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)');
```

See Also

ST_GeomFromEWKT, ST_GeomFromWKB, ST_SRID

8.3.17 ST_GeomFromWKB

ST_GeomFromWKB — Creates a geometry instance from a Well-Known Binary geometry representation (WKB) and optional SRID.

Synopsis

geometry **ST_GeomFromWKB**(bytea geom);
geometry **ST_GeomFromWKB**(bytea geom, integer srid);

Description

The `ST_GeomFromWKB` function, takes a well-known binary representation of a geometry and a Spatial Reference System ID (`SRID`) and creates an instance of the appropriate geometry type. This function plays the role of the Geometry Factory in SQL. This is an alternate name for ST_WKBToSQL.

If SRID is not specified, it defaults to 0 (Unknown).

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s3.2.7.2 - the optional SRID is from the conformance suite

This method implements the SQL/MM specification. SQL-MM 3: 5.1.41

This method supports Circular Strings and Curves

Examples

```
--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)
```

See Also

ST_WKBToSQL, ST_AsBinary, ST_GeomFromEWKB

8.3.18 ST_LineFromMultiPoint

ST_LineFromMultiPoint — Creates a LineString from a MultiPoint geometry.

Synopsis

geometry **ST_LineFromMultiPoint**(geometry aMultiPoint);

Description

Creates a LineString from a MultiPoint geometry.

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

Examples

```
--Create a 3d line string from a 3d multipoint
SELECT ST_AsEWKT(ST_LineFromMultiPoint(ST_GeomFromEWKT('MULTIPOINT(1 2 3, 4 5 6, 7 8 9)')));
--result--
LINESTRING(1 2 3,4 5 6,7 8 9)
```

See Also

ST_AsEWKT, ST_Collect, ST_MakeLine

8.3.19 ST_LineFromText

ST_LineFromText — Makes a Geometry from WKT representation with the given SRID. If SRID is not given, it defaults to 0.

Synopsis

geometry **ST_LineFromText**(text WKT);
geometry **ST_LineFromText**(text WKT, integer srid);

Description

Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to 0. If WKT passed in is not a LINESTRING, then null is returned.

> **Note**
> OGC SPEC 3.2.6.2 - option SRID is from the conformance suite.

> **Note**
> If you know all your geometries are LINESTRINGS, its more efficient to just use ST_GeomFromText. This just calls ST_GeomFromText and adds additional validation that it returns a linestring.

This method implements the OpenGIS 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

Examples

```
SELECT ST_LineFromText('LINESTRING(1 2, 3 4)') AS aline, ST_LineFromText('POINT(1 2)') AS ↩
    null_return;
aline                            | null_return
------------------------------------------------
010200000002000000000000000000F ... | t
```

See Also

ST_GeomFromText

8.3.20 ST_LineFromWKB

ST_LineFromWKB — Makes a `LINESTRING` from WKB with the given SRID

Synopsis

geometry **ST_LineFromWKB**(bytea WKB);
geometry **ST_LineFromWKB**(bytea WKB, integer srid);

Description

The `ST_LineFromWKB` function, takes a well-known binary representation of geometry and a Spatial Reference System ID (`SRID`) and creates an instance of the appropriate geometry type - in this case, a `LINESTRING` geometry. This function plays the role of the Geometry Factory in SQL.

If an SRID is not specified, it defaults to 0. `NULL` is returned if the input `bytea` does not represent a `LINESTRING`.

> **Note**
> OGC SPEC 3.2.6.2 - option SRID is from the conformance suite.

> **Note**
> If you know all your geometries are `LINESTRING`s, its more efficient to just use ST_GeomFromWKB. This function just calls ST_GeomFromWKB and adds additional validation that it returns a linestring.

This method implements the OpenGIS 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

Examples

```
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
```

See Also

ST_GeomFromWKB, ST_LinestringFromWKB

8.3.21 ST_LinestringFromWKB

ST_LinestringFromWKB — Makes a geometry from WKB with the given SRID.

Synopsis

geometry **ST_LinestringFromWKB**(bytea WKB);
geometry **ST_LinestringFromWKB**(bytea WKB, integer srid);

Description

The ST_LinestringFromWKB function, takes a well-known binary representation of geometry and a Spatial Reference System ID (SRID) and creates an instance of the appropriate geometry type - in this case, a LINESTRING geometry. This function plays the role of the Geometry Factory in SQL.

If an SRID is not specified, it defaults to 0. NULL is returned if the input bytea does not represent a LINESTRING geometry. This an alias for ST_LineFromWKB.

> **Note**
> OGC SPEC 3.2.6.2 - optional SRID is from the conformance suite.

> **Note**
> If you know all your geometries are LINESTRINGs, it's more efficient to just use ST_GeomFromWKB. This function just calls ST_GeomFromWKB and adds additional validation that it returns a LINESTRING.

This method implements the OpenGIS 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

Examples

```
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
```

See Also

ST_GeomFromWKB, ST_LineFromWKB

8.3.22 ST_MakeBox2D

ST_MakeBox2D — Creates a BOX2D defined by the given point geometries.

Synopsis

box2d **ST_MakeBox2D**(geometry pointLowLeft, geometry pointUpRight);

Description

Creates a BOX2D defined by the given point geometries. This is useful for doing range queries

Examples

```
--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, the_geom
FROM features
WHERE the_geom && ST_SetSRID(ST_MakeBox2D(ST_Point(-989502.1875, 528439.5625),
  ST_Point(-987121.375 ,529933.1875)),2163)
```

See Also

ST_MakePoint, ST_Point, ST_SetSRID, ST_SRID

8.3.23 ST_3DMakeBox

ST_3DMakeBox — Creates a BOX3D defined by the given 3d point geometries.

Synopsis

box3d **ST_3DMakeBox**(geometry point3DLowLeftBottom, geometry point3DUpRightTop);

Description

Creates a BOX3D defined by the given 2 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

Examples

```
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)
```

See Also

ST_MakePoint, ST_SetSRID, ST_SRID

8.3.24 ST_MakeLine

ST_MakeLine — Creates a Linestring from point or line geometries.

Synopsis

geometry **ST_MakeLine**(geometry set geoms);
geometry **ST_MakeLine**(geometry geom1, geometry geom2);
geometry **ST_MakeLine**(geometry[] geoms_array);

Description

ST_MakeLine comes in 3 forms: a spatial aggregate that takes rows of point-or-line geometries and returns a line string, a function that takes an array of point-or-lines, and a regular function that takes two point-or-line geometries. You might want to use a subselect to order points before feeding them to the aggregate version of this function.

When adding line components a common node is removed from the output.

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

Availability: 1.4.0 - ST_MakeLine(geomarray) was introduced. ST_MakeLine aggregate functions was enhanced to handle more points faster.

Availability: 2.0.0 - Support for linestring input elements was introduced

Examples: Spatial Aggregate version

This example takes a sequence of GPS points and creates one record for each gps travel where the geometry field is a line string composed of the gps points in the order of the travel.

```
-- For pre-PostgreSQL 9.0 - this usually works,
-- but the planner may on occasion choose not to respect the order of the subquery
SELECT gps.gps_track, ST_MakeLine(gps.the_geom) As newgeom
  FROM (SELECT gps_track,gps_time, the_geom
      FROM gps_points ORDER BY gps_track, gps_time) As gps
  GROUP BY gps.gps_track;
```

```
-- If you are using PostgreSQL 9.0+
-- (you can use the new ORDER BY support for aggregates)
-- this is a guaranteed way to get a correctly ordered linestring
-- Your order by part can order by more than one column if needed
SELECT gps.gps_track, ST_MakeLine(gps.the_geom ORDER BY gps_time) As newgeom
  FROM gps_points As gps
  GROUP BY gps.gps_track;
```

Examples: Non-Spatial Aggregate version

First example is a simple one off line string composed of 2 points. The second formulates line strings from 2 points a user draws. The third is a one-off that joins 2 3d points to create a line in 3d space.

```
SELECT ST_AsText(ST_MakeLine(ST_MakePoint(1,2), ST_MakePoint(3,4)));
    st_astext
---------------------
 LINESTRING(1 2,3 4)

SELECT userpoints.id, ST_MakeLine(startpoint, endpoint) As drawn_line
  FROM userpoints ;

SELECT ST_AsEWKT(ST_MakeLine(ST_MakePoint(1,2,3), ST_MakePoint(3,4,5)));
    st_asewkt
-------------------------
 LINESTRING(1 2 3,3 4 5)
```

Examples: Using Array version

```
SELECT ST_MakeLine(ARRAY(SELECT ST_Centroid(the_geom) FROM visit_locations ORDER BY ↩
    visit_time));

--Making a 3d line with 3 3-d 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)
```

See Also

ST_AsEWKT, ST_AsText, ST_GeomFromText, ST_MakePoint

8.3.25 ST_MakeEnvelope

ST_MakeEnvelope — Creates a rectangular Polygon formed from the given minimums and maximums. Input values must be in SRS specified by the SRID.

Synopsis

geometry **ST_MakeEnvelope**(double precision xmin, double precision ymin, double precision xmax, double precision ymax, integer srid=unknown);

Description

Creates a rectangular Polygon formed from the minima and maxima. by the given shell. Input values must be in SRS specified by the SRID. If no SRID is specified the unknown spatial reference system is assumed

Availability: 1.5

Enhanced: 2.0: Ability to specify an envelope without specifying an SRID was introduced.

Example: Building a bounding box polygon

```
SELECT ST_AsText(ST_MakeEnvelope(10, 10, 11, 11, 4326));

st_asewkt
-----------
POLYGON((10 10, 10 11, 11 11, 11 10, 10 10))
```

See Also

ST_MakePoint, ST_MakeLine, ST_MakePolygon

8.3.26 ST_MakePolygon

ST_MakePolygon — Creates a Polygon formed by the given shell. Input geometries must be closed LINESTRINGS.

Synopsis

geometry **ST_MakePolygon**(geometry linestring);

geometry **ST_MakePolygon**(geometry outerlinestring, geometry[] interiorlinestrings);

Description

Creates a Polygon formed by the given shell. Input geometries must be closed LINESTRINGS. Comes in 2 variants.

Variant 1: takes one closed linestring.

Variant 2: Creates a Polygon formed by the given shell and array of holes. You can construct a geometry array using ST_Accum or the PostgreSQL ARRAY[] and ARRAY() constructs. Input geometries must be closed LINESTRINGS.

Note
This function will not accept a MULTILINESTRING. Use ST_LineMerge or ST_Dump to generate line strings.

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

Examples: Single closed LINESTRING

```
--2d line
SELECT ST_MakePolygon(ST_GeomFromText('LINESTRING(75.15 29.53,77 29,77.6 29.5, 75.15 29.53) ↩
    '));
--If linestring is not closed
--you can add the start point to close it
SELECT ST_MakePolygon(ST_AddPoint(foo.open_line, ST_StartPoint(foo.open_line)))
FROM (
SELECT ST_GeomFromText('LINESTRING(75.15 29.53,77 29,77.6 29.5)') As open_line) As foo;

--3d closed line
SELECT ST_MakePolygon(ST_GeomFromText('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))

--measured line --
SELECT ST_MakePolygon(ST_GeomFromText('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))
```

Examples: Outter shell with inner shells

Build a donut with an ant hole

```
SELECT ST_MakePolygon(
    ST_ExteriorRing(ST_Buffer(foo.line,10)),
  ARRAY[ST_Translate(foo.line,1,1),
    ST_ExteriorRing(ST_Buffer(ST_MakePoint(20,20),1)) ]
```

```
  )
FROM
   (SELECT ST_ExteriorRing(ST_Buffer(ST_MakePoint(10,10),10,10))
     As line )
     As foo;
```

Build province boundaries with holes representing lakes in the province from a set of province polygons/multipolygons and water line strings this is an example of using PostGIS ST_Accum

> **Note**
> The use of CASE because feeding a null array into ST_MakePolygon results in NULL

> **Note**
> the use of left join to guarantee we get all provinces back even if they have no lakes

```
SELECT p.gid, p.province_name,
  CASE WHEN
    ST_Accum(w.the_geom) IS NULL THEN p.the_geom
  ELSE  ST_MakePolygon(ST_LineMerge(ST_Boundary(p.the_geom)), ST_Accum(w.the_geom)) END
FROM
  provinces p LEFT JOIN waterlines w
    ON (ST_Within(w.the_geom, p.the_geom) AND ST_IsClosed(w.the_geom))
GROUP BY p.gid, p.province_name, p.the_geom;

--Same example above but utilizing a correlated subquery
--and PostgreSQL built-in ARRAY() function that converts a row set to an array

SELECT p.gid,  p.province_name, CASE WHEN
  EXISTS(SELECT w.the_geom
    FROM waterlines w
    WHERE ST_Within(w.the_geom, p.the_geom)
    AND ST_IsClosed(w.the_geom))
  THEN
  ST_MakePolygon(ST_LineMerge(ST_Boundary(p.the_geom)),
    ARRAY(SELECT w.the_geom
      FROM waterlines w
      WHERE ST_Within(w.the_geom, p.the_geom)
      AND ST_IsClosed(w.the_geom)))
  ELSE p.the_geom END As the_geom
FROM
  provinces p;
```

See Also

ST_Accum, ST_AddPoint, ST_GeometryType, ST_IsClosed, ST_LineMerge, ST_BuildArea

8.3.27 ST_MakePoint

ST_MakePoint — Creates a 2D,3DZ or 4D point geometry.

Synopsis

geometry **ST_MakePoint**(double precision x, double precision y);

geometry **ST_MakePoint**(double precision x, double precision y, double precision z);

geometry **ST_MakePoint**(double precision x, double precision y, double precision z, double precision m);

Description

Creates a 2D,3DZ or 4D point geometry (geometry with measure). `ST_MakePoint` while not being OGC compliant is generally faster and more precise than ST_GeomFromText and ST_PointFromText. It is also easier to use if you have raw coordinates rather than WKT.

> **Note**
> Note x is longitude and y is latitude

> **Note**
> Use ST_MakePointM if you need to make a point with x,y,m.

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

Examples

```
--Return point with unknown SRID
SELECT ST_MakePoint(-71.1043443253471, 42.3150676015829);

--Return point marked as WGS 84 long lat
SELECT ST_SetSRID(ST_MakePoint(-71.1043443253471, 42.3150676015829),4326);

--Return 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
```

See Also

ST_GeomFromText, ST_PointFromText, ST_SetSRID, ST_MakePointM

8.3.28 ST_MakePointM

ST_MakePointM — Creates a point geometry with an x y and m coordinate.

Synopsis

geometry **ST_MakePointM**(float x, float y, float m);

Description

Creates a point with x, y and measure coordinates.

> **Note**
> Note x is longitude and y is latitude.

Examples

We use ST_AsEWKT in these examples to show the text representation instead of ST_AsText because ST_AsText does not support returning M.

```
--Return EWKT representation of point with unknown SRID
SELECT ST_AsEWKT(ST_MakePointM(-71.1043443253471, 42.3150676015829, 10));

--result
           st_asewkt
-----------------------------------------------
 POINTM(-71.1043443253471 42.3150676015829 10)

--Return EWKT representation of point with measure marked as WGS 84 long lat
SELECT ST_AsEWKT(ST_SetSRID(ST_MakePointM(-71.1043443253471, 42.3150676015829,10),4326));

            st_asewkt
---------------------------------------------------------
SRID=4326;POINTM(-71.1043443253471 42.3150676015829 10)

--Return a 3d point (e.g. has altitude)
SELECT ST_MakePoint(1, 2,1.5);

--Get m of point
SELECT ST_M(ST_MakePointM(-71.1043443253471, 42.3150676015829,10));
result
-------
10
```

See Also

ST_AsEWKT, ST_MakePoint, ST_SetSRID

8.3.29 ST_MLineFromText

ST_MLineFromText — Return a specified ST_MultiLineString value from WKT representation.

Synopsis

geometry **ST_MLineFromText**(text WKT, integer srid);
geometry **ST_MLineFromText**(text WKT);

Description

Makes a Geometry from Well-Known-Text (WKT) with the given SRID. If SRID is not give, it defaults to 0.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Returns null if the WKT is not a MULTILINESTRING

> **Note**
> If you are absolutely sure all your WKT geometries are points, don't use this function. It is slower than ST_GeomFromText since it adds an additional validation step.

This method implements the OpenGIS 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

Examples

```
SELECT ST_MLineFromText('MULTILINESTRING((1 2, 3 4), (4 5, 6 7))');
```

See Also

ST_GeomFromText

8.3.30 ST_MPointFromText

ST_MPointFromText — Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to 0.

Synopsis

geometry **ST_MPointFromText**(text WKT, integer srid);
geometry **ST_MPointFromText**(text WKT);

Description

Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to 0.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Returns null if the WKT is not a MULTIPOINT

> **Note**
> If you are absolutely sure all your WKT geometries are points, don't use this function. It is slower than ST_GeomFromText since it adds an additional validation step.

This method implements the OpenGIS 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

Examples

```
SELECT ST_MPointFromText('MULTIPOINT(1 2, 3 4)');
SELECT ST_MPointFromText('MULTIPOINT(-70.9590 42.1180, -70.9611 42.1223)', 4326);
```

See Also

ST_GeomFromText

8.3.31 ST_MPolyFromText

ST_MPolyFromText — Makes a MultiPolygon Geometry from WKT with the given SRID. If SRID is not give, it defaults to 0.

Synopsis

geometry **ST_MPolyFromText**(text WKT, integer srid);
geometry **ST_MPolyFromText**(text WKT);

Description

Makes a MultiPolygon from WKT with the given SRID. If SRID is not give, it defaults to 0.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Throws an error if the WKT is not a MULTIPOLYGON

> **Note**
> If you are absolutely sure all your WKT geometries are multipolygons, don't use this function. It is slower than ST_GeomFromText since it adds an additional validation step.

This method implements the OpenGIS 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

Examples

```
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);
```

See Also

ST_GeomFromText, ST_SRID

8.3.32 ST_Point

ST_Point — Returns an ST_Point with the given coordinate values. OGC alias for ST_MakePoint.

Synopsis

geometry **ST_Point**(float x_lon, float y_lat);

Description

Returns an ST_Point with the given coordinate values. MM compliant alias for ST_MakePoint that takes just an x and y.

This method implements the SQL/MM specification. SQL-MM 3: 6.1.2

Examples: Geometry

```
SELECT ST_SetSRID(ST_Point(-71.1043443253471, 42.3150676015829),4326)
```

Examples: Geography

```
SELECT CAST(ST_SetSRID(ST_Point(-71.1043443253471, 42.3150676015829),4326) As geography);
```

```
-- the :: is PostgreSQL short-hand for casting.
SELECT ST_SetSRID(ST_Point(-71.1043443253471, 42.3150676015829),4326)::geography;
```

```
--If your point coordinates are in a different spatial reference from WGS-84 long lat, then you need to transform before casting
-- This example we convert a point in Pennsylvania State Plane feet to WGS 84 and then geography
SELECT ST_Transform(ST_SetSRID(ST_Point(3637510, 3014852),2273),4326)::geography;
```

See Also

Section 4.2.1, ST_MakePoint, ST_SetSRID, ST_Transform

8.3.33 ST_PointFromGeoHash

ST_PointFromGeoHash — Return a point from a GeoHash string.

Synopsis

point **ST_PointFromGeoHash**(text geohash, integer precision=full_precision_of_geohash);

Description

Return a point from a GeoHash string. The point represents the center point of the GeoHash.

If no `precision` is specficified ST_PointFromGeoHash returns a point based on full precision of the input GeoHash string.

If `precision` is specified ST_PointFromGeoHash will use that many characters from the GeoHash to create the point.

Availability: 2.1.0

Examples

```
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)
```

See Also

ST_GeoHash, ST_Box2dFromGeoHash, ST_GeomFromGeoHash

8.3.34 ST_PointFromText

ST_PointFromText — Makes a point Geometry from WKT with the given SRID. If SRID is not given, it defaults to unknown.

Synopsis

geometry **ST_PointFromText**(text WKT);
geometry **ST_PointFromText**(text WKT, integer srid);

Description

Constructs a PostGIS ST_Geometry point object from the OGC Well-Known text representation. If SRID is not give, 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**
> There are 2 variants of ST_PointFromText function, the first takes no SRID and returns a geometry with no defined spatial reference system. The second takes a spatial reference id as the second argument and returns an ST_Geometry that includes this srid as part of its meta-data. The srid must be defined in the spatial_ref_sys table.

> **Note**
> If you are absolutely sure all your WKT geometries are points, don't use this function. It is slower than ST_GeomFromText since it adds an additional validation step. If you are building points from long lat coordinates and care more about performance and accuracy than OGC compliance, use ST_MakePoint or OGC compliant alias ST_Point.

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s3.2.6.2 - option SRID is from the conformance suite.

This method implements the SQL/MM specification. SQL-MM 3: 6.1.8

Examples

```
SELECT ST_PointFromText('POINT(-71.064544 42.28787)');
SELECT ST_PointFromText('POINT(-71.064544 42.28787)', 4326);
```

See Also

ST_GeomFromText, ST_MakePoint, ST_Point, ST_SRID

8.3.35 ST_PointFromWKB

ST_PointFromWKB — Makes a geometry from WKB with the given SRID

Synopsis

geometry **ST_GeomFromWKB**(bytea geom);
geometry **ST_GeomFromWKB**(bytea geom, integer srid);

Description

The `ST_PointFromWKB` function, takes a well-known binary representation of geometry and a Spatial Reference System ID (`SRID`) and creates an instance of the appropriate geometry type - in this case, a `POINT` geometry. This function plays the role of the Geometry Factory in SQL.

If an SRID is not specified, it defaults to 0. `NULL` is returned if the input `bytea` does not represent a `POINT` geometry.

This method implements the OpenGIS 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

Examples

```
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)
```

See Also

ST_GeomFromWKB, ST_LineFromWKB

8.3.36 ST_Polygon

ST_Polygon — Returns a polygon built from the specified linestring and SRID.

Synopsis

geometry **ST_Polygon**(geometry aLineString, integer srid);

Description

Returns a polygon built from the specified linestring and SRID.

> **Note**
> ST_Polygon is similar to first version oST_MakePolygon except it also sets the spatial ref sys (SRID) of the polygon. Will not work with MULTILINESTRINGS so use LineMerge to merge multilines. Also does not create polygons with holes. Use ST_MakePolygon for that.

This method implements the OpenGIS 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.

Examples

```
--a 2d polygon
SELECT ST_Polygon(ST_GeomFromText('LINESTRING(75.15 29.53,77 29,77.6 29.5, 75.15 29.53)'), ↵
    4326);

--result--
POLYGON((75.15 29.53,77 29,77.6 29.5,75.15 29.53))
--a 3d polygon
SELECT ST_AsEWKT(ST_Polygon(ST_GeomFromEWKT('LINESTRING(75.15 29.53 1,77 29 1,77.6 29.5 1, ↵
    75.15 29.53 1)'), 4326));

result
------
SRID=4326;POLYGON((75.15 29.53 1,77 29 1,77.6 29.5 1,75.15 29.53 1))
```

See Also

ST_AsEWKT, ST_AsText, ST_GeomFromEWKT, ST_GeomFromText, ST_LineMerge, ST_MakePolygon

8.3.37 ST_PolygonFromText

ST_PolygonFromText — Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to 0.

Synopsis

geometry **ST_PolygonFromText**(text WKT);
geometry **ST_PolygonFromText**(text WKT, integer srid);

Description

Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to 0. Returns null if WKT is not a polygon.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

> **Note**
> If you are absolutely sure all your WKT geometries are polygons, don't use this function. It is slower than ST_GeomFromText since it adds an additional validation step.

This method implements the OpenGIS 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

Examples

```
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
```

See Also

ST_GeomFromText

8.3.38 ST_WKBToSQL

ST_WKBToSQL — Return a specified ST_Geometry value from Well-Known Binary representation (WKB). This is an alias name for ST_GeomFromWKB that takes no srid

Synopsis

geometry **ST_WKBToSQL**(bytea WKB);

Description

This method implements the SQL/MM specification. SQL-MM 3: 5.1.36

See Also

ST_GeomFromWKB

8.3.39 ST_WKTToSQL

ST_WKTToSQL — Return a specified ST_Geometry value from Well-Known Text representation (WKT). This is an alias name for ST_GeomFromText

Synopsis

geometry **ST_WKTToSQL**(text WKT);

Description

This method implements the SQL/MM specification. SQL-MM 3: 5.1.34

See Also

ST_GeomFromText

8.4 Geometry Accessors

8.4.1 GeometryType

GeometryType — Returns the type of the geometry as a string. Eg: 'LINESTRING', 'POLYGON', 'MULTIPOINT', etc.

Synopsis

text **GeometryType**(geometry geomA);

Description

Returns the type of the geometry as a string. Eg: 'LINESTRING', 'POLYGON', 'MULTIPOINT', etc.

OGC SPEC s2.1.1.1 - Returns the name of the instantiable subtype of Geometry of which this Geometry instance is a member. The name of the instantiable subtype of Geometry is returned as a string.

Note
This function also indicates if the geometry is measured, by returning a string of the form 'POINTM'.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

This method implements the OpenGIS 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).

Examples

```
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
```

See Also

ST_GeometryType

8.4.2 ST_Boundary

ST_Boundary — Returns the closure of the combinatorial boundary of this Geometry.

Synopsis

geometry **ST_Boundary**(geometry geomA);

Description

Returns the closure of the combinatorial boundary of this Geometry. The combinatorial boundary is defined as described in section 3.12.3.2 of the OGC SPEC. Because the result of this function is a closure, and hence topologically closed, the resulting boundary can be represented using representational geometry primitives as discussed in the OGC SPEC, section 3.12.2.

Performed by the GEOS module

> **Note**
> Prior to 2.0.0, this function throws an exception if used with `GEOMETRYCOLLECTION`. From 2.0.0 up it will return NULL instead (unsupported input).

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. OGC SPEC s2.1.1.1

This method implements the SQL/MM specification. SQL-MM 3: 5.1.14

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

Enhanced: 2.1.0 support for Triangle was introduced

Examples

```
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)
```

See Also

ST_ExteriorRing, ST_MakePolygon

8.4.3 ST_CoordDim

ST_CoordDim — Return the coordinate dimension of the ST_Geometry value.

Synopsis

integer **ST_CoordDim**(geometry geomA);

Description

Return the coordinate dimension of the ST_Geometry value.

This is the MM compliant alias name for ST_NDims

This method implements the OpenGIS 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).

Examples

```
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
```

See Also

ST_NDims

8.4.4 ST_Dimension

ST_Dimension — The inherent dimension of this Geometry object, which must be less than or equal to the coordinate dimension.

Synopsis

integer **ST_Dimension**(geometry g);

Description

The inherent dimension of this Geometry object, which must be less than or equal to the coordinate dimension. OGC SPEC s2.1.1.1 - returns 0 for `POINT`, 1 for `LINESTRING`, 2 for `POLYGON`, and the largest dimension of the components of a `GEOMETRYCOLLECTION`. If unknown (empty geometry) null is returned.

This method implements the SQL/MM specification. SQL-MM 3: 5.1.2

Enhanced: 2.0.0 support for Polyhedral surfaces and TINs was introduced. No longer throws an exception if given empty geometry.

Note
Prior to 2.0.0, this function throws an exception if used with empty geometry.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Examples

```
SELECT ST_Dimension('GEOMETRYCOLLECTION(LINESTRING(1 1,0 0),POINT(0 0))');
ST_Dimension
-----------
1
```

See Also

ST_NDims

8.4.5 ST_EndPoint

ST_EndPoint — Returns the last point of a LINESTRING geometry as a POINT.

Synopsis

boolean **ST_EndPoint**(geometry g);

Description

Returns the last point of a LINESTRING geometry as a POINT or NULL if the input parameter is not a LINESTRING.

This method implements the SQL/MM specification. SQL-MM 3: 7.1.4

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

Note
Changed: 2.0.0 no longer works with single geometry multilinestrings. In older versions of PostGIS -- a single line multilinestring would work happily with this function and return the start point. In 2.0.0 it just returns NULL like any other multilinestring. The older behavior was an undocumented feature, but people who assumed they had their data stored as LINESTRING may experience these returning NULL in 2.0 now.

Examples

```
postgis=# SELECT ST_AsText(ST_EndPoint('LINESTRING(1 1, 2 2, 3 3)'::geometry));
 st_astext
------------
 POINT(3 3)
(1 row)

postgis=# SELECT ST_EndPoint('POINT(1 1)'::geometry) IS NULL AS is_null;
  is_null
----------
 t
(1 row)

--3d endpoint
SELECT ST_AsEWKT(ST_EndPoint('LINESTRING(1 1 2, 1 2 3, 0 0 5)'));
  st_asewkt
--------------
 POINT(0 0 5)
(1 row)
```

See Also

ST_PointN, ST_StartPoint

8.4.6 ST_Envelope

ST_Envelope — Returns a geometry representing the double precision (float8) bounding box of the supplied geometry.

Synopsis

geometry **ST_Envelope**(geometry g1);

Description

Returns the float8 minimum bounding box for the supplied geometry, as a geometry. The polygon is defined by the corner points of the bounding box ((MINX, MINY), (MINX, MAXY), (MAXX, MAXY), (MAXX, MINY), (MINX, MINY)). (PostGIS will add a ZMIN/ZMAX coordinate as well).

Degenerate cases (vertical lines, points) will return a geometry of lower dimension than POLYGON, ie. POINT or LINESTRING.

Availability: 1.5.0 behavior changed to output double precision instead of float4

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s2.1.1.1

This method implements the SQL/MM specification. SQL-MM 3: 5.1.15

Examples

```
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;
```

See Also

Box2D, Box3D

8.4.7 ST_ExteriorRing

ST_ExteriorRing — Returns a line string representing the exterior ring of the POLYGON geometry. Return NULL if the geometry is not a polygon. Will not work with MULTIPOLYGON

Synopsis

geometry **ST_ExteriorRing**(geometry a_polygon);

Description

Returns a line string representing the exterior ring of the POLYGON geometry. Return NULL if the geometry is not a polygon.

Note
Only works with POLYGON geometry types

This method implements the OpenGIS 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.

Examples

```
--If you have a table of polygons
SELECT gid, ST_ExteriorRing(the_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(the_geom)) AS erings
  FROM (SELECT gid, (ST_Dump(the_geom)).geom As the_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)
```

See Also

ST_InteriorRingN, ST_Boundary, ST_NumInteriorRings

8.4.8 ST_GeometryN

ST_GeometryN — Return the 1-based Nth geometry if the geometry is a GEOMETRYCOLLECTION, (MULTI)POINT, (MULTI)LINE MULTICURVE or (MULTI)POLYGON, POLYHEDRALSURFACE Otherwise, return NULL.

Synopsis

geometry **ST_GeometryN**(geometry geomA, integer n);

Description

Return the 1-based Nth geometry if the geometry is a GEOMETRYCOLLECTION, (MULTI)POINT, (MULTI)LINESTRING, MULTICURVE or (MULTI)POLYGON, POLYHEDRALSURFACE Otherwise, return NULL

Note
Index is 1-based as for OGC specs since version 0.8.0. Previous versions implemented this as 0-based instead.

Note
If you want to extract all geometries, of a geometry, ST_Dump is more efficient and will also work for singular geoms.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

Changed: 2.0.0 Prior versions would return NULL for singular geometries. This was changed to return the geometry for ST_GeometryN(..,1) case.

This method implements the OpenGIS 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).

Standard Examples

```
--Extracting a subset of points from a 3d multipoint
SELECT n, ST_AsEWKT(ST_GeometryN(the_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(the_geom)
  CROSS JOIN generate_series(1,100) n
WHERE n <= ST_NumGeometries(the_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(the_geom, n)
FROM sometable CROSS JOIN generate_series(1,100) n
WHERE n <= ST_NumGeometries(the_geom);
```

Polyhedral Surfaces, TIN and Triangle Examples

```
-- 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))
```

See Also

ST_Dump, ST_NumGeometries

8.4.9 ST_GeometryType

ST_GeometryType — Return the geometry type of the ST_Geometry value.

Synopsis

text **ST_GeometryType**(geometry g1);

Description

Returns the type of the geometry as a string. EG: 'ST_Linestring', 'ST_Polygon','ST_MultiPolygon' etc. This function differs from GeometryType(geometry) in the case of the string and ST in front that is returned, as well as the fact that it will not indicate whether the geometry is measured.

Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

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.

Examples

```
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
```

See Also

GeometryType

8.4.10 ST_InteriorRingN

ST_InteriorRingN — Return the Nth interior linestring ring of the polygon geometry. Return NULL if the geometry is not a polygon or the given N is out of range.

Synopsis

geometry **ST_InteriorRingN**(geometry a_polygon, integer n);

Description

Return the Nth interior linestring ring of the polygon geometry. Return NULL if the geometry is not a polygon or the given N is out of range. index starts at 1.

> **Note**
> This will not work for MULTIPOLYGONs. Use in conjunction with ST_Dump for MULTIPOLYGONS

This method implements the OpenGIS 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.

Examples

```
SELECT ST_AsText(ST_InteriorRingN(the_geom, 1)) As the_geom
FROM (SELECT ST_BuildArea(
    ST_Collect(ST_Buffer(ST_Point(1,2), 20,3),
      ST_Buffer(ST_Point(1, 2), 10,3))) As the_geom
    )  as foo
```

See Also

ST_ExteriorRing ST_BuildArea, ST_Collect, ST_Dump, ST_NumInteriorRing, ST_NumInteriorRings

8.4.11 ST_IsClosed

ST_IsClosed — Returns `TRUE` if the `LINESTRING`'s start and end points are coincident. For Polyhedral surface is closed (volumetric).

Synopsis

boolean **ST_IsClosed**(geometry g);

Description

Returns `TRUE` if the `LINESTRING`'s start and end points are coincident. For Polyhedral Surfaces, it tells you if the surface is areal (open) or volumetric (closed).

This method implements the OpenGIS 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

Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

This function supports Polyhedral surfaces.

Line String and Point Examples

```
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)
```

Polyhedral Surface Examples

```
    -- 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
```

See Also

ST_IsRing

8.4.12 ST_IsCollection

ST_IsCollection — Returns TRUE if the argument is a collection (MULTI*, GEOMETRYCOLLECTION, ...)

Synopsis

boolean **ST_IsCollection**(geometry g);

Description

Returns TRUE if the geometry type of the argument is either:

- GEOMETRYCOLLECTION
- MULTI{POINT,POLYGON,LINESTRING,CURVE,SURFACE}
- COMPOUNDCURVE

Note
This function analyzes the type of the geometry. This means that it will return TRUE on collections that are empty or that contain a single element.

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

This method supports Circular Strings and Curves

Examples

```
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)
```

See Also

ST_NumGeometries

8.4.13 ST_IsEmpty

ST_IsEmpty — Returns true if this Geometry is an empty geometrycollection, polygon, point etc.

Synopsis

boolean **ST_IsEmpty**(geometry geomA);

Description

Returns true if this Geometry is an empty geometry. If true, then this Geometry represents an empty geometry collection, polygon, point etc.

Note
SQL-MM defines the result of ST_IsEmpty(NULL) to be 0, while PostGIS returns NULL.

This method implements the OpenGIS 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
Changed: 2.0.0 In prior versions of PostGIS ST_GeomFromText('GEOMETRYCOLLECTION(EMPTY)') was allowed. This is now illegal in PostGIS 2.0.0 to better conform with SQL/MM standards

Examples

```
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)
```

8.4.14 ST_IsRing

ST_IsRing — Returns TRUE if this LINESTRING is both closed and simple.

Synopsis

boolean **ST_IsRing**(geometry g);

Description

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 OpenGIS 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.

Examples

```
SELECT ST_IsRing(the_geom), ST_IsClosed(the_geom), ST_IsSimple(the_geom)
FROM (SELECT 'LINESTRING(0 0, 0 1, 1 1, 1 0, 0 0)'::geometry AS the_geom) AS foo;
 st_isring | st_isclosed | st_issimple
-----------+-------------+-------------
 t         | t           | t
(1 row)

SELECT ST_IsRing(the_geom), ST_IsClosed(the_geom), ST_IsSimple(the_geom)
FROM (SELECT 'LINESTRING(0 0, 0 1, 1 0, 1 1, 0 0)'::geometry AS the_geom) AS foo;
 st_isring | st_isclosed | st_issimple
-----------+-------------+-------------
 f         | t           | f
(1 row)
```

See Also

ST_IsClosed, ST_IsSimple, ST_StartPoint, ST_EndPoint

8.4.15 ST_IsSimple

ST_IsSimple — Returns (TRUE) if this Geometry has no anomalous geometric points, such as self intersection or self tangency.

Synopsis

boolean **ST_IsSimple**(geometry geomA);

Description

Returns true if this Geometry has no anomalous geometric points, such as self intersection or self tangency. For more information on the OGC's definition of geometry simplicity and validity, refer to "Ensuring OpenGIS compliancy of geometries"

Note
SQL-MM defines the result of ST_IsSimple(NULL) to be 0, while PostGIS returns NULL.

This method implements the OpenGIS 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.

Examples

```
 SELECT ST_IsSimple(ST_GeomFromText('POLYGON((1 2, 3 4, 5 6, 1 2))'));
 st_issimple
-------------
 t
(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)
```

See Also

ST_IsValid

8.4.16 ST_IsValid

ST_IsValid — Returns `true` if the `ST_Geometry` is well formed.

Synopsis

boolean **ST_IsValid**(geometry g);
boolean **ST_IsValid**(geometry g, integer flags);

Description

Test if an ST_Geometry value is well formed. For geometries that are invalid, the PostgreSQL NOTICE will provide details of why it is not valid. For more information on the OGC's definition of geometry simplicity and validity, refer to "Ensuring OpenGIS compliancy of geometries"

Note
SQL-MM defines the result of ST_IsValid(NULL) to be 0, while PostGIS returns NULL.

The version accepting flags is available starting with 2.0.0 and requires GEOS >= 3.3.0. Such version does not print a NOTICE explaining the invalidity. Allowed `flags` are documented in ST_IsValidDetail.

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

This method implements the SQL/MM specification. SQL-MM 3: 5.1.9

Examples

```
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
```

See Also

ST_IsSimple, ST_IsValidReason, ST_IsValidDetail, ST_Summary

8.4.17 ST_IsValidReason

ST_IsValidReason — Returns text stating if a geometry is valid or not and if not valid, a reason why.

Synopsis

text **ST_IsValidReason**(geometry geomA);
text **ST_IsValidReason**(geometry geomA, integer flags);

Description

Returns text stating if a geometry is valid or not an if not valid, 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.

Availability: 1.4 - requires GEOS >= 3.1.0.

Availability: 2.0 - requires GEOS >= 3.3.0 for the version taking flags.

Examples

```
--First 3 Rejects from a successful quintuplet experiment
SELECT gid, ST_IsValidReason(the_geom) as validity_info
FROM
(SELECT ST_MakePolygon(ST_ExteriorRing(e.buff), ST_Accum(f.line)) As the_geom, gid
FROM (SELECT ST_Buffer(ST_MakePoint(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_MakePoint(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(the_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
```

See Also

ST_IsValid, ST_Summary

8.4.18 ST_IsValidDetail

ST_IsValidDetail — Returns a valid_detail (valid,reason,location) row stating if a geometry is valid or not and if not valid, a reason why and a location where.

Synopsis

valid_detail **ST_IsValidDetail**(geometry geom);
valid_detail **ST_IsValidDetail**(geometry geom, integer flags);

Description

Returns a valid_detail row, formed by 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 substitute and improve the combination of ST_IsValid and ST_IsValidReason to generate a detailed report of invalid geometries.

The 'flags' argument is a bitfield. It can have the following values:

- 1: Consider self-intersecting rings forming holes as valid. This is also know as "the ESRI flag". Note that this is against the OGC model.

Availability: 2.0.0 - requires GEOS >= 3.3.0.

Examples

```
--First 3 Rejects from a successful quintuplet experiment
SELECT gid, reason(ST_IsValidDetail(the_geom)), ST_AsText(location(ST_IsValidDetail( ↩
    the_geom))) as location
FROM
(SELECT ST_MakePolygon(ST_ExteriorRing(e.buff), ST_Accum(f.line)) As the_geom, gid
FROM (SELECT ST_Buffer(ST_MakePoint(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_MakePoint(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(the_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     |        |
```

See Also

ST_IsValid, ST_IsValidReason

8.4.19 ST_M

ST_M — Return the M coordinate of the point, or NULL if not available. Input must be a point.

Synopsis

float **ST_M**(geometry a_point);

Description

Return the M coordinate of the point, or NULL if not available. Input must be a point.

Note
This is not (yet) part of the OGC spec, but is listed here to complete the point coordinate extractor function list.

This method implements the OpenGIS 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.

Examples

```
SELECT ST_M(ST_GeomFromEWKT('POINT(1 2 3 4)'));
 st_m
------
   4
(1 row)
```

See Also

ST_GeomFromEWKT, ST_X, ST_Y, ST_Z

8.4.20 ST_NDims

ST_NDims — Returns coordinate dimension of the geometry as a small int. Values are: 2,3 or 4.

Synopsis

integer **ST_NDims**(geometry g1);

Description

Returns the coordinate dimension of the geometry. PostGIS supports 2 - (x,y) , 3 - (x,y,z) or 2D with measure - x,y,m, and 4 - 3D with measure space x,y,z,m

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

Examples

```
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
```

See Also

ST_CoordDim, ST_Dimension, ST_GeomFromEWKT

8.4.21 ST_NPoints

ST_NPoints — Return the number of points (vertexes) in a geometry.

Synopsis

integer **ST_NPoints**(geometry g1);

Description

Return the number of points in a geometry. Works for all geometries.

Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

> **Note**
> Prior to 1.3.4, this function crashes if used with geometries that contain CURVES. This is fixed in 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.

Examples

```
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
```

See Also

ST_NumPoints

8.4.22 ST_NRings

ST_NRings — If the geometry is a polygon or multi-polygon returns the number of rings.

Synopsis

integer **ST_NRings**(geometry geomA);

Description

If the geometry is a polygon or multi-polygon returns the number of rings. Unlike NumInteriorRings, it counts the outer rings as well.

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

This method supports Circular Strings and Curves

Examples

```
SELECT ST_NRings(the_geom) As Nrings, ST_NumInteriorRings(the_geom) As ninterrings
          FROM (SELECT ST_GeomFromText('POLYGON((1 2, 3 4, 5 6, 1 2))') As the_geom) As foo ←
              ;
   nrings | ninterrings
--------+-------------
    1 |           0
(1 row)
```

See Also

ST_NumInteriorRings

8.4.23 ST_NumGeometries

ST_NumGeometries — If geometry is a GEOMETRYCOLLECTION (or MULTI*) return the number of geometries, for single geometries will return 1, otherwise return NULL.

Synopsis

integer **ST_NumGeometries**(geometry geom);

Description

Returns the number of Geometries. If geometry is a GEOMETRYCOLLECTION (or MULTI*) return the number of geometries, for single geometries will return 1, otherwise return NULL.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

Changed: 2.0.0 In prior versions this would return NULL if the geometry was not a collection/MULTI type. 2.0.0+ now returns 1 for single geometries e.g POLYGON, LINESTRING, POINT.

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).

Examples

```
--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
```

See Also

ST_GeometryN, ST_Multi

8.4.24 ST_NumInteriorRings

ST_NumInteriorRings — Return the number of interior rings of the a polygon in the geometry. This will work with POLYGON and return NULL for a MULTIPOLYGON type or any other type

Synopsis

integer **ST_NumInteriorRings**(geometry a_polygon);

Description

Return the number of interior rings of the first polygon in the geometry. This will work with both POLYGON and MULTIPOLYGON types but only looks at the first polygon. Return NULL if there is no polygon in the geometry.

This method implements the SQL/MM specification. SQL-MM 3: 8.2.5

Changed: 2.0.0 - in prior versions it would return the number of interior rings for the first POLYGON in a MULTIPOLYGON.

Examples

```
--If you have a regular polygon
SELECT gid, field1, field2, ST_NumInteriorRings(the_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(the_geom)) AS numholes
FROM (SELECT gid, field1, field2, (ST_Dump(the_geom)).geom As the_geom
  FROM sometable) As foo
GROUP BY gid, field1,field2;
```

See Also

ST_NumInteriorRing

8.4.25 ST_NumInteriorRing

ST_NumInteriorRing — Return the number of interior rings of the first polygon in the geometry. Synonym to ST_NumInteriorRings.

Synopsis

integer **ST_NumInteriorRing**(geometry a_polygon);

See Also

ST_NumInteriorRings

8.4.26 ST_NumPatches

ST_NumPatches — Return the number of faces on a Polyhedral Surface. Will return null for non-polyhedral geometries.

Synopsis

integer **ST_NumPatches**(geometry g1);

Description

Return the number of faces on a Polyhedral Surface. Will return null for non-polyhedral geometries. This is an alias for ST_NumGeometries to support MM naming. Faster to use ST_NumGeometries if you don't care about MM convention.

Availability: 2.0.0

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

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

This method implements the SQL/MM specification. SQL-MM 3: ?

This function supports Polyhedral surfaces.

Examples

```
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
```

See Also

ST_GeomFromEWKT, ST_NumGeometries

8.4.27 ST_NumPoints

ST_NumPoints — Return the number of points in an ST_LineString or ST_CircularString value.

Synopsis

integer **ST_NumPoints**(geometry g1);

Description

Return the number of points in an ST_LineString or ST_CircularString value. Prior to 1.4 only works with Linestrings as the specs state. From 1.4 forward this is an alias for ST_NPoints which returns number of vertexes for not just line strings. Consider using ST_NPoints instead which is multi-purpose and works with many geometry types.

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

This method implements the SQL/MM specification. SQL-MM 3: 7.2.4

Examples

```
SELECT ST_NumPoints(ST_GeomFromText('LINESTRING(77.29 29.07,77.42 29.26,77.27 29.31,77.29 ↩
    29.07)'));
    --result
    4
```

See Also

ST_NPoints

8.4.28 ST_PatchN

ST_PatchN — Return the 1-based Nth geometry (face) if the geometry is a POLYHEDRALSURFACE, POLYHEDRALSURFACEM. Otherwise, return NULL.

Synopsis

geometry **ST_PatchN**(geometry geomA, integer n);

Description

>Return the 1-based Nth geometry (face) if the geometry is a POLYHEDRALSURFACE, POLYHEDRALSURFACEM. Otherwise, return NULL. This returns the same answer as ST_GeometryN for Polyhedral Surfaces. Using ST_GemoetryN is faster.

> **Note**
> Index is 1-based.

> **Note**
> If you want to extract all geometries, of a geometry, ST_Dump is more efficient.

Availability: 2.0.0

This method implements the SQL/MM specification. SQL-MM 3: ?

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

This function supports Polyhedral surfaces.

Examples

```
--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))
```

See Also

ST_AsEWKT, ST_GeomFromEWKT, ST_Dump, ST_GeometryN, ST_NumGeometries

8.4.29 ST_PointN

ST_PointN — Return the Nth point in the first linestring or circular linestring in the geometry. Return NULL if there is no linestring in the geometry.

Synopsis

geometry **ST_PointN**(geometry a_linestring, integer n);

Description

Return the Nth point in a single linestring or circular linestring in the geometry. Return NULL if there is no linestring in the geometry.

Note
Index is 1-based as for OGC specs since version 0.8.0. Previous versions implemented this as 0-based instead.

Note
If you want to get the nth point of each line string in a multilinestring, use in conjunction with ST_Dump

This method implements the OpenGIS 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
Changed: 2.0.0 no longer works with single geometry multilinestrings. In older versions of PostGIS -- a single line multilinestring would work happily with this function and return the start point. In 2.0.0 it just returns NULL like any other multilinestring.

Examples

```
-- 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)
```

See Also

ST_NPoints

8.4.30 ST_SRID

ST_SRID — Returns the spatial reference identifier for the ST_Geometry as defined in spatial_ref_sys table.

Synopsis

integer **ST_SRID**(geometry g1);

Description

Returns the spatial reference identifier for the ST_Geometry as defined in spatial_ref_sys table. Section 4.3.1

> **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 OpenGIS 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

Examples

```
SELECT ST_SRID(ST_GeomFromText('POINT(-71.1043 42.315)',4326));
    --result
    4326
```

See Also

Section 4.3.1, ST_GeomFromText, ST_SetSRID, ST_Transform

8.4.31 ST_StartPoint

ST_StartPoint — Returns the first point of a `LINESTRING` geometry as a `POINT`.

Synopsis

geometry **ST_StartPoint**(geometry geomA);

Description

Returns the first point of a `LINESTRING` geometry as a `POINT` or `NULL` if the input parameter is not a `LINESTRING`.

This method implements the SQL/MM specification. SQL-MM 3: 7.1.3

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

Note
Changed: 2.0.0 no longer works with single geometry multilinestrings. In older versions of PostGIS -- a single line multilinestring would work happily with this function and return the start point. In 2.0.0 it just returns NULL like any other multilinestring. The older behavior was an undocumented feature, but people who assumed they had their data stored as LINESTRING may experience these returning NULL in 2.0 now.

Examples

```
SELECT ST_AsText(ST_StartPoint('LINESTRING(0 1, 0 2)'::geometry));
 st_astext
------------
 POINT(0 1)
(1 row)

SELECT ST_StartPoint('POINT(0 1)'::geometry) IS NULL AS is_null;
  is_null
----------
 t
(1 row)

--3d line
SELECT ST_AsEWKT(ST_StartPoint('LINESTRING(0 1 1, 0 2 2)'::geometry));
 st_asewkt
------------
 POINT(0 1 1)
(1 row)
```

See Also

ST_EndPoint, ST_PointN

8.4.32 ST_Summary

ST_Summary — Returns a text summary of the contents of the geometry.

Synopsis

text **ST_Summary**(geometry g);
text **ST_Summary**(geography g);

Description

Returns a text summary of the contents of the geometry.

Flags shown square brackets after the geometry type have the following meaning:

- M: has M ordinate
- Z: has Z ordinate
- B: has a cached bounding box
- G: is geodetic (geography)
- S: has spatial reference system

Availability: 1.2.2

Enhanced: 2.0.0 added support for geography

Enhanced: 2.1.0 S flag to denote if has a known spatial reference system

Examples

```
=# 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)
```

See Also

PostGIS_DropBBox, PostGIS_AddBBox, ST_Force3DM, ST_Force3DZ, ST_Force2D, geography

ST_IsValid, ST_IsValid, ST_IsValidReason, ST_IsValidDetail

8.4.33 ST_X

ST_X — Return the X coordinate of the point, or NULL if not available. Input must be a point.

Synopsis

float **ST_X**(geometry a_point);

Description

Return the X coordinate of the point, or NULL if not available. Input must be a point.

Note
If you want to get the max min x values of any geometry look at ST_XMin, ST_XMax functions.

This method implements the SQL/MM specification. SQL-MM 3: 6.1.3

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

Examples

```
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)
```

See Also

ST_Centroid, ST_GeomFromEWKT, ST_M, ST_XMax, ST_XMin, ST_Y, ST_Z

8.4.34 ST_XMax

ST_XMax — Returns X maxima of a bounding box 2d or 3d or a geometry.

Synopsis

float **ST_XMax**(box3d aGeomorBox2DorBox3D);

Description

Returns X maxima of a bounding box 2d or 3d or a geometry.

Note
Although this function is only defined for box3d, it will work for box2d and geometry because of the auto-casting behavior defined for geometries and box2d. However you can not feed it a geometry or box2d text representation, since that will not auto-cast.

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

This method supports Circular Strings and Curves

Examples

```
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 autocast the string representation to a ↩
     BOX3D
SELECT ST_XMax('LINESTRING(1 3, 5 6)');

--ERROR:  BOX3D parser - doesnt start with BOX3D(

SELECT ST_XMax(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227  ↩
    150406 3)'));
st_xmax
--------
220288.248780547
```

See Also

ST_XMin, ST_YMax, ST_YMin, ST_ZMax, ST_ZMin

8.4.35 ST_XMin

ST_XMin — Returns X minima of a bounding box 2d or 3d or a geometry.

Synopsis

float **ST_XMin**(box3d aGeomorBox2DorBox3D);

Description

Returns X minima of a bounding box 2d or 3d or a geometry.

> **Note**
> Although this function is only defined for box3d, it will work for box2d and geometry because of the auto-casting behavior defined for geometries and box2d. However you can not feed it a geometry or box2d text representation, since that will not auto-cast.

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

This method supports Circular Strings and Curves

Examples

```
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 autocast the string representation to a ↵
     BOX3D
SELECT ST_XMin('LINESTRING(1 3, 5 6)');

--ERROR:  BOX3D parser - doesnt start with BOX3D(

SELECT ST_XMin(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227  ↵
    150406 3)'));
st_xmin
--------
220186.995121892
```

See Also

ST_XMax, ST_YMax, ST_YMin, ST_ZMax, ST_ZMin

8.4.36 ST_Y

ST_Y — Return the Y coordinate of the point, or NULL if not available. Input must be a point.

Synopsis

float **ST_Y**(geometry a_point);

Description

Return the Y coordinate of the point, or NULL if not available. Input must be a point.

✓ This method implements the OpenGIS 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.

Examples

```
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)
```

See Also

ST_Centroid, ST_GeomFromEWKT, ST_M, ST_X, ST_YMax, ST_YMin, ST_Z

8.4.37 ST_YMax

ST_YMax — Returns Y maxima of a bounding box 2d or 3d or a geometry.

Synopsis

float **ST_YMax**(box3d aGeomorBox2DorBox3D);

Description

Returns Y maxima of a bounding box 2d or 3d or a geometry.

> **Note**
> Although this function is only defined for box3d, it will work for box2d and geometry because of the auto-casting behavior defined for geometries and box2d. However you can not feed it a geometry or box2d text representation, since that will not auto-cast.

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

This method supports Circular Strings and Curves

Examples

```
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 autocast the string representation to a ↩
     BOX3D
SELECT ST_YMax('LINESTRING(1 3, 5 6)');

--ERROR:  BOX3D parser - doesnt start with BOX3D(

SELECT ST_YMax(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227  ↩
    150406 3)'));
st_ymax
--------
150506.126829327
```

See Also

ST_XMin, ST_XMax, ST_YMin, ST_ZMax, ST_ZMin

8.4.38 ST_YMin

ST_YMin — Returns Y minima of a bounding box 2d or 3d or a geometry.

Synopsis

float **ST_YMin**(box3d aGeomorBox2DorBox3D);

Description

Returns Y minima of a bounding box 2d or 3d or a geometry.

> **Note**
> Although this function is only defined for box3d, it will work for box2d and geometry because of the auto-casting behavior defined for geometries and box2d. However you can not feed it a geometry or box2d text representation, since that will not auto-cast.

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

This method supports Circular Strings and Curves

Examples

```
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 autocast the string representation to a ↩
     BOX3D
SELECT ST_YMin('LINESTRING(1 3, 5 6)');

--ERROR:  BOX3D parser - doesnt start with BOX3D(

SELECT ST_YMin(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227  ↩
    150406 3)'));
st_ymin
--------
150406
```

See Also

ST_GeomFromEWKT, ST_XMin, ST_XMax, ST_YMax, ST_ZMax, ST_ZMin

8.4.39 ST_Z

ST_Z — Return the Z coordinate of the point, or NULL if not available. Input must be a point.

Synopsis

float **ST_Z**(geometry a_point);

Description

Return the Z coordinate of the point, or NULL if not available. Input must be a point.

✓ This method implements the SQL/MM specification.

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

Examples

```
SELECT ST_Z(ST_GeomFromEWKT('POINT(1 2 3 4)'));
 st_z
------
  3
(1 row)
```

See Also

ST_GeomFromEWKT, ST_M, ST_X, ST_Y, ST_ZMax, ST_ZMin

8.4.40 ST_ZMax

ST_ZMax — Returns Z minima of a bounding box 2d or 3d or a geometry.

Synopsis

float **ST_ZMax**(box3d aGeomorBox2DorBox3D);

Description

Returns Z maxima of a bounding box 2d or 3d or a geometry.

> **Note**
> Although this function is only defined for box3d, it will work for box2d and geometry because of the auto-casting behavior defined for geometries and box2d. However you can not feed it a geometry or box2d text representation, since that will not auto-cast.

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

This method supports Circular Strings and Curves

Examples

```
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 autocast the string representation to a ↩
     BOX3D
SELECT ST_ZMax('LINESTRING(1 3 4, 5 6 7)');

--ERROR:  BOX3D parser - doesnt start with BOX3D(

SELECT ST_ZMax(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227  ↩
    150406 3)'));
st_zmax
--------
3
```

See Also

ST_GeomFromEWKT, ST_XMin, ST_XMax, ST_YMax, ST_YMin, ST_ZMax

8.4.41 ST_Zmflag

ST_Zmflag — Returns ZM (dimension semantic) flag of the geometries as a small int. Values are: 0=2d, 1=3dm, 2=3dz, 3=4d.

Synopsis

smallint **ST_Zmflag**(geometry geomA);

Description

Returns ZM (dimension semantic) flag of the geometries as a small int. Values are: 0=2d, 1=3dm, 2=3dz, 3=4d.

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

This method supports Circular Strings and Curves

Examples

```
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
```

See Also

ST_CoordDim, ST_NDims, ST_Dimension

8.4.42 ST_ZMin

ST_ZMin — Returns Z minima of a bounding box 2d or 3d or a geometry.

Synopsis

float **ST_ZMin**(box3d aGeomorBox2DorBox3D);

Description

Returns Z minima of a bounding box 2d or 3d or a geometry.

> **Note**
> Although this function is only defined for box3d, it will work for box2d and geometry because of the auto-casting behavior defined for geometries and box2d. However you can not feed it a geometry or box2d text representation, since that will not auto-cast.

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

This method supports Circular Strings and Curves

Examples

```
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 autocast the string representation to a ↩
     BOX3D
SELECT ST_ZMin('LINESTRING(1 3 4, 5 6 7)');

--ERROR:  BOX3D parser - doesnt start with BOX3D(

SELECT ST_ZMin(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227  ↩
    150406 3)'));
st_zmin
--------
1
```

See Also

ST_GeomFromEWKT, ST_GeomFromText, ST_XMin, ST_XMax, ST_YMax, ST_YMin, ST_ZMax

8.5 Geometry Editors

8.5.1 ST_AddPoint

ST_AddPoint — Adds a point to a LineString before point <position> (0-based index).

Synopsis

geometry **ST_AddPoint**(geometry linestring, geometry point);

geometry **ST_AddPoint**(geometry linestring, geometry point, integer position);

Description

Adds a point to a LineString before point <position> (0-based index). Third parameter can be omitted or set to -1 for appending.

Availability: 1.1.0

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

Examples

```
--guarantee all linestrings in a table are closed
--by adding the start point of each linestring to the end of the line string
--only for those that are not closed
UPDATE sometable
SET the_geom = ST_AddPoint(the_geom, ST_StartPoint(the_geom))
FROM sometable
WHERE ST_IsClosed(the_geom) = false;

--Adding point to a 3-d line
SELECT ST_AsEWKT(ST_AddPoint(ST_GeomFromEWKT('LINESTRING(0 0 1, 1 1 1)'), ST_MakePoint ↩
    (1, 2, 3)));

--result
st_asewkt
----------
LINESTRING(0 0 1,1 1 1,1 2 3)
```

See Also

ST_RemovePoint, ST_SetPoint

8.5.2 ST_Affine

ST_Affine — Applies a 3d affine transformation to the geometry to do things like translate, rotate, scale in one step.

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);

Description

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.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

Availability: 1.1.2. Name changed from Affine to ST_Affine in 1.2.2

Note
Prior to 1.3.4, this function crashes if used with geometries that contain CURVES. This is fixed in 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

Examples

```
--Rotate a 3d line 180 degrees about the z axis.  Note this is long-hand for doing ↩
    ST_Rotate();
 SELECT ST_AsEWKT(ST_Affine(the_geom,  cos(pi()), -sin(pi()), 0,  sin(pi()), cos(pi()), 0,  ↩
      0, 0, 1,  0, 0, 0)) As using_affine,
   ST_AsEWKT(ST_Rotate(the_geom, pi())) As using_rotate
  FROM (SELECT ST_GeomFromEWKT('LINESTRING(1 2 3, 1 4 3)') As the_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(the_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 the_geom) As foo;
           st_asewkt
-------------------------------
 LINESTRING(-1 -2 -3,-1 -4 -3)
(1 row)
```

See Also

ST_Rotate, ST_Scale, ST_Translate, ST_TransScale

8.5.3 ST_Force2D

ST_Force2D — Forces the geometries into a "2-dimensional mode" so that all output representations will only have the X and Y coordinates.

Synopsis

geometry **ST_Force2D**(geometry geomA);

Description

Forces the geometries into a "2-dimensional mode" so that all output representations will only have the X and Y coordinates. This is useful for force OGC-compliant output (since OGC only specifies 2-D geometries).

Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

Changed: 2.1.0. Up to 2.0.x this was called 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.

Examples

```
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))
```

See Also

ST_Force3D

8.5.4 ST_Force3D

ST_Force3D — Forces the geometries into XYZ mode. This is an alias for ST_Force3DZ.

Synopsis

geometry **ST_Force3D**(geometry geomA);

Description

Forces the geometries into XYZ mode. This is an alias for ST_Force_3DZ. If a geometry has no Z component, then a 0 Z coordinate is tacked on.

Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

Changed: 2.1.0. Up to 2.0.x this was called ST_Force_3D.

✓ This function supports Polyhedral surfaces.

✓ This method supports Circular Strings and Curves

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

Examples

```
    --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))
```

See Also

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3DZ

8.5.5 ST_Force3DZ

ST_Force3DZ — Forces the geometries into XYZ mode. This is a synonym for ST_Force3D.

Synopsis

geometry **ST_Force3DZ**(geometry geomA);

Description

Forces the geometries into XYZ mode. This is a synonym for ST_Force3DZ. If a geometry has no Z component, then a 0 Z coordinate is tacked on.

Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

Changed: 2.1.0. Up to 2.0.x this was called ST_Force_3DZ.

This function supports Polyhedral surfaces.

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

This method supports Circular Strings and Curves

Examples

```
--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))
```

See Also

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3D

8.5.6 ST_Force3DM

ST_Force3DM — Forces the geometries into XYM mode.

Synopsis

geometry **ST_Force3DM**(geometry geomA);

Description

Forces the geometries into XYM mode. If a geometry has no M component, then a 0 M coordinate is tacked on. If it has a Z component, then Z is removed

Changed: 2.1.0. Up to 2.0.x this was called ST_Force_3DM.

This method supports Circular Strings and Curves

Examples

```
--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))
```

See Also

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3D, ST_GeomFromEWKT

8.5.7 ST_Force4D

ST_Force4D — Forces the geometries into XYZM mode.

Synopsis

geometry **ST_Force4D**(geometry geomA);

Description

Forces the geometries into XYZM mode. 0 is tacked on for missing Z and M dimensions.

Changed: 2.1.0. Up to 2.0.x this was called ST_Force_4D.

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

✓ This method supports Circular Strings and Curves

Examples

```
--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))
```

See Also

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3D

8.5.8 ST_ForceCollection

ST_ForceCollection — Converts the geometry into a GEOMETRYCOLLECTION.

Synopsis

geometry **ST_ForceCollection**(geometry geomA);

Description

Converts the geometry into a GEOMETRYCOLLECTION. This is useful for simplifying the WKB representation.

Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

Availability: 1.2.2, prior to 1.3.4 this function will crash with Curves. This is fixed in 1.3.4+

Changed: 2.1.0. Up to 2.0.x this was called 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

Examples

```
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))
)
```

See Also

ST_AsEWKT, ST_Force2D, ST_Force3DM, ST_Force3D, ST_GeomFromEWKT

8.5.9 ST_ForceSFS

ST_ForceSFS — Forces the geometries to use SFS 1.1 geometry types only.

Synopsis

geometry **ST_ForceSFS**(geometry geomA);
geometry **ST_ForceSFS**(geometry geomA, text version);

Description

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.

8.5.10 ST_ForceRHR

ST_ForceRHR — Forces the orientation of the vertices in a polygon to follow the Right-Hand-Rule.

Synopsis

geometry **ST_ForceRHR**(geometry g);

Description

Forces the orientation of the vertices in a polygon to follow the Right-Hand-Rule. In GIS terminology, this means that 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.

Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

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

This function supports Polyhedral surfaces.

Examples

```
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)
```

See Also

ST_BuildArea, ST_Polygonize, ST_Reverse

8.5.11 ST_LineMerge

ST_LineMerge — Returns a (set of) LineString(s) formed by sewing together a MULTILINESTRING.

Synopsis

geometry **ST_LineMerge**(geometry amultilinestring);

Description

Returns a (set of) LineString(s) formed by sewing together the constituent line work of a MULTILINESTRING.

> **Note**
> Only use with MULTILINESTRING/LINESTRINGs. If you feed a polygon or geometry collection into this function, it will return an empty GEOMETRYCOLLECTION

Availability: 1.1.0

> **Note**
> requires GEOS >= 2.1.0

Examples

```
SELECT ST_AsText(ST_LineMerge(
ST_GeomFromText('MULTILINESTRING((-29 -27,-30 -29.7,-36 -31,-45 -33),(-45 -33,-46 -32))')
    )
);
st_astext
-------------------------------------------------------------------------------------------------- ←

LINESTRING(-29 -27,-30 -29.7,-36 -31,-45 -33,-46 -32)
(1 row)

--If can't be merged - original MULTILINESTRING is returned
SELECT ST_AsText(ST_LineMerge(
ST_GeomFromText('MULTILINESTRING((-29 -27,-30 -29.7,-36 -31,-45 -33),(-45.2 -33.2,-46 -32)) ←
    ')
)
);
st_astext
----------------
MULTILINESTRING((-45.2 -33.2,-46 -32),(-29 -27,-30 -29.7,-36 -31,-45 -33))
```

See Also

ST_Segmentize, ST_LineSubstring

8.5.12 ST_CollectionExtract

ST_CollectionExtract — Given a (multi)geometry, returns a (multi)geometry consisting only of elements of the specified type.

Synopsis

geometry **ST_CollectionExtract**(geometry collection, integer type);

Description

Given a (multi)geometry, returns a (multi)geometry consisting only of elements of the specified type. Sub-geometries that are not the specified type are ignored. If there are no sub-geometries of the right type, an EMPTY geometry will be returned. Only points, lines and polygons are supported. Type numbers are 1 == POINT, 2 == LINESTRING, 3 == POLYGON.

Warning
When a multipolygon is returned the multipolygon may have shared edges. This results in an invalid multipolygon.

Availability: 1.5.0

Note
Prior to 1.5.3 this function returned non-collection inputs untouched, no matter type. In 1.5.3 non-matching single geometries result in a NULL return. In of 2.0.0 every case of missing match results in a typed EMPTY return.

Examples

```
-- Constants: 1 == POINT, 2 == LINESTRING, 3 == POLYGON
SELECT ST_AsText(ST_CollectionExtract(ST_GeomFromText('GEOMETRYCOLLECTION( ↩
    GEOMETRYCOLLECTION(POINT(0 0)))'),1));
st_astext
---------------
MULTIPOINT(0 0)
(1 row)

SELECT ST_AsText(ST_CollectionExtract(ST_GeomFromText('GEOMETRYCOLLECTION( ↩
    GEOMETRYCOLLECTION(LINESTRING(0 0, 1 1)),LINESTRING(2 2, 3 3))'),2));
st_astext
---------------
MULTILINESTRING((0 0, 1 1), (2 2, 3 3))
(1 row)
```

See Also

ST_Multi, ST_Dump, ST_CollectionHomogenize

8.5.13 ST_CollectionHomogenize

ST_CollectionHomogenize — Given a geometry collection, returns the "simplest" representation of the contents.

Synopsis

geometry **ST_CollectionHomogenize**(geometry collection);

Description

Given a geometry collection, returns the "simplest" representation of the contents. Singletons will be returned as singletons. Collections that are homogeneous will be returned as the appropriate multi-type.

> **Warning**
> When a multipolygon is returned the multipolygon may have shared edges. This results in an invalid multipolygon.

Availability: 2.0.0

Examples

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(POINT(0 0))'));

st_astext
------------
 POINT(0 0)
(1 row)

SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(POINT(0 0),POINT(1 1))'));

st_astext
---------------------
 MULTIPOINT(0 0,1 1)
(1 row)
```

See Also

ST_Multi, ST_CollectionExtract

8.5.14 ST_Multi

ST_Multi — Returns the geometry as a MULTI* geometry. If the geometry is already a MULTI*, it is returned unchanged.

Synopsis

geometry **ST_Multi**(geometry g1);

Description

Returns the geometry as a MULTI* geometry. If the geometry is already a MULTI*, it is returned unchanged.

Examples

```
SELECT ST_AsText(ST_Multi(ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,
      743265 2967450,743265.625 2967416,743238 2967416))')));
      st_astext
      ----------------------------------------------------------------------------------------

      MULTIPOLYGON(((743238 2967416,743238 2967450,743265 2967450,743265.625 2967416,
      743238 2967416)))
      (1 row)
```

See Also

ST_AsText

8.5.15 ST_RemovePoint

ST_RemovePoint — Removes point from a linestring. Offset is 0-based.

Synopsis

geometry **ST_RemovePoint**(geometry linestring, integer offset);

Description

Removes point from a linestring. Useful for turning a closed ring into an open line string

Availability: 1.1.0

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

Examples

```
--guarantee no LINESTRINGS are closed
--by removing the end point.  The below assumes the_geom is of type LINESTRING
UPDATE sometable
  SET the_geom = ST_RemovePoint(the_geom, ST_NPoints(the_geom) - 1)
  FROM sometable
  WHERE ST_IsClosed(the_geom) = true;
```

See Also

ST_AddPoint, ST_NPoints, ST_NumPoints

8.5.16 ST_Reverse

ST_Reverse — Returns the geometry with vertex order reversed.

Synopsis

geometry **ST_Reverse**(geometry g1);

Description

Can be used on any geometry and reverses the order of the vertexes.

Examples

```
SELECT ST_AsText(the_geom) as line, ST_AsText(ST_Reverse(the_geom)) As reverseline
FROM
(SELECT ST_MakeLine(ST_MakePoint(1,2),
    ST_MakePoint(1,10)) As the_geom) as foo;
--result
    line         |     reverseline
---------------------+----------------------
LINESTRING(1 2,1 10) | LINESTRING(1 10,1 2)
```

8.5.17 ST_Rotate

ST_Rotate — Rotate a geometry rotRadians counter-clockwise about an origin.

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);

Description

Rotates geometry rotRadians counter-clockwise about the origin. 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).

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

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).

Examples

```
--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)
```

See Also

ST_Affine, ST_RotateX, ST_RotateY, ST_RotateZ

8.5.18 ST_RotateX

ST_RotateX — Rotate a geometry rotRadians about the X axis.

Synopsis

geometry **ST_RotateX**(geometry geomA, float rotRadians);

Description

Rotate 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)`.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

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).

Examples

```
--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)
```

See Also

ST_Affine, ST_RotateY, ST_RotateZ

8.5.19 ST_RotateY

ST_RotateY — Rotate a geometry rotRadians about the Y axis.

Synopsis

geometry **ST_RotateY**(geometry geomA, float rotRadians);

Description

Rotate 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

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

✓ 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).

Examples

```
--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)
```

See Also

ST_Affine, ST_RotateX, ST_RotateZ

8.5.20 ST_RotateZ

ST_RotateZ — Rotate a geometry rotRadians about the Z axis.

Synopsis

geometry **ST_RotateZ**(geometry geomA, float rotRadians);

Description

Rotate 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).`

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

Availability: 1.1.2. Name changed from RotateZ to ST_RotateZ in 1.2.2

> **Note**
> Prior to 1.3.4, this function crashes if used with geometries that contain CURVES. This is fixed in 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).

Examples

```
--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(the_geom, pi()/2))
FROM (SELECT ST_LineToCurve(ST_Buffer(ST_GeomFromText('POINT(234 567)'), 3)) As the_geom) ↩
    As foo;

                             st_asewkt
----------------------------------------------------------------------------------------------------------------------------

 CURVEPOLYGON(CIRCULARSTRING(-567 237,-564.87867965644 236.12132034356,-564 ↩
    234,-569.12132034356 231.87867965644,-567 237))
```

See Also

ST_Affine, ST_RotateX, ST_RotateY

8.5.21 ST_Scale

ST_Scale — Scales the geometry to a new size by multiplying the ordinates with the parameters. Ie: ST_Scale(geom, Xfactor, Yfactor, Zfactor).

Synopsis

geometry **ST_Scale**(geometry geomA, float XFactor, float YFactor, float ZFactor);
geometry **ST_Scale**(geometry geomA, float XFactor, float YFactor);

Description

Scales the geometry to a new size by multiplying the ordinates with the parameters. Ie: ST_Scale(geom, Xfactor, Yfactor, Zfactor).

> **Note**
> `ST_Scale(geomA, XFactor, YFactor, ZFactor)` is short-hand for `ST_Affine(geomA, XFactor, 0, 0, 0, YFactor, 0, 0, 0, ZFactor, 0, 0, 0)`.

> **Note**
> Prior to 1.3.4, this function crashes if used with geometries that contain CURVES. This is fixed in 1.3.4+

Availability: 1.1.0.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN 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).

Examples

```
--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)
```

See Also

ST_Affine, ST_TransScale

8.5.22 ST_Segmentize

ST_Segmentize — Return a modified geometry/geography having no segment longer than the given distance. Distance computation is performed in 2d only. For geometry, length units are in units of spatial reference. For geography, units are in meters.

Synopsis

geometry **ST_Segmentize**(geometry geom, float max_segment_length);
geography **ST_Segmentize**(geography geog, float max_segment_length);

Description

Returns a modified geometry having no segment longer than the given `max_segment_length`. Distance computation is performed in 2d only. For geometry, length units are in units of spatial reference. For geography, units are in meters.

Availability: 1.2.2

Enhanced: 2.1.0 support for geography was introduced.

Changed: 2.1.0 As a result of the introduction of geography support: The construct `SELECT ST_Segmentize('LINESTRING(1 2, 3 4)',0.5);` will result in ambiguous function error. You need to have properly typed object e.g. a geometry/geography column, use ST_GeomFromText, ST_GeogFromText or `SELECT ST_Segmentize('LINESTRING(1 2, 3 4)'::geometry,0.5);`

Note
This will only increase segments. It will not lengthen segments shorter than max length

Examples

```
SELECT ST_AsText(ST_Segmentize(
ST_GeomFromText('MULTILINESTRING((-29 -27,-30 -29.7,-36 -31,-45 -33),(-46 -32))')
    ,5)
);
st_astext
--------------------------------------------------------------------------------------------------- ←

MULTILINESTRING((-29 -27,-30 -29.7,-34.886615700134 -30.758766735029,-36 -31,
-40.8809353009198 -32.0846522890933,-45 -33),
(-45 -33,-46 -32))
(1 row)

SELECT ST_AsText(ST_Segmentize(ST_GeomFromText('POLYGON((-29 28, -30 40, -29 28))'),10));
st_astext
```

```
-----------------------
POLYGON((-29 28,-29.8304547985374 37.9654575824488,-30 40,-29.1695452014626  ↩
    30.0345424175512,-29 28))
(1 row)
```

See Also

ST_LineSubstring

8.5.23 ST_SetPoint

ST_SetPoint — Replace point N of linestring with given point. Index is 0-based.

Synopsis

geometry **ST_SetPoint**(geometry linestring, integer zerobasedposition, geometry point);

Description

Replace point N of linestring with given point. Index is 0-based. This is especially useful in triggers when trying to maintain relationship of joints when one vertex moves.

Availability: 1.1.0

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

Examples

```
--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.the_geom, ST_NumPoints(foo.the_geom) - 1, ST_GeomFromEWKT ↩
    ('POINT(-1 1 3)')))
FROM (SELECT ST_GeomFromEWKT('LINESTRING(-1 2 3,-1 3 4, 5 6 7)') As the_geom) As foo;
     st_asewkt
-----------------------
LINESTRING(-1 2 3,-1 3 4,-1 1 3)
```

See Also

ST_AddPoint, ST_NPoints, ST_NumPoints, ST_PointN, ST_RemovePoint

8.5.24 ST_SetSRID

ST_SetSRID — Sets the SRID on a geometry to a particular integer value.

Synopsis

geometry **ST_SetSRID**(geometry geom, integer srid);

Description

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 OpenGIS Simple Features Implementation Specification for SQL 1.1.

This method supports Circular Strings and Curves

Examples

-- 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)
```

See Also

Section 4.3.1, ST_AsEWKT, ST_Point, ST_SRID, ST_Transform, UpdateGeometrySRID

8.5.25 ST_SnapToGrid

ST_SnapToGrid — Snap all points of the input geometry to a regular grid.

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);

Description

Variant 1,2,3: Snap all points of the input geometry to the grid defined by its origin and cell size. Remove consecutive points falling on the same cell, eventually returning NULL if output points are not enough to define a geometry of the given type. Collapsed geometries in a collection are stripped from it. Useful for reducing precision.

Variant 4: Introduced 1.1.0 - Snap all points of the input geometry to the grid defined by its origin (the second argument, must be a point) and cell sizes. Specify 0 as size for any dimension you don't want to snap to a grid.

Note
The returned geometry might loose its simplicity (see ST_IsSimple).

Note
Before release 1.1.0 this function always returned a 2d geometry. Starting at 1.1.0 the returned geometry will have same dimensionality as the input one with higher dimension values untouched. Use the version taking a second geometry argument to define all grid dimensions.

Availability: 1.0.0RC1

Availability: 1.1.0 - Z and M support

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

Examples

```
--Snap your geometries to a precision grid of 10^-3
UPDATE mytable
   SET the_geom = ST_SnapToGrid(the_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)
```

See Also

ST_Snap, ST_AsEWKT, ST_AsText, ST_GeomFromText, ST_GeomFromEWKT, ST_Simplify

8.5.26 ST_Snap

ST_Snap — Snap segments and vertices of input geometry to vertices of a reference geometry.

Synopsis

geometry **ST_Snap**(geometry input, geometry reference, float tolerance);

Description

Snaps the vertices and segments of a geometry another Geometry's vertices. A snap distance tolerance is used to control where snapping is performed.

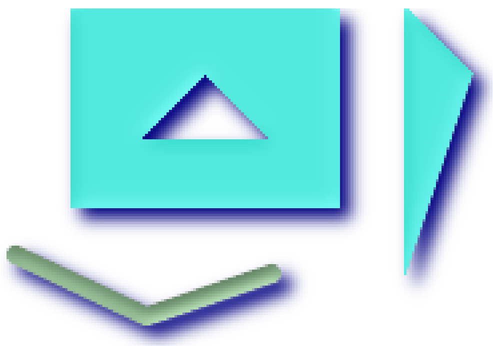
Snapping one geometry to another can improve robustness for overlay operations by eliminating nearly-coincident edges (which cause problems during noding and intersection calculation).

Too much snapping can result in invalid topology being created, so the number and location of snapped vertices is decided using heuristics to determine when it is safe to snap. This can result in some potential snaps being omitted, however.

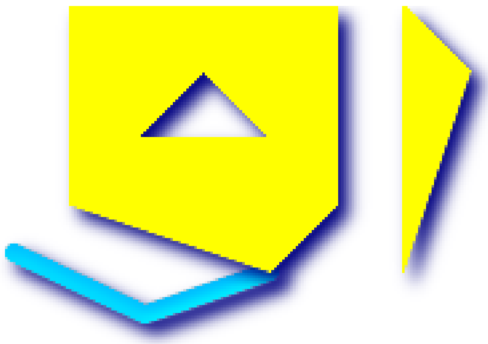
Note
The returned geometry might loose its simplicity (see ST_IsSimple) and validity (see ST_IsValid).

Availability: 2.0.0 requires GEOS >= 3.3.0.

Examples



A multipolygon shown with a linestring (before any snapping)

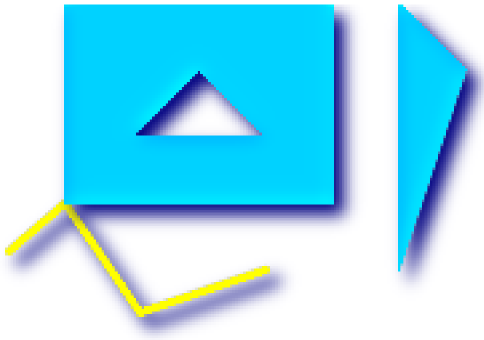


A multipolygon snapped to linestring to tolerance: 1.01 of distance. The new multipolygon is shown with reference linestring

```
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)))
```

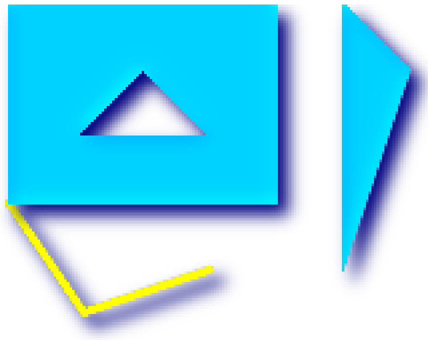
A multipolygon snapped to linestring to tolerance: 1.25 of distance. The new multipolygon is shown with reference linestring

```
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)))
```



The linestring snapped to the original multipolygon at tolerance 1.01 of distance. The new linestring is shown with reference multipolygon

```
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)
```



The linestring snapped to the original multipolygon at tolerance 1.25 of distance. The new linestring is shown with reference multipolygon

```
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)
```

See Also

ST_SnapToGrid

8.5.27 ST_Transform

ST_Transform — Returns a new geometry with its coordinates transformed to the SRID referenced by the integer parameter.

Synopsis

geometry **ST_Transform**(geometry g1, integer srid);

Description

Returns a new geometry with its coordinates transformed to spatial reference system referenced by the SRID integer parameter. The destination SRID must exist in the `SPATIAL_REF_SYS` table.

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

> **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**
> Prior to 1.3.4, this function crashes if used with geometries that contain CURVES. This is fixed in 1.3.4+

Enhanced: 2.0.0 support for Polyhedral surfaces 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.

Examples

Change Mass 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_the_geom_26986_parcels
  ON parcels
  USING gist
  (ST_Transform(the_geom, 26986))
  WHERE the_geom IS NOT NULL;
```

Configuring transformation behaviour

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 behaviour can be configured on a per-SRID basis by 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;
```

See Also

PostGIS_Full_Version, ST_AsText, ST_SetSRID, UpdateGeometrySRID

8.5.28 ST_Translate

ST_Translate — Translates the geometry to a new location using the numeric parameters as offsets. Ie: ST_Translate(geom, X, Y) or ST_Translate(geom, X, Y,Z).

Synopsis

geometry **ST_Translate**(geometry g1, float deltax, float deltay);
geometry **ST_Translate**(geometry g1, float deltax, float deltay, float deltaz);

Description

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**
> Prior to 1.3.4, this function crashes if used with geometries that contain CURVES. This is fixed in 1.3.4+

Availability: 1.2.2

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

✓ This method supports Circular Strings and Curves

Examples

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));
                             st_astext
------------------------------------------------------------------------------------------------------------

 GEOMETRYCOLLECTION(CURVEPOLYGON(CIRCULARSTRING(5 5,4.12 2.878,2 2,-0.121 7.1213,7 9,9 11,5 ↵
      5)),POINT(2 5))
```

See Also

ST_Affine, ST_AsText, ST_GeomFromText

8.5.29 ST_TransScale

ST_TransScale — Translates the geometry using the deltaX and deltaY args, then scales it using the XFactor, YFactor args, working in 2D only.

Synopsis

geometry **ST_TransScale**(geometry geomA, float deltaX, float deltaY, float XFactor, float YFactor);

Description

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**
> Prior to 1.3.4, this function crashes if used with geometries that contain CURVES. This is fixed in 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

Examples

```
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));
                              st_astext
------------------------------------------------------------------------------------------------------

 CURVEPOLYGON(CIRCULARSTRING(714 2276,711.363961030679 2267.51471862576,705 ↩
    2264,698.636038969321 2284.48528137424,714 2276))
```

See Also

ST_Affine, ST_Translate

8.6 Geometry Outputs

8.6.1 ST_AsBinary

ST_AsBinary — Return the 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);

Description

Returns the Well-Known Binary representation of the geometry. There are 2 variants of the function. The first variant takes no endian encoding parameter and defaults to server machine endian. The second variant takes a second argument denoting the encoding - using little-endian ('NDR') or big-endian ('XDR') encoding.

This is useful in binary cursors to pull data out of the database without converting it to a string representation.

> **Note**
> The WKB spec does not include the SRID. To get the WKB with SRID format use ST_AsEWKB

> **Note**
> ST_AsBinary is the reverse of ST_GeomFromWKB for geometry. Use ST_GeomFromWKB to convert to a postgis geometry from ST_AsBinary representation.

> **Note**
> The default behavior in PostgreSQL 9.0 has been changed to output bytea in hex encoding. ST_AsBinary is the reverse of ST_GeomFromWKB for geometry. If your GUI tools require the old behavior, then SET bytea_output='escape' in your database.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

Enhanced: 2.0.0 support for higher coordinate dimensions was introduced.

Enhanced: 2.0.0 support for specifying endian with geography was introduced.

Availability: 1.5.0 geography support was introduced.

Changed: 2.0.0 Inputs to this function can not be unknown -- must be geometry. Constructs such as `ST_AsBinary('POINT(1 2)')` are no longer valid and you will get an `n st_asbinary(unknown) is not unique error`. Code like that needs to be changed to `ST_AsBinary('POINT(1 2)'::geometry);`. If that is not possible, then install `legacy.sql`.

This method implements the OpenGIS 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.

Examples

```
SELECT ST_AsBinary(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

       st_asbinary
--------------------------------
\001\003\000\000\000\001\000\000\000\005
\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000
\000\000\000\360?\000\000\000\000\000\000
\360?\000\000\000\000\000\000\360?\000\000
\000\000\000\000\360?\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000
(1 row)
```

```
SELECT ST_AsBinary(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326), 'XDR');
       st_asbinary
--------------------------------
\000\000\000\000\003\000\000\000\001\000\000\000\005\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000
\000?\360\000\000\000\000\000\000?\360\000\000\000\000\000\000?\360\000\000
\000\000\000\000?\360\000\000\000\000\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000
(1 row)
```

See Also

ST_GeomFromWKB ST_AsEWKB, ST_AsText,

8.6.2 ST_AsEWKB

ST_AsEWKB — Return the Well-Known Binary (WKB) representation of the geometry with SRID meta data.

Synopsis

bytea **ST_AsEWKB**(geometry g1);
bytea **ST_AsEWKB**(geometry g1, text NDR_or_XDR);

Description

Returns the Well-Known Binary representation of the geometry with SRID metadata. There are 2 variants of the function. The first variant takes no endian encoding parameter and defaults to little endian. The second variant takes a second argument denoting the encoding - using little-endian ('NDR') or big-endian ('XDR') encoding.

This is useful in binary cursors to pull data out of the database without converting it to a string representation.

Note
The WKB spec does not include the SRID. To get the OGC WKB format use ST_AsBinary

> **Note**
> ST_AsEWKB is the reverse of ST_GeomFromEWKB. Use ST_GeomFromEWKB to convert to a postgis geometry from ST_AsEWKB representation.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

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).

Examples

```
SELECT ST_AsEWKB(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

       st_asewkb
--------------------------------
\001\003\000\000 \346\020\000\000\001\000
\000\000\005\000\000\000\000
\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000
\000\000\360?\000\000\000\000\000\000\360?
\000\000\000\000\000\000\360?\000\000\000\000\000
\000\360?\000\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000\000\000
(1 row)
```

```
      SELECT ST_AsEWKB(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326), 'XDR');
       st_asewkb
--------------------------------
\000 \000\000\003\000\000\020\346\000\000\000\001\000\000\000\005\000\000\000\000\
000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000?
\360\000\000\000\000\000\000?\360\000\000\000\000\000\000?\360\000\000\000\000
\000\000?\360\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000\000\000
```

See Also

ST_AsBinary, ST_AsEWKT, ST_AsText, ST_GeomFromEWKT, ST_SRID

8.6.3 ST_AsEWKT

ST_AsEWKT — Return the Well-Known Text (WKT) representation of the geometry with SRID meta data.

Synopsis

text **ST_AsEWKT**(geometry g1);
text **ST_AsEWKT**(geography g1);

Description

Returns the Well-Known Text representation of the geometry prefixed with the SRID.

> **Note**
> The WKT spec does not include the SRID. To get the OGC WKT format use ST_AsText

WKT format does not maintain precision so to prevent floating truncation, use ST_AsBinary or ST_AsEWKB format for transport.

> **Note**
> ST_AsEWKT is the reverse of ST_GeomFromEWKT. Use ST_GeomFromEWKT to convert to a postgis geometry from ST_AsEWKT representation.

Enhanced: 2.0.0 support for Geography, Polyhedral surfaces, Triangles and TIN was introduced.

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).

Examples

```
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)
```

See Also

ST_AsBinaryST_AsEWKBST_AsText, ST_GeomFromEWKT

8.6.4 ST_AsGeoJSON

ST_AsGeoJSON — Return the geometry as a GeoJSON element.

Synopsis

text **ST_AsGeoJSON**(geometry geom, integer maxdecimaldigits=15, integer options=0);
text **ST_AsGeoJSON**(geography geog, integer maxdecimaldigits=15, integer options=0);
text **ST_AsGeoJSON**(integer gj_version, geometry geom, integer maxdecimaldigits=15, integer options=0);
text **ST_AsGeoJSON**(integer gj_version, geography geog, integer maxdecimaldigits=15, integer options=0);

Description

Return the geometry as a Geometry Javascript Object Notation (GeoJSON) element. (Cf GeoJSON specifications 1.0). 2D and 3D Geometries are both supported. GeoJSON only support SFS 1.1 geometry type (no curve support for example).

The gj_version parameter is the major version of the GeoJSON spec. If specified, must be 1. This represents the spec version of GeoJSON.

The third argument may be used to reduce the maximum number of decimal places used in output (defaults to 15).

The last 'options' argument could be used to add Bbox or Crs in GeoJSON output:

- 0: means no option (default value)
- 1: GeoJSON Bbox
- 2: GeoJSON Short CRS (e.g EPSG:4326)
- 4: GeoJSON Long CRS (e.g urn:ogc:def:crs:EPSG::4326)

Version 1: ST_AsGeoJSON(geom) / precision=15 version=1 options=0

Version 2: ST_AsGeoJSON(geom, precision) / version=1 options=0

Version 3: ST_AsGeoJSON(geom, precision, options) / version=1

Version 4: ST_AsGeoJSON(gj_version, geom) / precision=15 options=0

Version 5: ST_AsGeoJSON(gj_version, geom, precision) /options=0

Version 6: ST_AsGeoJSON(gj_version, geom, precision,options)

Availability: 1.3.4

Availability: 1.5.0 geography support was introduced.

Changed: 2.0.0 support default args and named args.

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

Examples

GeoJSON format is generally more efficient than other formats for use in ajax mapping. One popular javascript client that supports this is Open Layers. Example of its use is OpenLayers GeoJSON Example

```
SELECT ST_AsGeoJSON(the_geom) from fe_edges limit 1;
             st_asgeojson
----------------------------------------------------------------------------------------------------



{"type":"MultiLineString","coordinates":[[[-89.734634999999997,31.492072000000000],
```

```
[-89.734955999999997,31.492237999999997]]]}
(1 row)
--3d point
SELECT ST_AsGeoJSON('LINESTRING(1 2 3, 4 5 6)');

st_asgeojson
-----------------------------------------------------------------------------------------
 {"type":"LineString","coordinates":[[1,2,3],[4,5,6]]}
```

8.6.5 ST_AsGML

ST_AsGML — Return the geometry as a GML version 2 or 3 element.

Synopsis

text **ST_AsGML**(geometry geom, integer maxdecimaldigits=15, integer options=0);
text **ST_AsGML**(geography geog, integer maxdecimaldigits=15, integer options=0);
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);

Description

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 precision argument may be used to reduce the maximum number of decimal places (`maxdecimaldigits`) used in output (defaults to 15).

GML 2 refer to 2.1.2 version, GML 3 to 3.1.1 version

The 'options' argument is a bitfield. It could be used to define CRS output type in GML output, and to declare data as lat/lon:

- 0: GML Short CRS (e.g EPSG:4326), default value
- 1: GML Long CRS (e.g urn:ogc:def:crs:EPSG::4326)
- 2: For GML 3 only, remove srsDimension attribute from output.
- 4: For GML 3 only, use <LineString> rather than <Curve> tag for lines.
- 16: Declare that datas are lat/lon (e.g srid=4326). Default is to assume that data are planars. This option is useful for GML 3.1.1 output only, related to axis order. So if you set it, it will swap the coordinates so order is lat lon instead of database lon lat.
- 32: Output the box of the geometry (envelope).

The 'namespace prefix' argument may be used to specify a custom namespace prefix or no prefix (if empty). If null or omitted 'gml' prefix is used

Availability: 1.3.2

Availability: 1.5.0 geography support was introduced.

Enhanced: 2.0.0 prefix support was introduced. Option 4 for GML3 was introduced to allow using LineString instead of Curve tag for lines. GML3 Support for Polyhedral surfaces and TINS was introduced. Option 32 was introduced to output the box.

Changed: 2.0.0 use default named args

Enhanced: 2.1.0 id support was introduced, for GML 3.

Note
Only version 3+ of ST_AsGML supports Polyhedral Surfaces and TINS.

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).

Examples: Version 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>
```

Examples: Version 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>
```

See Also

ST_GeomFromGML

8.6.6 ST_AsHEXEWKB

ST_AsHEXEWKB — Returns a Geometry in HEXEWKB format (as text) using either little-endian (NDR) or big-endian (XDR) encoding.

Synopsis

text **ST_AsHEXEWKB**(geometry g1, text NDRorXDR);
text **ST_AsHEXEWKB**(geometry g1);

Description

Returns a Geometry in HEXEWKB format (as text) using either little-endian (NDR) or big-endian (XDR) encoding. If no encoding is specified, then NDR is used.

Note
Availability: 1.2.2

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

This method supports Circular Strings and Curves

Examples

```
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
    --------
    0103000020E6100000010000000500
    00000000000000000000000000000000
    00000000000000000000000000000000F03F
    000000000000F03F000000000000F03F000000000000F03
    F000000000000000000000000000000000000000000000000
```

8.6.7 ST_AsKML

ST_AsKML — Return the geometry as a KML element. Several variants. Default version=2, default precision=15

Synopsis

text **ST_AsKML**(geometry geom, integer maxdecimaldigits=15);
text **ST_AsKML**(geography geog, integer maxdecimaldigits=15);
text **ST_AsKML**(integer version, geometry geom, integer maxdecimaldigits=15, text nprefix=NULL);
text **ST_AsKML**(integer version, geography geog, integer maxdecimaldigits=15, text nprefix=NULL);

Description

Return the geometry as a Keyhole Markup Language (KML) element. There are several variants of this function. maximum number of decimal places used in output (defaults to 15), version default to 2 and default namespace is no prefix.

Version 1: ST_AsKML(geom_or_geog, maxdecimaldigits) / version=2 / maxdecimaldigits=15

Version 2: ST_AsKML(version, geom_or_geog, maxdecimaldigits, nprefix) maxdecimaldigits=15 / nprefix=NULL

Note
Requires PostGIS be compiled with Proj support. Use PostGIS_Full_Version to confirm you have proj support compiled in.

Note
Availability: 1.2.2 - later variants that include version param came in 1.3.2

Note
Enhanced: 2.0.0 - Add prefix namespace. Default is no prefix

Note
Changed: 2.0.0 - uses default args and supports named args

Note
AsKML output will not work with geometries that do not have an SRID

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

Examples

```
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>
```

See Also

ST_AsSVG, ST_AsGML

8.6.8 ST_AsSVG

ST_AsSVG — Returns a Geometry in SVG path data given a geometry or geography object.

Synopsis

text **ST_AsSVG**(geometry geom, integer rel=0, integer maxdecimaldigits=15);
text **ST_AsSVG**(geography geog, integer rel=0, integer maxdecimaldigits=15);

Description

Return the geometry as Scalar Vector Graphics (SVG) path data. Use 1 as second argument to have the path data implemented in terms of relative moves, the default (or 0) uses absolute moves. Third argument may be used to reduce the maximum number of decimal digits used in output (defaults to 15). Point geometries will be rendered as cx/cy when 'rel' arg is 0, x/y when 'rel' is 1. Multipoint geometries are delimited by commas (","), GeometryCollection geometries are delimited by semicolons (";").

> **Note**
> Availability: 1.2.2. Availability: 1.4.0 Changed in PostGIS 1.4.0 to include L command in absolute path to conform to http://www.w3.org/TR/SVG/paths.html#PathDataBNF

Changed: 2.0.0 to use default args and support named args

Examples

```
SELECT ST_AsSVG(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

    st_assvg
    --------
    M 0 0 L 0 -1 1 -1 1 0 Z
```

8.6.9 ST_AsX3D

ST_AsX3D — Returns a Geometry in X3D xml node element format: ISO-IEC-19776-1.2-X3DEncodings-XML

Synopsis

text **ST_AsX3D**(geometry g1, integer maxdecimaldigits=15, integer options=0);

Description

Returns a geometry as an X3D xml formatted node element http://www.web3d.org/standards/number/19776-1. If `maxdecimaldigits` (precision) is not specified then defaults to 15.

> **Note**
> There are various options for translating PostGIS geometries to X3D since X3D geometry types don't map directly to PostGIS geometry types and some newer X3D types that might be better mappings we ahve avoided since most rendering tools don't currently support them. These are the mappings we have settled on. Feel free to post a bug ticket if you have thoughts on the idea or ways we can allow people to denote their preferred mappings.
> Below is how we currently map PostGIS 2D/3D types to X3D types

PostGIS Type	2D X3D Type	3D X3D Type
LINESTRING	not yet implemented - will be PolyLine2D	LineSet
MULTILINESTRING	not yet implemented - will be PolyLine2D	IndexedLineSet
MULTIPOINT	Polypoint2D	PointSet
POINT	outputs the space delimited coordinates	outputs the space delimited coordinates
(MULTI) POLYGON, POLYHEDRALSURFACE	Invalid X3D markup	IndexedFaceSet (inner rings currently output as another faceset)
TIN	TriangleSet2D (Not Yet Implemented)	IndexedTriangleSet

Note
2D geometry support not yet complete. Inner rings currently just drawn as separate polygons. We are working on these.

Lots of advancements happening in 3D space particularly with X3D Integration with HTML5

There is also a nice open source X3D viewer you can use to view rendered geometries. Free Wrl http://freewrl.sourceforge.net/ binaries available for Mac, Linux, and Windows. Use the FreeWRL_Launcher packaged to view the geometries.

Also check out PostGIS minimalist X3D viewer that utilizes this function and x3dDom html/js open source toolkit.

Availability: 2.0.0: ISO-IEC-19776-1.2-X3DEncodings-XML

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).

Example: Create a fully functional X3D document - This will generate a cube that is viewable in FreeWrl and other X3D viewers.

```
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 1 0 0  ↩
                1 0 1 0 0 1 1 1 0 1 1 1 1 0 1 1 0 0 0 1 0 0 1 1 1 1 1 1 1 0 0 0 1 1 0 1 1 1  ↩
                1 0 1 1' />
      </IndexedFaceSet>
      </Shape>
    </Transform>
  </Scene>
</X3D>
```

Example: An Octagon elevated 3 Units and decimal precision of 6

```
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>
```

Example: 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>
```

Example: Closed multilinestring (the boundary of a polygon with holes)

```
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>
```

8.6.10 ST_GeoHash

ST_GeoHash — Return a GeoHash representation of the geometry.

Synopsis

text **ST_GeoHash**(geometry geom, integer maxchars=full_precision_of_point);

Description

Return a GeoHash representation (http://en.wikipedia.org/wiki/Geohash) of the geometry. A GeoHash encodes a 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 also be thought of as a box, that contains the actual point.

If no `maxchars` is specficified ST_GeoHash returns a GeoHash based on full precision of the input geometry type. Points return a GeoHash with 20 characters of precision (about enough to hold the full double precision of the input). Other types return a GeoHash with a variable amount of precision, based on the size of the feature. Larger features are represented with less precision, smaller features with more precision. The idea is that the box implied by the GeoHash will always contain the input feature.

If `maxchars` is specified ST_GeoHash returns a GeoHash with at most that many characters so 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.

Availability: 1.4.0

Note
ST_GeoHash will not work with geometries that are not in geographic (lon/lat) coordinates.

This method supports Circular Strings and Curves

Examples

```
SELECT ST_GeoHash(ST_SetSRID(ST_MakePoint(-126,48),4326));

   st_geohash
----------------------
 c0w3hf1s70w3hf1s70w3
```

```
SELECT ST_GeoHash(ST_SetSRID(ST_MakePoint(-126,48),4326),5);

 st_geohash
------------
 c0w3h
```

See Also

ST_GeomFromGeoHash

8.6.11 ST_AsText

ST_AsText — Return the Well-Known Text (WKT) representation of the geometry/geography without SRID metadata.

Synopsis

text **ST_AsText**(geometry g1);
text **ST_AsText**(geography g1);

Description

Returns the Well-Known Text representation of the geometry/geography.

> **Note**
> The WKT spec does not include the SRID. To get the SRID as part of the data, use the non-standard PostGIS ST_AsEWKT

WKT format does not maintain precision so to prevent floating truncation, use ST_AsBinary or ST_AsEWKB format for transport.

> **Note**
> ST_AsText is the reverse of ST_GeomFromText. Use ST_GeomFromText to convert to a postgis geometry from ST_AsText representation.

Availability: 1.5 - support for geography was introduced.

This method implements the OpenGIS 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

Examples

```
SELECT ST_AsText('01030000000100000005000000000000000000
000000000000000000000000000000000000000000000000
F03F000000000000F03F000000000000F03F000000000000F03
F000000000000000000000000000000000000000000000000');

       st_astext
--------------------------------
 POLYGON((0 0,0 1,1 1,1 0,0 0))
(1 row)
```

See Also

ST_AsBinary, ST_AsEWKB, ST_AsEWKT, ST_GeomFromText

8.6.12 ST_AsLatLonText

ST_AsLatLonText — Return the Degrees, Minutes, Seconds representation of the given point.

Synopsis

text **ST_AsLatLonText**(geometry pt);
text **ST_AsLatLonText**(geometry pt, text format);

Description

Returns the Degrees, Minutes, Seconds representation of the point.

> **Note**
> It is assumed the point is in a lat/lon projection. The X (lon) and Y (lat) coordinates are normalized in the output to the "normal" range (-180 to +180 for lon, -90 to +90 for lat).

The text parameter is a format string containing the format for the resulting text, similar to a date format string. Valid tokens are "D" for degrees, "M" for minutes, "S" for seconds, and "C" for cardinal direction (NSEW). DMS tokens may be repeated to indicate desired width and precision ("SSS.SSSS" means " 1.0023").

"M", "S", and "C" are optional. If "C" is omitted, degrees are shown with a "-" sign if south or west. If "S" is omitted, minutes will be shown as decimal with as many digits of precision as you specify. If "M" is also omitted, degrees are shown as decimal with as many digits precision as you specify.

If the format string is omitted (or zero-length) a default format will be used.

Availability: 2.0

Examples

Default format.

```
SELECT (ST_AsLatLonText('POINT (-3.2342342 -2.32498)'));
      st_aslatlontext
----------------------------
 2\textdegree{}19'29.928"S 3\textdegree{}14'3.243"W
```

Providing a format (same as the default).

```
SELECT (ST_AsLatLonText('POINT (-3.2342342 -2.32498)', 'D\textdegree{}M''S.SSS"C'));
      st_aslatlontext
----------------------------
 2\textdegree{}19'29.928"S 3\textdegree{}14'3.243"W
```

Characters other than D, M, S, C and . are just passed through.

```
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
```

Signed degrees instead of cardinal directions.

```
SELECT (ST_AsLatLonText('POINT (-3.2342342 -2.32498)', 'D\textdegree{}M''S.SSS"'));
      st_aslatlontext
----------------------------
 -2\textdegree{}19'29.928" -3\textdegree{}14'3.243"
```

Decimal degrees.

```
SELECT (ST_AsLatLonText('POINT (-3.2342342 -2.32498)', 'D.DDDD degrees C'));
          st_aslatlontext
-----------------------------------
 2.3250 degrees S 3.2342 degrees W
```

Excessively large values are normalized.

```
SELECT (ST_AsLatLonText('POINT (-302.2342342 -792.32498)'));
        st_aslatlontext
-------------------------------
 72\textdegree{}19'29.928"S 57\textdegree{}45'56.757"E
```

8.7 Operators

8.7.1 &&

&& — Returns `TRUE` if A's 2D bounding box intersects B's 2D bounding box.

Synopsis

boolean **&&**(geometry A , geometry B);
boolean **&&**(geography A , geography B);

Description

The `&&` operator returns `TRUE` if the 2D bounding box of geometry A intersects the 2D bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

Availability: 1.5.0 support for geography was introduced.

This method supports Circular Strings and Curves

This function supports Polyhedral surfaces.

Examples

```
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)
```

See Also

|&>, &>, &<|, &<, ~, @

8.7.2 &&&

&&& — Returns `TRUE` if A's n-D bounding box intersects B's n-D bounding box.

Synopsis

boolean **&&&**(geometry A , geometry B);

Description

The `&&&` operator returns `TRUE` if the n-D bounding box of geometry A intersects the n-D bounding box of geometry B.

Note
This operand will make use of any indexes that may be available on the geometries.

Availability: 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.

Examples: 3D LineStrings

```
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
```

Examples: 3M LineStrings

```
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
```

See Also

&&

8.7.3 &<

&< — Returns `TRUE` if A's bounding box overlaps or is to the left of B's.

Synopsis

boolean **&<**(geometry A , geometry B);

Description

The `&<` operator returns `TRUE` if the bounding box of geometry A overlaps or is to the left of the bounding box of geometry B, or more accurately, overlaps or is NOT to the right of the bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

&&, |&>, &>, &<|

8.7.4 &<|

&<| — Returns `TRUE` if A's bounding box overlaps or is below B's.

Synopsis

boolean **&<|**(geometry A , geometry B);

Description

The `&<|` operator returns `TRUE` if the bounding box of geometry A overlaps or is below of the bounding box of geometry B, or more accurately, overlaps or is NOT above the bounding box of geometry B.

This method supports Circular Strings and Curves

This function supports Polyhedral surfaces.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

&&, |&>, &>, &<

8.7.5 &>

&> — Returns `TRUE` if A' bounding box overlaps or is to the right of B's.

Synopsis

boolean **&>**(geometry A , geometry B);

Description

The `&>` operator returns `TRUE` if the bounding box of geometry A overlaps or is to the right of the bounding box of geometry B, or more accurately, overlaps or is NOT to the left of the bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

&&, |&>, &<|, &<

8.7.6 <<

<< — Returns `TRUE` if A's bounding box is strictly to the left of B's.

Synopsis

boolean **<<**(geometry A , geometry B);

Description

The << operator returns `TRUE` if the bounding box of geometry A is strictly to the left of the bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

>>, |>>, <<|

8.7.7 <<|

<<| — Returns `TRUE` if A's bounding box is strictly below B's.

Synopsis

boolean **<<|**(geometry A , geometry B);

Description

The `<<|` operator returns `TRUE` if the bounding box of geometry A is strictly below the bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

<<, >>, |>>

8.7.8 =

= — Returns `TRUE` if A's bounding box is the same as B's. Uses double precision bounding box.

Synopsis

boolean =(geometry A , geometry B);
boolean =(geography A , geography B);

Description

The = operator returns `TRUE` if the bounding box of geometry/geography A is the same as the bounding box 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).

> **Warning**
> This is cause for a lot of confusion. When you compare geometryA = geometryB it will return true even when the geometries are clearly different IF their bounding boxes are the same. To check for true equality use ST_OrderingEquals or ST_Equals

---

Caution
This operand will NOT make use of any indexes that may be available on the geometries.

This method supports Circular Strings and Curves

This function supports Polyhedral surfaces.

Changed: 2.0.0 , the bounding box of geometries was changed to use double precision instead of float4 precision of prior. The side effect of this is that in particular points in prior versions that were a little different may have returned true in prior versions and false in 2.0+ since their float4 boxes would be the same but there float8 (double precision), would be different.

Examples

```
SELECT 'LINESTRING(0 0, 0 1, 1 0)'::geometry = 'LINESTRING(1 1, 0 0)'::geometry;
 ?column?
----------
 t
(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)
(1 row)

-- 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
```

See Also

ST_Equals, ST_OrderingEquals

8.7.9 >>

>> — Returns TRUE if A's bounding box is strictly to the right of B's.

Synopsis

boolean **>>**(geometry A , geometry B);

Description

The >> operator returns `TRUE` if the bounding box of geometry A is strictly to the right of the bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

<<, |>>, <<|

8.7.10 @

@ — Returns `TRUE` if A's bounding box is contained by B's.

Synopsis

boolean @(geometry A , geometry B);

Description

The `@` operator returns `TRUE` if the bounding box of geometry A is completely contained by the bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

~, &&

8.7.11 |&>

|&> — Returns TRUE if A's bounding box overlaps or is above B's.

Synopsis

boolean **|&>**(geometry A , geometry B);

Description

The `|&>` operator returns TRUE if the bounding box of geometry A overlaps or is above the bounding box of geometry B, or more accurately, overlaps or is NOT below the bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

&&, &>, &<|, &<

8.7.12 |>>

|>> — Returns TRUE if A's bounding box is strictly above B's.

Synopsis

boolean **|>>**(geometry A , geometry B);

Description

The |>> operator returns TRUE if the bounding box of geometry A is strictly to the right of the bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

<<, >>, <<|

8.7.13 ~

~ — Returns TRUE if A's bounding box contains B's.

Synopsis

boolean ~(geometry A , geometry B);

Description

The ~ operator returns TRUE if the bounding box of geometry A completely contains the bounding box of geometry B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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)
```

See Also

@, &&

8.7.14 ~=

~= — Returns TRUE if A's bounding box is the same as B's.

Synopsis

boolean ~=(geometry A , geometry B);

Description

The ~= operator returns TRUE if the bounding box of geometry/geography A is the same as the bounding box of geometry/geography B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Availability: 1.5.0 changed behavior

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 and to check for bounding box equality =; operator is a safer option.

Examples

```
select 'LINESTRING(0 0, 1 1)'::geometry ~= 'LINESTRING(0 1, 1 0)'::geometry as equality;
 equality   |
-----------------+
          t     |
```

The above can be used to test if you have the new or old behavior of ~= operator.

See Also

ST_Equals, ST_OrderingEquals, =

8.7.15 <->

<-> — Returns the 2D distance between the centroids of A and B bounding boxes.

Synopsis

double precision **<->**(geometry A , geometry B);

Description

The <-> operator returns the 2D distance between the centroids of the bounding boxes of two geometries. Useful for doing nearest neighbor **approximate** distance ordering.

Note
This operand will make use of 2D GiST indexes that may be available on the geometries. It is different from other operators that use spatial indexes in that the spatial index is only used when the operator is in the ORDER BY clause.

Note
Index only kicks in if one of the geometries is a constant (not in a subquery/cte). e.g. 'SRID=3005;POINT(1011102 450541)'::geometry instead of a.geom

---

Refer to OpenGeo workshop: Nearest-Neighbour Searching for real live example.

Availability: 2.0.0 -- KNN only available for PostgreSQL 9.1+

Examples

```
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)
```

Then the KNN raw answer:

```
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
 5579.67450712005 | ALQ    | 001
 5541.57712511724 | ALQ    | 129A
 8694.20710669982 | ALQ    | 129B
 9564.24289057111 | ALQ    | 130
  6083.4207708641 | ALQ    | 131
  12089.665931705 | ALQ    | 127
  24795.264503022 | ALQ    | 124
 24587.6584922302 | ALQ    | 123
 26764.2555463114 | ALQ    | 125
(10 rows)
```

Note the misordering in the actual distances and the different entries that actually show up in the top 10.

Finally the hybrid:

```
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)
```

See Also

ST_DWithin, ST_Distance, <#>

8.7.16 <#>

<#> — Returns the 2D distance between bounding boxes of 2 geometries.

Synopsis

double precision **<#>**(geometry A , geometry B);

Description

The <#> operator returns distance between two floating point bounding boxes, possibly reading them from a spatial index (PostgreSQL 9.1+ required). Useful for doing nearest neighbor **approximate** distance ordering.

> **Note**
> This operand will make use of any indexes that may be available on the geometries. It is different from other operators that use spatial indexes in that the spatial index is only used when the operator is in the ORDER BY clause.

> **Note**
> Index only kicks in if one of the geometries is a constant e.g. ORDER BY (ST_GeomFromText('POINT(1 2)') <#> geom) instead of g1.geom <#>.

Availability: 2.0.0 -- KNN only available for PostgreSQL 9.1+

Examples

```
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)
```

See Also

ST_DWithin, ST_Distance, <->

8.8 Spatial Relationships and Measurements

8.8.1 ST_3DClosestPoint

ST_3DClosestPoint — Returns the 3-dimensional point on g1 that is closest to g2. This is the first point of the 3D shortest line.

Synopsis

geometry **ST_3DClosestPoint**(geometry g1, geometry g2);

Description

Returns the 3-dimensional point on g1 that is closest to g2. This is the first point of the 3D shortest line. The 3D length of the 3D shortest line is the 3D distance.

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

This function supports Polyhedral surfaces.

Availability: 2.0.0

Examples

linestring and point -- both 3d and 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)
```

linestring and multipoint -- both 3d and 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)
```

Multilinestring and polygon both 3d and 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)
```

See Also

ST_AsEWKT, ST_ClosestPoint, ST_3DDistance, ST_3DShortestLine

8.8.2 ST_3DDistance

ST_3DDistance — For geometry type Returns the 3-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units.

Synopsis

float **ST_3DDistance**(geometry g1, geometry g2);

Description

For geometry type returns the 3-dimensional minimum cartesian distance between two geometries in projected units (spatial ref units).

✓ 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 ?

✓ This method is also provided by SFCGAL backend.

Availability: 2.0.0

Examples

```
-- 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(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)
    ) As dist_3d,
    ST_Distance(
      ST_Transform(ST_GeomFromText('POINT(-72.1235 42.3521)',4326),2163),
      ST_Transform(ST_GeomFromText('LINESTRING(-72.1260 42.45, -72.123 42.1546)', 4326),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  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;
      dist3d       | dist2d
-------------------+--------
 0.716635696066337 |      0
```

See Also

ST_Distance, ST_3DClosestPoint, ST_3DDWithin, ST_3DMaxDistance, ST_3DShortestLine, ST_Transform

8.8.3 ST_3DDWithin

ST_3DDWithin — For 3d (z) geometry type Returns true if two geometries 3d distance is within number of units.

Synopsis

boolean **ST_3DDWithin**(geometry g1, geometry g2, double precision distance_of_srid);

Description

For geometry type returns true if the 3d distance between two objects is within distance_of_srid specified projected units (spatial ref units).

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 ?

Availability: 2.0.0

Examples

```
-- 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
```

See Also

ST_3DDistance, ST_Distance, ST_DWithin, ST_3DMaxDistance, ST_Transform

8.8.4 ST_3DDFullyWithin

ST_3DDFullyWithin — Returns true if all of the 3D geometries are within the specified distance of one another.

Synopsis

boolean **ST_3DDFullyWithin**(geometry g1, geometry g2, double precision distance);

Description

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 call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries.

Availability: 2.0.0

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

This function supports Polyhedral surfaces.

Examples

```
-- 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
```

See Also

ST_3DMaxDistance, ST_3DDWithin, ST_DWithin, ST_DFullyWithin

8.8.5 ST_3DIntersects

ST_3DIntersects — Returns TRUE if the Geometries "spatially intersect" in 3d - only for points and linestrings

Synopsis

boolean **ST_3DIntersects**(geometry geomA , geometry geomB);

Description

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.

Availability: 2.0.0

Note
This function call will automatically include a bounding box comparison that will make use of any 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 3: ?

Geometry Examples

```
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)
```

See Also

ST_Intersects

8.8.6 ST_3DLongestLine

ST_3DLongestLine — Returns the 3-dimensional longest line between two geometries

Synopsis

geometry **ST_3DLongestLine**(geometry g1, geometry g2);

Description

Returns the 3-dimensional longest line between two geometries. The function will only return the first longest line if more than one. The line returned will always start in g1 and end in g2. The 3D length of the line this function returns will always be the same as ST_3DMaxDistance returns for g1 and g2.

Availability: 2.0.0

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

This function supports Polyhedral surfaces.

Examples

linestring and point -- both 3d and 2d longest line

```
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)
```

linestring and multipoint -- both 3d and 2d longest line

```
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)
```

Multilinestring and polygon both 3d and 2d longest line

```
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)
```

See Also

ST_3DClosestPoint, ST_3DDistance, ST_LongestLine, ST_3DShortestLine, ST_3DMaxDistance

8.8.7 ST_3DMaxDistance

ST_3DMaxDistance — For geometry type Returns the 3-dimensional cartesian maximum distance (based on spatial ref) between two geometries in projected units.

Synopsis

float **ST_3DMaxDistance**(geometry g1, geometry g2);

Description

For geometry type returns the 3-dimensional maximum cartesian distance between two geometries in projected units (spatial ref units).

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

This function supports Polyhedral surfaces.

Availability: 2.0.0

Examples

```
-- 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
```

See Also

ST_Distance, ST_3DDWithin, ST_3DMaxDistance, ST_Transform

8.8.8 ST_3DShortestLine

ST_3DShortestLine — Returns the 3-dimensional shortest line between two geometries

Synopsis

geometry **ST_3DShortestLine**(geometry g1, geometry g2);

Description

Returns the 3-dimensional shortest line between two geometries. The function will only return the first shortest line if more than one, that the function finds. If g1 and g2 intersects in just one point the function will return a line with both start and end in that intersection-point. If g1 and g2 are intersecting with more than one point the function will return a line with start and end in the same point but it can be any of the intersecting points. The line returned will always start in g1 and end in g2. The 3D length of the line this function returns will always be the same as ST_3DDistance returns for g1 and g2.

Availability: 2.0.0

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

This function supports Polyhedral surfaces.

Examples

linestring and point -- both 3d and 2d shortest line

```
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)
```

linestring and multipoint -- both 3d and 2d shortest line

```
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)
```

Multilinestring and polygon both 3d and 2d shortest line

```
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)
```

See Also

ST_3DClosestPoint, ST_3DDistance, ST_LongestLine, ST_ShortestLine, ST_3DMaxDistance

8.8.9 ST_Area

ST_Area — Returns the area of the surface if it is a polygon or multi-polygon. For "geometry" type area is in SRID units. For "geography" area is in square meters.

Synopsis

float **ST_Area**(geometry g1);
float **ST_Area**(geography geog, boolean use_spheroid=true);

Description

Returns the area of the geometry if it is a polygon or multi-polygon. Return the area measurement of an ST_Surface or ST_MultiSurface value. For geometry Area is in the units of the srid. For geography area is in square meters and defaults to measuring about the spheroid of the geography (currently only WGS84). To measure around the faster but less accurate sphere -- ST_Area(geog,false).

Enhanced: 2.0.0 - support for 2D polyhedral surfaces was introduced.

This method implements the OpenGIS 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
For polyhedral surfaces, only supports 2D polyhedral surfaces (not 2.5D). For 2.5D, may give a non-zero answer, but only for the faces that sit completely in XY plane.

This method is also provided by SFCGAL backend.

Examples

Return area in square feet for a plot of Massachusetts land and multiply by conversion to get square meters. Note this is in square feet because 2249 is Mass State Plane Feet

```
SELECT ST_Area(the_geom) As sqft, ST_Area(the_geom)*POWER(0.3048,2) As sqm
    FROM (SELECT
    ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,
      743265 2967450,743265.625 2967416,743238 2967416))',2249) ) As foo(the_geom);
  sqft   |     sqm
---------+-------------
 928.625 | 86.27208552
```

Return area square feet and transform to Massachusetts state plane meters (26986) to get square meters. Note this is in square feet because 2249 is Mass State Plane Feet and transformed area is in square meters since 26986 is state plane mass meters

```
SELECT ST_Area(the_geom) As sqft, ST_Area(ST_Transform(the_geom,26986)) As sqm
    FROM (SELECT
    ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,
      743265 2967450,743265.625 2967416,743238 2967416))',2249) ) As foo(the_geom);
  sqft   |       sqm
---------+------------------
 928.625 | 86.2724304199219
```

Return area square feet and square meters using Geography data type. Note that we transform to our geometry to geography (before you can do that make sure your geometry is in WGS 84 long lat 4326). Geography always measures in meters. This is just for demonstration to compare. Normally your table will be stored in geography data type already.

```
SELECT ST_Area(the_geog)/POWER(0.3048,2) As sqft_spheroid,  ST_Area(the_geog,false)/POWER ↩
    (0.3048,2) As sqft_sphere, ST_Area(the_geog) As sqm_spheroid
    FROM (SELECT
    geography(
    ST_Transform(
      ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,743265 2967450,743265.625  ↩
          2967416,743238 2967416))',
        2249
        ) ,4326
      )
    )
  ) As foo(the_geog);
 sqft_spheroid   |   sqft_sphere    |   sqm_spheroid
-----------------+------------------+------------------
928.684405217197 | 927.186481558724 | 86.2776044452694
```

```
--if your data is in geography already
SELECT ST_Area(the_geog)/POWER(0.3048,2) As  sqft, ST_Area(the_geog) As sqm
 FROM somegeogtable;
```

See Also

ST_GeomFromText, ST_GeographyFromText, ST_SetSRID, ST_Transform

8.8.10 ST_Azimuth

ST_Azimuth — Returns the north-based azimuth as the angle in radians measured clockwise from the vertical on pointA to pointB.

Synopsis

float **ST_Azimuth**(geometry pointA, geometry pointB);
float **ST_Azimuth**(geography pointA, geography pointB);

Description

Returns the azimuth in radians of the segment defined by the given point-geometries, or NULL if the two points are coincident. The azimuth is north-based and is measured clockwise: North = 0; East = PI/2; South = PI; West = 3PI/2.

The Azimuth is mathematical concept defined as the angle, in this case measured in radian, between a reference plane and a point.

Availability: 1.1.0

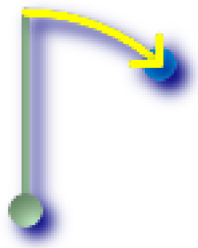
Enhanced: 2.0.0 support for geography was introduced.

Azimuth is especially useful in conjunction with ST_Translate for shifting an object along its perpendicular axis. See upgis_lineshift Plpgsqlfunctions PostGIS wiki section for example of this.

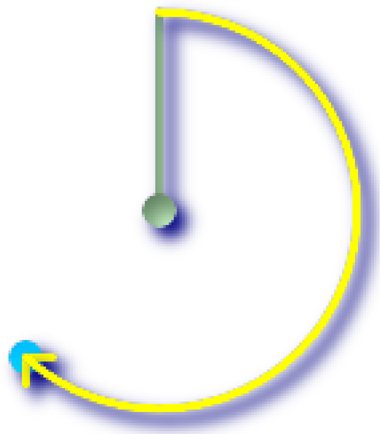
Examples

Geometry Azimuth in degrees

```
SELECT ST_Azimuth(ST_Point(25,45), ST_Point(75,100))/(2*pi())*360 as degA_B,
  ST_Azimuth(ST_Point(75,100), ST_Point(25,45))/(2*pi())*360 As degB_A;

-- NOTE easier to remember syntax using PostgreSQL built-in degrees function --
-- Both yield same answer --
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
```



Green: the start Point(25,45) with its vertical. Yellow: degA_B as the path to travel (azimuth).



Green: the start Point(75,100) with its vertical. Yellow: degB_A as the path to travel (azimuth).

See Also

ST_Point, ST_Translate, ST_Project, PostgreSQL Math Functions

8.8.11 ST_Centroid

ST_Centroid — Returns the geometric center of a geometry.

Synopsis

geometry **ST_Centroid**(geometry g1);

Description

Computes the geometric center of a geometry, or equivalently, the center of mass of the geometry as a `POINT`. For `[MULTI]POINT`s, this is computed as the arithmetic mean of the input coordinates. For `[MULTI]LINESTRING`s, this is computed as the weighted length of each line segment. For `[MULTI]POLYGON`s, "weight" is thought in terms of area. If an empty geometry is supplied, an empty `GEOMETRYCOLLECTION` is returned. If `NULL` is supplied, `NULL` is returned.

The centroid is equal to the centroid of the set of component Geometries of highest dimension (since the lower-dimension geometries contribute zero "weight" to the centroid).

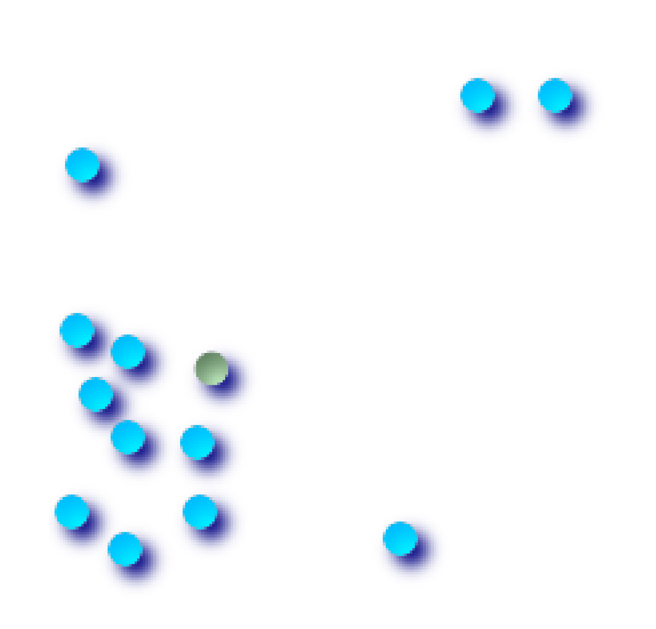
Note
Computation will be more accurate if performed by the GEOS module (enabled at compile time).

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

This method implements the SQL/MM specification. SQL-MM 3: 8.1.4, 9.5.5

Examples

In each of the following illustrations, the blue dot represents the centroid of the source geometry.



Centroid of a `MULTIPOINT`

Centroid of a `LINESTRING`

Centroid of a `POLYGON`

Centroid of a `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)
```

See Also

ST_PointOnSurface

8.8.12 ST_ClosestPoint

ST_ClosestPoint — Returns the 2-dimensional point on g1 that is closest to g2. This is the first point of the shortest line.

Synopsis

geometry **ST_ClosestPoint**(geometry g1, geometry g2);

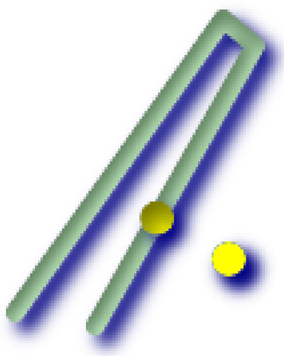
Description

Returns the 2-dimensional point on g1 that is closest to g2. This is the first point of the shortest line.

Note
If you have a 3D Geometry, you may prefer to use ST_3DClosestPoint.

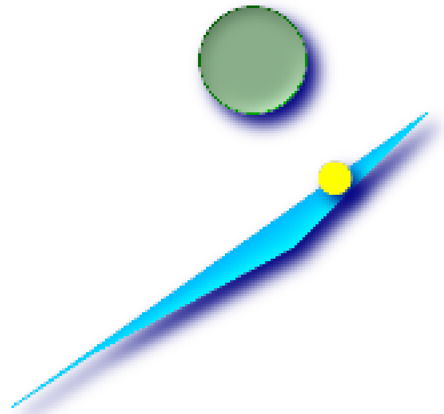
Availability: 1.5.0

Examples



Closest between point and linestring is the point itself, but closest point between a linestring and point is the point on line string that is closest.

```
SELECT ST_AsText(ST_ClosestPoint(pt,line) ↩
    ) AS cp_pt_line,
        ST_AsText(ST_ClosestPoint(line,pt ↩
    )) As cp_line_pt
FROM (SELECT 'POINT(100 100)'::geometry  ↩
    As pt,
                'LINESTRING (20 80, 98  ↩
    190, 110 180, 50 75 )'::geometry As line
        ) As foo;


   cp_pt_line    |                 ↩
    cp_line_pt
----------------+------------------------------------------ ↩

 POINT(100 100) | POINT(73.0769230769231  ↩
    115.384615384615)
```



closest point on polygon A to polygon B

```
SELECT ST_AsText(
                ST_ClosestPoint(
                        ST_GeomFromText(' ↩
    POLYGON((175 150, 20 40, 50 60, 125 100, 175 150
                        ST_Buffer( ↩
    ST_GeomFromText('POINT(110 170)'), 20)
                        )
                ) As ptwkt;

                  ptwkt
------------------------------------------ ↩

 POINT(140.752120669087 125.695053378061)
```

See Also

ST_3DClosestPoint,ST_Distance, ST_LongestLine, ST_ShortestLine, ST_MaxDistance

8.8.13 ST_Contains

ST_Contains — Returns true if and only if no points of B lie in the exterior of A, and at least one point of the interior of B lies in the interior of A.

Synopsis

boolean **ST_Contains**(geometry geomA, geometry geomB);

Description

Geometry A contains Geometry B if and only if no points of B lie in the exterior of A, and at least one point of the interior of B lies in the interior of A. An important subtlety of this definition is that A does not contain its boundary, but A does contain itself. Contrast that to ST_ContainsProperly where geometry A does not Contain Properly itself.

Returns TRUE if geometry B is completely inside geometry A. For this function to make sense, the source geometries must both be of the same coordinate projection, having the same SRID. ST_Contains is the inverse of ST_Within. So ST_Contains(A,B) implies ST_Within(B,A) except in the case of invalid geometries where the result is always false regardless or not defined.

Performed by the GEOS module

Important
Do not call with a `GEOMETRYCOLLECTION` as an argument

Important
Do not use this function with invalid geometries. You will get unexpected results.

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_Contains.

NOTE: this is the "allowable" version that returns a boolean, not an integer.

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3 - same as within(geometry B, geometry A)

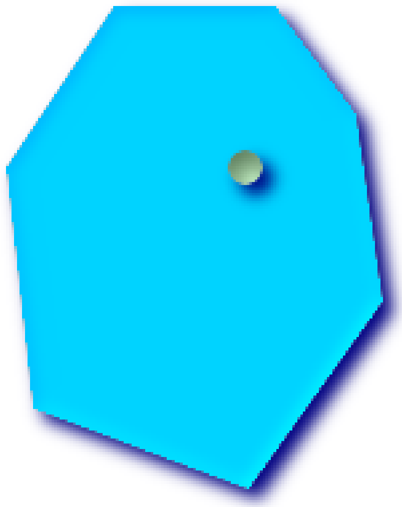
This method implements the SQL/MM specification. SQL-MM 3: 5.1.31

There are certain subtleties to ST_Contains and ST_Within that are not intuitively obvious. For details check out Subtleties of OGC Covers, Contains, Within

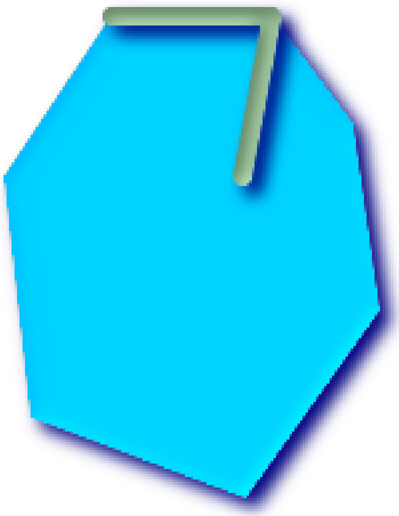
Examples

The `ST_Contains` predicate returns `TRUE` in all the following illustrations.

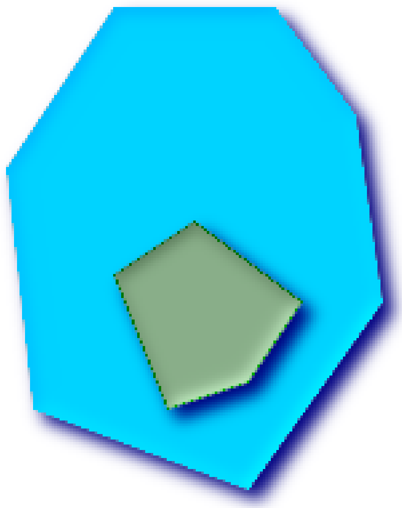
LINESTRING / MULTIPOINT



POLYGON / POINT

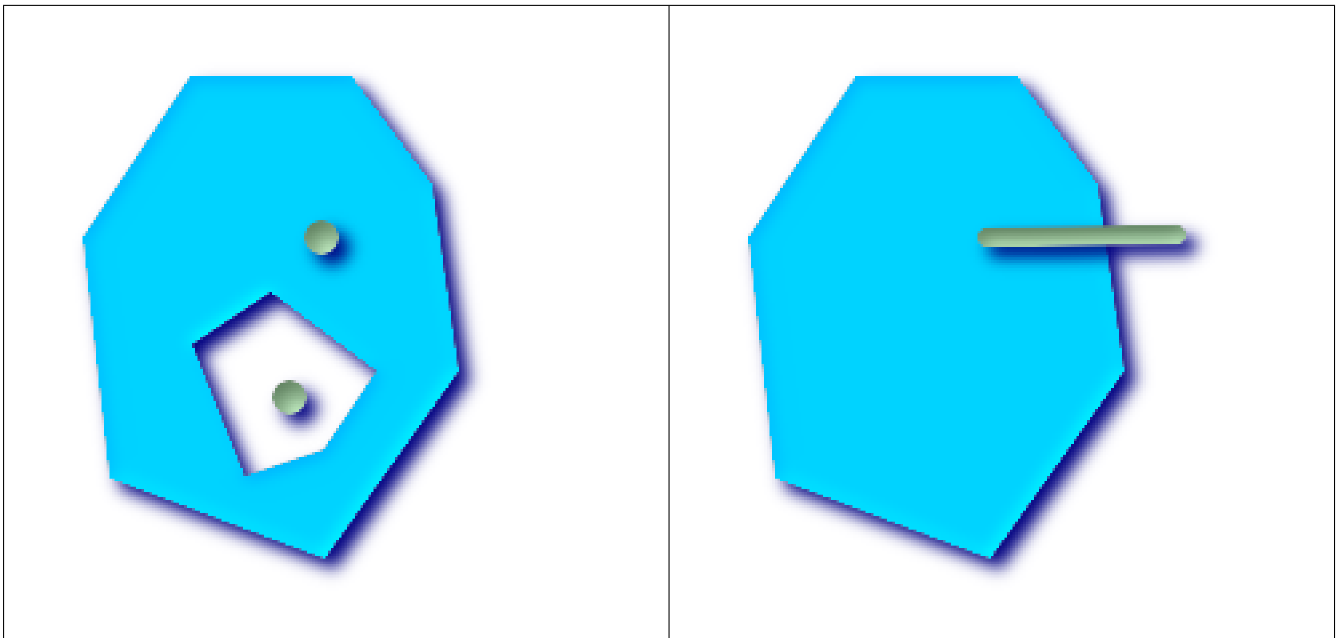


POLYGON / LINESTRING



POLYGON / POLYGON

The `ST_Contains` predicate returns `FALSE` in all the following illustrations.



POLYGON / MULTIPOINT *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
```

See Also

ST_Boundary, ST_ContainsProperly, ST_Covers, ST_CoveredBy, ST_Equals, ST_Within

8.8.14 ST_ContainsProperly

ST_ContainsProperly — Returns true if B intersects the interior of A but not the boundary (or exterior). A does not contain properly itself, but does contain itself.

Synopsis

boolean **ST_ContainsProperly**(geometry geomA, geometry geomB);

Description

Returns true if B intersects the interior of A but not the boundary (or exterior).

A does not contain properly itself, but does contain itself.

Every point of the other geometry is a point of this geometry's interior. The DE-9IM Intersection Matrix for the two geometries matches [T**FF*FF*] used in ST_Relate

> **Note**
> From JTS docs slightly reworded: The advantage to using this predicate over ST_Contains and ST_Intersects is that it can be computed efficiently, with no need to compute topology at individual points.
> An example use case 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 wholly inside the area. In these cases the intersection is known a priori to be exactly the original test geometry.

Availability: 1.4.0 - requires GEOS >= 3.1.0.

> **Important**
> Do not call with a `GEOMETRYCOLLECTION` as an argument

> **Important**
> Do not use this function with invalid geometries. You will get unexpected results.

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_ContainsProperly.

Examples

```
--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
```

See Also

ST_GeometryType, ST_Boundary, ST_Contains, ST_Covers, ST_CoveredBy, ST_Equals, ST_Relate, ST_Within

8.8.15 ST_Covers

ST_Covers — Returns 1 (TRUE) if no point in Geometry B is outside Geometry A

Synopsis

boolean **ST_Covers**(geometry geomA, geometry geomB);
boolean **ST_Covers**(geography geogpolyA, geography geogpointB);

Description

Returns 1 (TRUE) if no point in Geometry/Geography B is outside Geometry/Geography A

Performed by the GEOS module

Important
Do not call with a `GEOMETRYCOLLECTION` as an argument

> **Important**
> For geography only Polygon covers point is supported.

> **Important**
> Do not use this function with invalid geometries. You will get unexpected results.

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_Covers.

Availability: 1.2.2 - requires GEOS >= 3.0

Availability: 1.5 - support for geography was introduced.

NOTE: this is the "allowable" version that returns a boolean, not an integer.

Not an OGC standard, but Oracle has it too.

There are certain subtleties to ST_Contains and ST_Within that are not intuitively obvious. For details check out Subtleties of OGC Covers, Contains, Within

Examples

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
```

See Also

ST_Contains, ST_CoveredBy, ST_Within

8.8.16 ST_CoveredBy

ST_CoveredBy — Returns 1 (TRUE) if no point in Geometry/Geography A is outside Geometry/Geography B

Synopsis

boolean **ST_CoveredBy**(geometry geomA, geometry geomB);
boolean **ST_CoveredBy**(geography geogA, geography geogB);

Description

Returns 1 (TRUE) if no point in Geometry/Geography A is outside Geometry/Geography B

Performed by the GEOS module

> **Important**
> Do not call with a `GEOMETRYCOLLECTION` as an argument

> **Important**
> Do not use this function with invalid geometries. You will get unexpected results.

Availability: 1.2.2 - requires GEOS >= 3.0

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_CoveredBy.

NOTE: this is the "allowable" version that returns a boolean, not an integer.

Not an OGC standard, but Oracle has it too.

There are certain subtleties to ST_Contains and ST_Within that are not intuitively obvious. For details check out Subtleties of OGC Covers, Contains, Within

Examples

```
  --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)
```

See Also

ST_Contains, ST_Covers, ST_ExteriorRing, ST_Within

8.8.17 ST_Crosses

ST_Crosses — Returns TRUE if the supplied geometries have some, but not all, interior points in common.

Synopsis

boolean **ST_Crosses**(geometry g1, geometry g2);

Description

ST_Crosses takes two geometry objects and returns TRUE if their intersection "spatially cross", that is, the geometries have some, but not all interior points in common. The intersection of the interiors of the geometries must not be the empty set and must have a dimensionality less than the the maximum dimension of the two input geometries. Additionally, the intersection of the two geometries must not equal either of the source geometries. Otherwise, it returns FALSE.

In mathematical terms, this is expressed as:

$$a.Crosses(b) \Leftrightarrow (dim(I(a) \cap I(b)) < max(dim(I(a)), dim(I(b)))) \wedge (a \cap b \neq a) \wedge (a \cap b \neq b)$$

The DE-9IM Intersection Matrix for the two geometries is:

- 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)

For any other combination of dimensions this predicate returns false.

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.

Important
Do not call with a GEOMETRYCOLLECTION as an argument

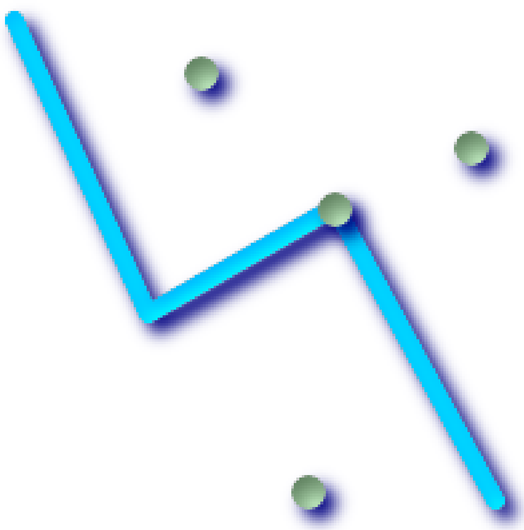
Note
This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries.

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s2.1.13.3

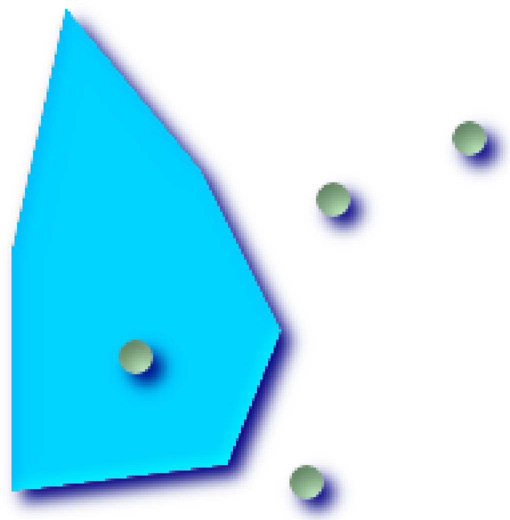
This method implements the SQL/MM specification. SQL-MM 3: 5.1.29

Examples

The following illustrations all return `TRUE`.



MULTIPOINT / LINESTRING



MULTIPOINT / POLYGON

LINESTRING / POLYGON

LINESTRING / LINESTRING

Consider a situation where a user has two tables: a table of roads and a table of highways.

<pre>CREATE TABLE roads (
  id serial NOT NULL,
  the_geom geometry,
  CONSTRAINT roads_pkey PRIMARY KEY (↩
    road_id)
);</pre>
	<pre>CREATE TABLE highways (
	  id serial NOT NULL,
	  the_gem geometry,
	  CONSTRAINT roads_pkey PRIMARY KEY (↩
	    road_id)
	);</pre>

To determine a list of roads that cross a highway, use a query similiar to:

```
SELECT roads.id
FROM roads, highways
WHERE ST_Crosses(roads.the_geom, highways.the_geom);
```

8.8.18 ST_LineCrossingDirection

ST_LineCrossingDirection — Given 2 linestrings, returns a number between -3 and 3 denoting what kind of crossing behavior. 0 is no crossing.

Synopsis

integer **ST_LineCrossingDirection**(geometry linestringA, geometry linestringB);

Description

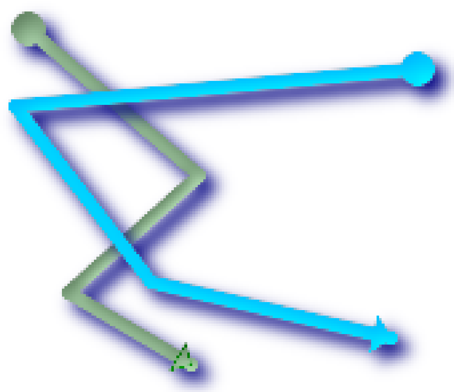
Given 2 linestrings, returns a number between -3 and 3 denoting what kind of crossing behavior. 0 is no crossing. This is only supported for `LINESTRING`

Definition of integer constants is as follows:

- 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

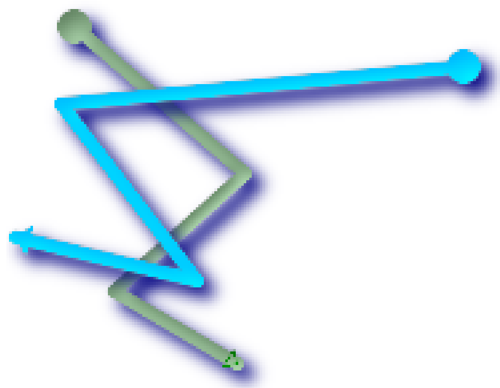
Availability: 1.4

Examples



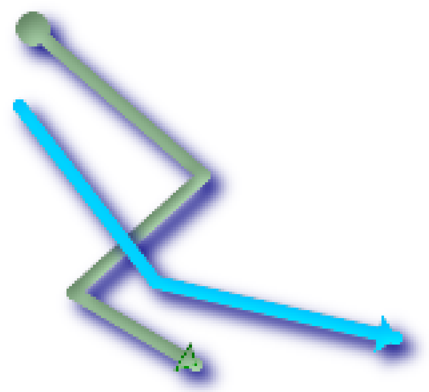
Line 1 (green), Line 2 ball is start point, triangle are end points. Query below.

```
SELECT ST_LineCrossingDirection(foo.line1
    , foo.line2) As l1_cross_l2 ,
          ST_LineCrossingDirection(foo.
    line2, foo.line1) As l2_cross_l1
FROM (
SELECT
 ST_GeomFromText('LINESTRING(25 169,89
    114,40 70,86 43)') As line1,
 ST_GeomFromText('LINESTRING(171 154,20
    140,71 74,161 53)') As line2
        ) As foo;

 l1_cross_l2 | l2_cross_l1
-------------+-------------
           3 |          -3
```



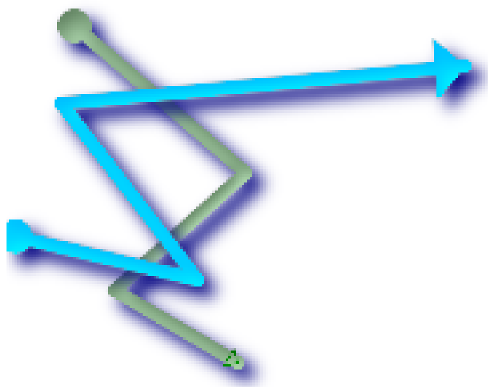
Line 1 (green), Line 2 (blue) ball is start point, triangle are end points. Query below.

```
SELECT ST_LineCrossingDirection(foo.line1
    , foo.line2) As l1_cross_l2 ,
          ST_LineCrossingDirection(foo.
    line2, foo.line1) As l2_cross_l1
FROM (
 SELECT
  ST_GeomFromText('LINESTRING(25 169,89
    114,40 70,86 43)') As line1,
  ST_GeomFromText('LINESTRING (171 154,
    20 140, 71 74, 2.99 90.16)') As line2
) As foo;

 l1_cross_l2 | l2_cross_l1
-------------+-------------
           2 |          -2
```



Line 1 (green), Line 2 (blue) ball is start point, triangle are end points. Query below.

```
SELECT
        ST_LineCrossingDirection(foo.line1, foo.line2) As l1_cross_l2 ,
        ST_LineCrossingDirection(foo.line2, foo.line1) As l2_cross_l1
FROM (
 SELECT
  ST_GeomFromText('LINESTRING(25 169,89 114,40 70,86 43)') As line1,
  ST_GeomFromText('LINESTRING (20 140, 71 74, 161 53)') As line2
  ) As foo;

 l1_cross_l2 | l2_cross_l1
-------------+-------------
          -1 |           1
```



Line 1 (green), Line 2 (blue) ball is start point, triangle are end points. Query below.

```
SELECT ST_LineCrossingDirection(foo.line1, foo.line2) As l1_cross_l2 ,
        ST_LineCrossingDirection(foo.line2, foo.line1) As l2_cross_l1
FROM (SELECT
        ST_GeomFromText('LINESTRING(25 169,89 114,40 70,86 43)') As line1,
        ST_GeomFromText('LINESTRING(2.99 90.16,71 74,20 140,171 154)') As line2
        ) As foo;

 l1_cross_l2 | l2_cross_l1
-------------+-------------
          -2 |           2
```

```
SELECT s1.gid, s2.gid, ST_LineCrossingDirection(s1.the_geom, s2.the_geom)
  FROM streets s1 CROSS JOIN streets s2 ON (s1.gid != s2.gid AND s1.the_geom && s2.the_geom )
WHERE ST_CrossingDirection(s1.the_geom, s2.the_geom) > 0;
```

See Also

ST_Crosses

8.8.19 ST_Disjoint

ST_Disjoint — Returns TRUE if the Geometries do not "spatially intersect" - if they do not share any space together.

Synopsis

boolean **ST_Disjoint**(geometry A , geometry B);

Description

Overlaps, Touches, Within all imply geometries are not spatially disjoint. If any of the aforementioned returns true, then the geometries are not spatially disjoint. Disjoint implies false for spatial intersection.

Important
Do not call with a GEOMETRYCOLLECTION as an argument

Performed by the GEOS module

Note
This function call does not use indexes

Note
NOTE: this is the "allowable" version that returns a boolean, not an integer.

This method implements the OpenGIS 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

Examples

```
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)
```

See Also

ST_IntersectsST_Intersects

8.8.20 ST_Distance

ST_Distance — For geometry type Returns the 2-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units. For geography type defaults to return spheroidal minimum distance between two geographies in meters.

Synopsis

float **ST_Distance**(geometry g1, geometry g2);
float **ST_Distance**(geography gg1, geography gg2);
float **ST_Distance**(geography gg1, geography gg2, boolean use_spheroid);

Description

For geometry type returns the 2-dimensional minimum cartesian distance between two geometries in projected units (spatial ref units). For geography type defaults to return the minimum distance around WGS 84 spheroid between two geographies in meters. Pass in false to return answer in sphere instead of spheroid.

✓ This method implements the OpenGIS 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

✓ This method is also provided by SFCGAL backend.

Availability: 1.5.0 geography support was introduced in 1.5. Speed improvements for planar to better handle large or many vertex geometries

Enhanced: 2.1.0 improved speed for geography. See Making Geography faster for details.

Enhanced: 2.1.0 - support for curved geometries was introduced.

Basic Geometry Examples

```
--Geometry example - units in planar degrees 4326 is WGS 84 long lat unit=degrees
SELECT ST_Distance(
    ST_GeomFromText('POINT(-72.1235 42.3521)',4326),
    ST_GeomFromText('LINESTRING(-72.1260 42.45, -72.123 42.1546)', 4326)
  );
st_distance
-----------------
0.00150567726382282

-- Geometry example - units in meters (SRID: 26986 Massachusetts state plane meters) (most ↩
    accurate for Massachusetts)
SELECT ST_Distance(
      ST_Transform(ST_GeomFromText('POINT(-72.1235 42.3521)',4326),26986),
      ST_Transform(ST_GeomFromText('LINESTRING(-72.1260 42.45, -72.123 42.1546)', 4326) ↩
          ,26986)
    );
st_distance
-----------------
123.797937878454

-- Geometry example - units in meters (SRID: 2163 US National Atlas Equal area) (least ↩
    accurate)
SELECT ST_Distance(
      ST_Transform(ST_GeomFromText('POINT(-72.1235 42.3521)',4326),2163),
      ST_Transform(ST_GeomFromText('LINESTRING(-72.1260 42.45, -72.123 42.1546)', 4326) ↩
          ,2163)
    );
```

```
st_distance
------------------
126.664256056812
```

Geography Examples

```
-- same as geometry example but note units in meters - use sphere for slightly faster less ↩
    accurate
SELECT ST_Distance(gg1, gg2) As spheroid_dist, ST_Distance(gg1, gg2, false) As sphere_dist
FROM (SELECT
  ST_GeographyFromText('SRID=4326;POINT(-72.1235 42.3521)') As gg1,
  ST_GeographyFromText('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)') As gg2
  ) As foo  ;

  spheroid_dist   |   sphere_dist
------------------+------------------
 123.802076746848 | 123.475736916397
```

See Also

ST_3DDistance, ST_DWithin, ST_Distance_Sphere, ST_Distance_Spheroid, ST_MaxDistance, ST_Transform

8.8.21 ST_HausdorffDistance

ST_HausdorffDistance — Returns the Hausdorff distance between two geometries. Basically a measure of how similar or dissimilar 2 geometries are. Units are in the units of the spatial reference system of the geometries.

Synopsis

float **ST_HausdorffDistance**(geometry g1, geometry g2);
float **ST_HausdorffDistance**(geometry g1, geometry g2, float densifyFrac);

Description

Implements algorithm for computing a distance metric which can be thought of as the "Discrete Hausdorff Distance". This is the Hausdorff distance restricted to discrete points for one of the geometries. Wikipedia article on Hausdorff distance Martin Davis note on how Hausdorff Distance calculation was used to prove correctness of the CascadePolygonUnion approach.

When densifyFrac is specified, this function performs a segment densification before computing the discrete hausdorff 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.

Note
The current implementation supports only vertices as the discrete locations. This could be extended to allow an arbitrary density of points to be used.

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 part of this subset is Linestrings that are roughly parallel to each other, and roughly equal in length. This is a useful metric for line matching.

Availability: 1.5.0 - requires GEOS >= 3.2.0

Examples

```
postgis=# SELECT st_HausdorffDistance(
        'LINESTRING (0 0, 2 0)'::geometry,
        'MULTIPOINT (0 1, 1 0, 2 1)'::geometry);
 st_hausdorffdistance
 ----------------------
          1
(1 row)
```

```
postgis=# SELECT st_hausdorffdistance('LINESTRING (130 0, 0 0, 0 150)'::geometry, ' ↩
    LINESTRING (10 10, 10 150, 130 10)'::geometry, 0.5);
 st_hausdorffdistance
 ----------------------
         70
(1 row)
```

8.8.22 ST_MaxDistance

ST_MaxDistance — Returns the 2-dimensional largest distance between two geometries in projected units.

Synopsis

float **ST_MaxDistance**(geometry g1, geometry g2);

Description

Some useful description here.

Note
Returns the 2-dimensional maximum distance between two linestrings in projected units. If g1 and g2 is the same geometry the function will return the distance between the two vertices most far from each other in that geometry.

Availability: 1.5.0

Examples

```
postgis=# SELECT ST_MaxDistance('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )'::geometry ↩
    );
   st_maxdistance
-----------------
 2
(1 row)

postgis=# SELECT ST_MaxDistance('POINT(0 0)'::geometry, 'LINESTRING ( 2 2, 2 2 )'::geometry ↩
    );
  st_maxdistance
------------------
 2.82842712474619
(1 row)
```

See Also

ST_Distance, ST_LongestLine

8.8.23 ST_Distance_Sphere

ST_Distance_Sphere — Returns minimum distance in meters between two lon/lat geometries. Uses a spherical earth and radius of 6370986 meters. Faster than ST_Distance_Spheroid ST_Distance_Spheroid, but less accurate. PostGIS versions prior to 1.5 only implemented for points.

Synopsis

float **ST_Distance_Sphere**(geometry geomlonlatA, geometry geomlonlatB);

Description

Returns minimum distance in meters between two lon/lat points. Uses a spherical earth and radius of 6370986 meters. Faster than ST_Distance_Spheroid, but less accurate. PostGIS Versions prior to 1.5 only implemented for points.

Note
This function currently does not look at the SRID of a geometry and will always assume its in WGS 84 long lat. Prior versions of this function only support points.

Availability: 1.5 - support for other geometry types besides points was introduced. Prior versions only work with points.

Examples

```
SELECT round(CAST(ST_Distance_Sphere(ST_Centroid(the_geom), ST_GeomFromText('POINT(-118 38) ↩
    ',4326)) As numeric),2) As dist_meters,
round(CAST(ST_Distance(ST_Transform(ST_Centroid(the_geom),32611),
    ST_Transform(ST_GeomFromText('POINT(-118 38)', 4326),32611)) As numeric),2) As  ↩
        dist_utm11_meters,
round(CAST(ST_Distance(ST_Centroid(the_geom), ST_GeomFromText('POINT(-118 38)', 4326)) As  ↩
    numeric),5) As dist_degrees,
round(CAST(ST_Distance(ST_Transform(the_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 the_geom)  ↩
     as foo;
   dist_meters | dist_utm11_meters | dist_degrees | min_dist_line_point_meters
  -------------+-------------------+--------------+----------------------------
    70424.47 |          70438.00 |      0.72900 |                   65871.18
```

See Also

ST_Distance, ST_Distance_Spheroid

8.8.24 ST_Distance_Spheroid

ST_Distance_Spheroid — Returns the minimum distance between two lon/lat geometries given a particular spheroid. PostGIS versions prior to 1.5 only support points.

Synopsis

float **ST_Distance_Spheroid**(geometry geomlonlatA, geometry geomlonlatB, spheroid measurement_spheroid);

Description

Returns minimum distance in meters between two lon/lat geometries given a particular spheroid. See the explanation of spheroids given for ST_Length_Spheroid. PostGIS version prior to 1.5 only support points.

> **Note**
> This function currently does not look at the SRID of a geometry and will always assume its represented in the coordinates of the passed in spheroid. Prior versions of this function only support points.

Availability: 1.5 - support for other geometry types besides points was introduced. Prior versions only work with points.

Examples

```
SELECT round(CAST(
    ST_Distance_Spheroid(ST_Centroid(the_geom), ST_GeomFromText('POINT(-118 38)',4326), ' ↩
        SPHEROID["WGS 84",6378137,298.257223563]')
      As numeric),2) As dist_meters_spheroid,
    round(CAST(ST_Distance_Sphere(ST_Centroid(the_geom), ST_GeomFromText('POINT(-118 38) ↩
        ',4326)) As numeric),2) As dist_meters_sphere,
round(CAST(ST_Distance(ST_Transform(ST_Centroid(the_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 the_geom)  ↩
      as foo;
 dist_meters_spheroid | dist_meters_sphere | dist_utm11_meters
----------------------+--------------------+-------------------
       70454.92 |           70424.47 |          70438.00
```

See Also

ST_Distance, ST_Distance_Sphere

8.8.25 ST_DFullyWithin

ST_DFullyWithin — Returns true if all of the geometries are within the specified distance of one another

Synopsis

boolean **ST_DFullyWithin**(geometry g1, geometry g2, double precision distance);

Description

Returns true if the geometries is 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 call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries.

Availability: 1.5.0

Examples

```
postgis=# 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
    (select ST_GeomFromText('POINT(1 1)') as geom_a,ST_GeomFromText('LINESTRING(1 5, 2 7, 1 ↩
        9, 14 12)') as geom_b) t1;

-----------------
 DFullyWithin10 | DWithin10 | DFullyWithin20 |
---------------+----------+---------------+
 f             | t        | t             |
```

See Also

ST_MaxDistance, ST_DWithin

8.8.26 ST_DWithin

ST_DWithin — Returns true if the geometries are within the specified distance of one another. For geometry units are in those of spatial reference and For geography units are in meters and measurement is defaulted to use_spheroid=true (measure around spheroid), for faster check, use_spheroid=false to measure along sphere.

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 **ST_DWithin**(geography gg1, geography gg2, double precision distance_meters, boolean use_spheroid);

Description

Returns true if the geometries are within the specified distance of one another.

For Geometries: 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.

For geography units are in meters and measurement is defaulted to use_spheroid=true (measure around WGS 84 spheroid), for faster check, use_spheroid=false to measure along sphere.

> **Note**
> This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries.

> **Note**
> Prior to 1.3, ST_Expand was commonly used in conjunction with && and ST_Distance to achieve the same effect and in pre-1.3.4 this function was basically short-hand for that construct. From 1.3.4, ST_DWithin uses a more short-circuit distance function which should make it more efficient than prior versions for larger buffer regions.

> **Note**
> Use ST_3DDWithin if you have 3D geometries.

This method implements the OpenGIS 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.

Examples

```
--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.the_geom, h.hospital_name
  FROM schools s
    LEFT JOIN hospitals h ON ST_DWithin(s.the_geom, h.the_geom, 3000)
  ORDER BY s.gid, ST_Distance(s.the_geom, h.the_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.the_geom, h.the_geom, 3000)
  WHERE h.gid IS NULL;
```

See Also

ST_Distance, ST_Expand

8.8.27 ST_Equals

ST_Equals — Returns true if the given geometries represent the same geometry. Directionality is ignored.

Synopsis

boolean **ST_Equals**(geometry A, geometry B);

Description

Returns TRUE if the given Geometries are "spatially equal". Use this for a 'better' answer than '='. Note by spatially equal we mean ST_Within(A,B) = true and ST_Within(B,A) = true and also mean ordering of points can be different but represent the same geometry structure. 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).

Important
This function will return false if either geometry is invalid even if they are binary equal.

This method implements the OpenGIS 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

Examples

```
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)
```

See Also

ST_IsValid, ST_OrderingEquals, ST_Reverse, ST_Within

8.8.28 ST_HasArc

ST_HasArc — Returns true if a geometry or geometry collection contains a circular string

Synopsis

boolean **ST_HasArc**(geometry geomA);

Description

Returns true if a geometry or geometry collection contains a circular string

Availability: 1.2.3?

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

This method supports Circular Strings and Curves

Examples

```
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
```

See Also

ST_CurveToLine, ST_LineToCurve

8.8.29 ST_Intersects

ST_Intersects — Returns TRUE if the Geometries/Geography "spatially intersect in 2D" - (share any portion of space) and FALSE if they don't (they are Disjoint). For geography -- tolerance is 0.00001 meters (so any points that close are considered to intersect)

Synopsis

boolean **ST_Intersects**(geometry geomA , geometry geomB);
boolean **ST_Intersects**(geography geogA , geography geogB);

Description

If a geometry or geography shares any portion of space then they intersect. For geography -- tolerance is 0.00001 meters (so any points that are close are considered to intersect)

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.

Important
Do not call with a `GEOMETRYCOLLECTION` as an argument for geometry version. The geography version supports GEOMETRYCOLLECTION since its a thin wrapper around distance implementation.

Performed by the GEOS module (for geometry), geography is native

Availability: 1.5 support for geography was introduced.

Note
This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries.

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 OpenGIS 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 is also provided by SFCGAL backend.

Geometry Examples

```
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)
```

Geography Examples

```
SELECT ST_Intersects(
    ST_GeographyFromText('SRID=4326;LINESTRING(-43.23456 72.4567,-43.23456 72.4568)'),
    ST_GeographyFromText('SRID=4326;POINT(-43.23456 72.4567772)')
    );

 st_intersects
---------------
t
```

See Also

ST_3DIntersects, ST_Disjoint

8.8.30 ST_Length

ST_Length — Returns the 2d length of the geometry if it is a linestring or multilinestring. geometry are in units of spatial reference and geography are in meters (default spheroid)

Synopsis

float **ST_Length**(geometry a_2dlinestring);
float **ST_Length**(geography geog, boolean use_spheroid=true);

Description

For geometry: Returns the cartesian 2D length of the geometry if it is a linestring, multilinestring, ST_Curve, ST_MultiCurve. 0 is returned for areal geometries. For areal geometries use ST_Perimeter. Geometry: Measurements are in the units of the spatial reference system of the geometry. Geography: Units are in meters and also acts as a Perimeter function for areal geogs.

Currently for geometry this is an alias for ST_Length2D, but this may change to support higher dimensions.

Warning
Changed: 2.0.0 Breaking change -- in prior versions applying this to a MULTI/POLYGON of type geography would give you the perimeter of the POLYGON/MULTIPOLYGON. In 2.0.0 this was changed to return 0 to be in line with geometry behavior. Please use ST_Perimeter if you want the perimeter of a polygon

Note
For geography measurement defaults spheroid measurement. To use the faster less accurate sphere use ST_Length(gg,false);

This method implements the OpenGIS 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

Availability: 1.5.0 geography support was introduced in 1.5.

This method is also provided by SFCGAL backend.

Geometry Examples

Return length in feet for line string. Note this is in feet because 2249 is Mass State Plane Feet

```
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
```

Geography Examples

Return length of WGS 84 geography line

```
      -- default calculation is using a sphere rather than 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
------------------+------------------
 34310.5703627305 | 34346.2060960742
(1 row)
```

See Also

ST_GeographyFromText, ST_GeomFromEWKT, ST_Length_Spheroid, ST_Perimeter, ST_Transform

8.8.31 ST_Length2D

ST_Length2D — Returns the 2-dimensional length of the geometry if it is a linestring or multi-linestring. This is an alias for `ST_Length`

Synopsis

float **ST_Length2D**(geometry a_2dlinestring);

Description

Returns the 2-dimensional length of the geometry if it is a linestring or multi-linestring. This is an alias for `ST_Length`

See Also

ST_Length, ST_3DLength

8.8.32 ST_3DLength

ST_3DLength — Returns the 3-dimensional or 2-dimensional length of the geometry if it is a linestring or multi-linestring.

Synopsis

float **ST_3DLength**(geometry a_3dlinestring);

Description

Returns the 3-dimensional or 2-dimensional length of the geometry if it is a linestring or multi-linestring. For 2-d lines it will just return the 2-d length (same as ST_Length and ST_Length2D)

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

Changed: 2.0.0 In prior versions this used to be called ST_Length3D

Examples

Return length in feet for a 3D cable. Note this is in feet because 2249 is Mass State Plane Feet

```
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
```

See Also

ST_Length, ST_Length2D

8.8.33 ST_Length_Spheroid

ST_Length_Spheroid — Calculates the 2D or 3D length/perimeter of a geometry on an ellipsoid. This is useful if the coordinates of the geometry are in longitude/latitude and a length is desired without reprojection.

Synopsis

float **ST_Length_Spheroid**(geometry a_geometry, spheroid a_spheroid);

Description

Calculates the length/perimeter of a geometry on an ellipsoid. This is useful if the coordinates of the geometry are in longitude/latitude and a length is desired without reprojection. The ellipsoid is a separate database type and can be constructed as follows:

```
SPHEROID[<NAME>,<SEMI-MAJOR AXIS>,<INVERSE FLATTENING>]
```

```
SPHEROID["GRS_1980",6378137,298.257222101]
```

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

Examples

```
SELECT ST_Length_Spheroid( geometry_column,
        'SPHEROID["GRS_1980",6378137,298.257222101]' )
        FROM geometry_table;

SELECT ST_Length_Spheroid( the_geom, sph_m ) As tot_len,
ST_Length_Spheroid(ST_GeometryN(the_geom,1), sph_m) As len_line1,
ST_Length_Spheroid(ST_GeometryN(the_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 the_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_Length_Spheroid( the_geom, sph_m ) As tot_len,
```

```
ST_Length_Spheroid(ST_GeometryN(the_geom,1), sph_m) As len_line1,
ST_Length_Spheroid(ST_GeometryN(the_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 the_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
```

See Also

ST_GeometryN, ST_Length, ST_3DLength_Spheroid

8.8.34 ST_Length2D_Spheroid

ST_Length2D_Spheroid — Calculates the 2D length/perimeter of a geometry on an ellipsoid. This is useful if the coordinates of the geometry are in longitude/latitude and a length is desired without reprojection.

Synopsis

float **ST_Length2D_Spheroid**(geometry a_geometry, spheroid a_spheroid);

Description

Calculates the 2D length of a geometry on an ellipsoid. This is useful if the coordinates of the geometry are in longitude/latitude and a length is desired without reprojection. The ellipsoid is a separate database type and can be constructed as follows:

```
SPHEROID[<NAME>,<SEMI-MAJOR AXIS>,<INVERSE FLATTENING>]
```

```
SPHEROID["GRS_1980",6378137,298.257222101]
```

Note
This is much like ST_Length_Spheroid and ST_3DLength_Spheroid except it will throw away the Z coordinate in calculations.

Examples

```
SELECT ST_Length2D_Spheroid( geometry_column,
        'SPHEROID["GRS_1980",6378137,298.257222101]' )
        FROM geometry_table;

SELECT ST_Length2D_Spheroid( the_geom, sph_m ) As tot_len,
ST_Length2D_Spheroid(ST_GeometryN(the_geom,1), sph_m) As len_line1,
ST_Length2D_Spheroid(ST_GeometryN(the_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 the_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 Observe same answer
SELECT ST_Length2D_Spheroid( the_geom, sph_m ) As tot_len,
ST_Length2D_Spheroid(ST_GeometryN(the_geom,1), sph_m) As len_line1,
ST_Length2D_Spheroid(ST_GeometryN(the_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 the_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
```

See Also

ST_GeometryN, ST_Length_Spheroid, ST_3DLength_Spheroid

8.8.35 ST_3DLength_Spheroid

ST_3DLength_Spheroid — Calculates the length of a geometry on an ellipsoid, taking the elevation into account. This is just an alias for ST_Length_Spheroid.

Synopsis

float **ST_3DLength_Spheroid**(geometry a_linestring, spheroid a_spheroid);

Description

Calculates the length of a geometry on an ellipsoid, taking the elevation into account. This is just an alias for ST_Length_Spheroid.

> **Note**
> Changed: 2.0.0 In prior versions this used to return 0 for anything that is not a MULTILINESTRING or LINESTRING and in 2.0.0 on returns the perimeter of if given a polgon.

> **Note**
> This function is just an alias for ST_Length_Spheroid.

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

Changed: 2.0.0 In prior versions this used to be called ST_Length3d_Spheroid

Examples

```
See ST_Length_Spheroid
```

See Also

ST_GeometryN, ST_Length, ST_Length_Spheroid

8.8.36 ST_LongestLine

ST_LongestLine — Returns the 2-dimensional longest line points of two geometries. The function will only return the first longest line if more than one, that the function finds. The line returned will always start in g1 and end in g2. The length of the line this function returns will always be the same as st_maxdistance returns for g1 and g2.

Synopsis

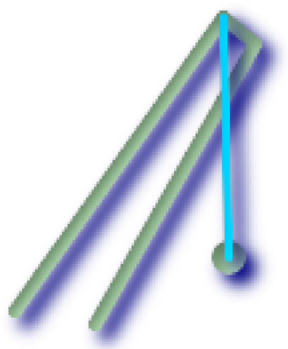
geometry **ST_LongestLine**(geometry g1, geometry g2);

Description

Returns the 2-dimensional longest line between the points of two geometries.

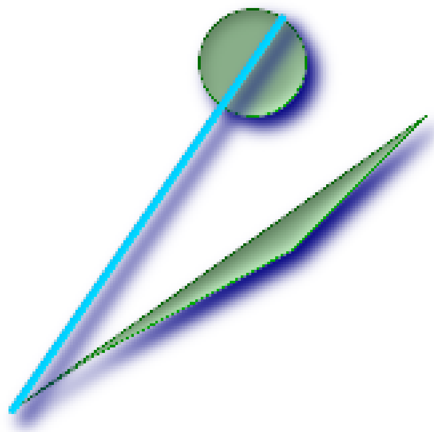
Availability: 1.5.0

Examples



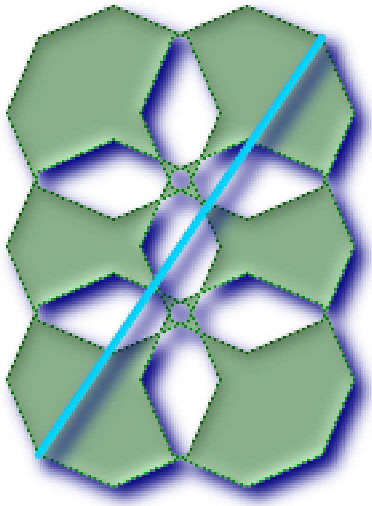
Longest line between point and line

```
SELECT ST_AsText(
        ST_LongestLine('POINT(100 100)':: ↩
    geometry,
                'LINESTRING (20 80, 98  ↩
    190, 110 180, 50 75 )'::geometry)
        ) As lline;


   lline
-----------------
LINESTRING(100 100,98 190)
```



longest line between polygon and polygon

```
SELECT ST_AsText(
        ST_LongestLine(
                ST_GeomFromText('POLYGON ↩
    ((175 150, 20 40,
                        50 60, 125 100,  ↩
    175 150))'),
                ST_Buffer(ST_GeomFromText ↩
    ('POINT(110 170)'), 20)
                )
        ) As llinewkt;

   lline
-----------------
LINESTRING(20 40,121.111404660392  ↩
    186.629392246051)
```



longest straight distance to travel from one part of an elegant city to the other Note the max distance = to the length of the line.

```
SELECT ST_AsText(ST_LongestLine(c.the_geom, c.the_geom)) As llinewkt,
        ST_MaxDistance(c.the_geom,c.the_geom) As max_dist,
        ST_Length(ST_LongestLine(c.the_geom, c.the_geom)) As lenll
FROM (SELECT ST_BuildArea(ST_Collect(the_geom)) As the_geom
        FROM (SELECT ST_Translate(ST_SnapToGrid(ST_Buffer(ST_Point(50 ,generate_series ↩
    (50,190, 50)
                        ),40, 'quad_segs=2'),1), x, 0)  As the_geom
                        FROM generate_series(1,100,50) As x)  AS foo
) As c;

          llinewkt          |      max_dist      |      lenll
---------------------------+------------------+------------------
 LINESTRING(23 22,129 178) | 188.605408193933 | 188.605408193933
```

See Also

ST_MaxDistance, ST_ShortestLine, ST_LongestLine

8.8.37 ST_OrderingEquals

ST_OrderingEquals — Returns true if the given geometries represent the same geometry and points are in the same directional order.

Synopsis

boolean **ST_OrderingEquals**(geometry A, geometry B);

Description

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

Examples

```
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)
```

See Also

ST_Equals, ST_Reverse

8.8.38 ST_Overlaps

ST_Overlaps — Returns TRUE if the Geometries share space, are of the same dimension, but are not completely contained by each other.

Synopsis

boolean **ST_Overlaps**(geometry A, geometry B);

Description

Returns TRUE if the Geometries "spatially overlap". By that we mean they intersect, but one does not completely contain another.

Performed by the GEOS module

Note
Do not call with a GeometryCollection as an argument

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_Overlaps.

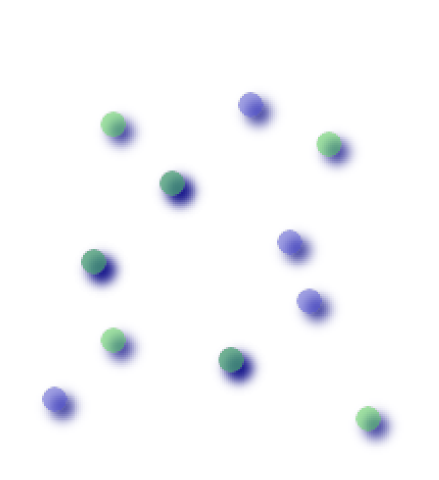
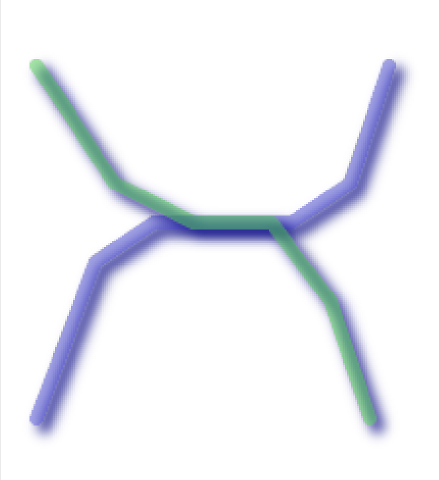
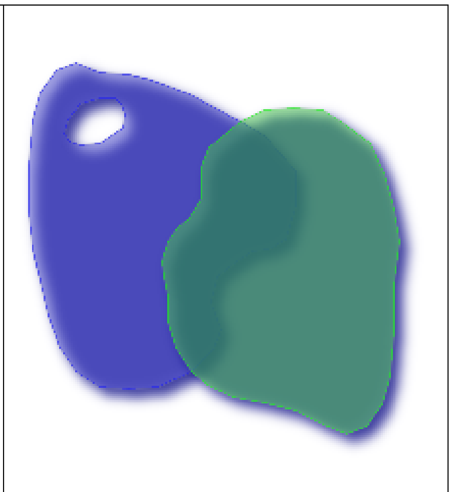
NOTE: this is the "allowable" version that returns a boolean, not an integer.

This method implements the OpenGIS 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

Examples

The following illustrations all return `TRUE`.

		
MULTIPOINT / MULTIPOINT	*LINESTRING / LINESTRING*	*POLYGON / POLYGON*

```
--a point on a line is contained by the line and is of a lower dimension, and therefore ↩
    does not overlap the line
      nor crosses

SELECT ST_Overlaps(a,b) As a_overlap_b,
  ST_Crosses(a,b) As a_crosses_b,
    ST_Intersects(a, b) As a_intersects_b, ST_Contains(b,a) As b_contains_a
FROM (SELECT ST_GeomFromText('POINT(1 0.5)') As a, ST_GeomFromText('LINESTRING(1 0, 1 1, 3 ↩
    5)')  As b)
  As foo

a_overlap_b | a_crosses_b | a_intersects_b | b_contains_a
------------+-------------+----------------+--------------
f           | f           | t              | t

--a line that is partly contained by circle, but not fully is defined as intersecting and ↩
    crossing,
-- but since of different dimension it does not overlap
SELECT ST_Overlaps(a,b) As a_overlap_b, ST_Crosses(a,b) As a_crosses_b,
  ST_Intersects(a, b) As a_intersects_b,
  ST_Contains(a,b) As a_contains_b
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 0.5)'), 3)  As a, ST_GeomFromText(' ↩
    LINESTRING(1 0, 1 1, 3 5)')  As b)
  As foo;

 a_overlap_b | a_crosses_b | a_intersects_b | a_contains_b
-------------+-------------+----------------+--------------
```

```
 f           | t            | t                | f

 -- a 2-dimensional bent hot dog (aka buffered line string) that intersects a circle,
 -- but is not fully contained by the circle is defined as overlapping since they are of ↩
    the same dimension,
--  but it does not cross, because the intersection of the 2 is of the same dimension
--  as the maximum dimension of the 2

SELECT ST_Overlaps(a,b) As a_overlap_b, ST_Crosses(a,b) As a_crosses_b, ST_Intersects(a, b) ↩
    As a_intersects_b,
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 ↩
   dima_intersection_b
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 0.5)'), 3)  As a,
  ST_Buffer(ST_GeomFromText('LINESTRING(1 0, 1 1, 3 5)'),0.5)  As b)
  As foo;

 a_overlap_b | a_crosses_b | a_intersects_b | b_contains_a | dim_a | dim_b | ↩
    dima_intersection_b
-------------+-------------+----------------+--------------+-------+-------+--------------------- ↩

 t           | f            | t                | f             |     2 |     2 |             2
```

See Also

ST_Contains, ST_Crosses, ST_Dimension, ST_Intersects

8.8.39 ST_Perimeter

ST_Perimeter — Return the length measurement of the boundary of an ST_Surface or ST_MultiSurface geometry or geography. (Polygon, Multipolygon). geometry measurement is in units of spatial reference and geography is in meters.

Synopsis

float **ST_Perimeter**(geometry g1);
float **ST_Perimeter**(geography geog, boolean use_spheroid=true);

Description

Returns the 2D perimeter of the geometry/geography if it is a ST_Surface, ST_MultiSurface (Polygon, Multipolygon). 0 is returned for non-areal geometries. For linestrings use ST_Length. Measurements for geometry are in the units of the spatial reference system of the geometry. Measurements for geography are in meters. If `use_spheroid` is set to false, then will model earth as a sphere instead of a spheroid.

Currently this is an alias for ST_Perimeter2D, but this may change to support higher dimensions.

This method implements the OpenGIS 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

Availability 2.0.0: Support for geography was introduced

Examples: Geometry

Return perimeter in feet for polygon and multipolygon. Note this is in feet because 2249 is Mass State Plane Feet

```
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)
```

Examples: Geography

Return perimeter in meters and feet for polygon and multipolygon. Note this is geography (WGS 84 long lat)

```
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
```

See Also

ST_GeogFromText, ST_GeomFromText, ST_Length

8.8.40 ST_Perimeter2D

ST_Perimeter2D — Returns the 2-dimensional perimeter of the geometry, if it is a polygon or multi-polygon. This is currently an alias for ST_Perimeter.

Synopsis

float **ST_Perimeter2D**(geometry geomA);

Description

Returns the 2-dimensional perimeter of the geometry, if it is a polygon or multi-polygon.

> **Note**
> This is currently an alias for ST_Perimeter. In future versions ST_Perimeter may return the highest dimension perimeter for a geometry. This is still under consideration

See Also

ST_Perimeter

8.8.41 ST_3DPerimeter

ST_3DPerimeter — Returns the 3-dimensional perimeter of the geometry, if it is a polygon or multi-polygon.

Synopsis

float **ST_3DPerimeter**(geometry geomA);

Description

Returns the 3-dimensional perimeter of the geometry, if it is a polygon or multi-polygon. If the geometry is 2-dimensional, then the 2-dimensional perimeter is returned.

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

Changed: 2.0.0 In prior versions this used to be called ST_Perimeter3D

Examples

Perimeter of a slightly elevated polygon in the air in Massachusetts state plane feet

```
SELECT ST_3DPerimeter(the_geom), ST_Perimeter2d(the_geom), ST_Perimeter(the_geom) FROM
      (SELECT ST_GeomFromEWKT('SRID=2249;POLYGON((743238 2967416 2,743238 2967450 1,
743265.625 2967416 1,743238 2967416 2))') As the_geom) As foo;

  ST_3DPerimeter  |  st_perimeter2d  |   st_perimeter
------------------+------------------+------------------
 105.465793597674 | 105.432997272188 | 105.432997272188
```

See Also

ST_GeomFromEWKT, ST_Perimeter, ST_Perimeter2D

8.8.42 ST_PointOnSurface

ST_PointOnSurface — Returns a POINT guaranteed to lie on the surface.

Synopsis

geometry **ST_PointOnSurface**(geometry g1);

Description

Returns a POINT guaranteed to intersect a surface.

This method implements the OpenGIS 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. According to the specs, ST_PointOnSurface works for surface geometries (POLYGONs, MULTIPOLYGONS, CURVED POLYGONS). So PostGIS seems to be extending what the spec allows here. Most databases Oracle,DB II, ESRI SDE seem to only support this function for surfaces. SQL Server 2008 like PostGIS supports for all common geometries.

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

Examples

```
SELECT ST_AsText(ST_PointOnSurface('POINT(0 5)'::geometry));
 st_astext
------------
 POINT(0 5)
(1 row)

SELECT ST_AsText(ST_PointOnSurface('LINESTRING(0 5, 0 10)'::geometry));
 st_astext
------------
 POINT(0 5)
(1 row)

SELECT ST_AsText(ST_PointOnSurface('POLYGON((0 0, 0 5, 5 5, 5 0, 0 0))'::geometry));
```

```
   st_astext
----------------
 POINT(2.5 2.5)
(1 row)

SELECT ST_AsEWKT(ST_PointOnSurface(ST_GeomFromEWKT('LINESTRING(0 5 1, 0 0 1, 0 10 2)')));
   st_asewkt
----------------
 POINT(0 0 1)
(1 row)
```

See Also

ST_Centroid, ST_Point_Inside_Circle

8.8.43 ST_Project

ST_Project — Returns a `POINT` projected from a start point using a distance in meters and bearing (azimuth) in radians.

Synopsis

geography **ST_Project**(geography g1, float distance, float azimuth);

Description

Returns a `POINT` projected from a start point using an azimuth (bearing) measured in radians and distance measured in meters.

Distance, azimuth and projection are all aspects of the same operation, describing (or in the case of projection, constructing) the relationship between two points on the world.

The azimuth is sometimes called the heading or the bearing in navigation. It is measured relative to true north (azimuth zero). East is azimuth 90 (`pi/2`), south is azimuth 180 (`pi`), west is azimuth 270 (`pi*1.5`).

The distance is given in meters.

Availability: 2.0.0

Example: Using degrees - projected point 100,000 meters and bearing 45 degrees

```
SELECT ST_AsText(ST_Project('POINT(0 0)'::geography, 100000, radians(45.0)));
        st_astext
------------------------------------------
 POINT(0.63523102912532 0.63947233472882)
(1 row)
```

Example: Using radians - projected point 100,000 meters and bearing pi/4 (45 degrees)

```
SELECT ST_AsText(ST_Project('POINT(0 0)'::geography, 100000, pi()/4));
        st_astext
------------------------------------------
 POINT(0.63523102912532 0.63947233472882)
(1 row)
```

See Also

ST_Azimuth, ST_Distance, PostgreSQL Math Functions

8.8.44 ST_Relate

ST_Relate — Returns true if this Geometry is spatially related to anotherGeometry, by testing for intersections between the Interior, Boundary and Exterior of the two geometries as specified by the values in the intersectionMatrixPattern. If no intersectionMatrixPattern is passed in, then returns the maximum intersectionMatrixPattern that relates the 2 geometries.

Synopsis

boolean **ST_Relate**(geometry geomA, geometry geomB, text intersectionMatrixPattern);
text **ST_Relate**(geometry geomA, geometry geomB);
text **ST_Relate**(geometry geomA, geometry geomB, int BoundaryNodeRule);

Description

Version 1: Takes geomA, geomB, intersectionMatrix and Returns 1 (TRUE) if this Geometry is spatially related to anotherGeometry, by testing for intersections between the Interior, Boundary and Exterior of the two geometries as specified by the values in the DE-9IM matrix pattern.

This is especially useful for testing compound checks of intersection, crosses, etc in one step.

Do not call with a GeometryCollection as an argument

> **Note**
> This is the "allowable" version that returns a boolean, not an integer. This is defined in OGC spec

> **Note**
> This DOES NOT automagically include an index call. The reason for that is some relationships are anti e.g. Disjoint. If you are using a relationship pattern that requires intersection, then include the && index call.

Version 2: Takes geomA and geomB and returns the Section 4.3.6

Version 3: same as version 2, but allows to specify a boundary node rule (1:OGC/MOD2, 2:Endpoint, 3:MultivalentEndpoint, 4:MonovalentEndpoint)

> **Note**
> Do not call with a GeometryCollection as an argument

not in OGC spec, but implied. see s2.1.13.2

Performed by the GEOS module

This method implements the OpenGIS 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

Enhanced: 2.0.0 - added support for specifying boundary node rule (requires GEOS >= 3.0).

Examples

```
--Find all compounds that intersect and not touch a poly (interior intersects)
SELECT l.* , b.name As poly_name
  FROM polys As b
INNER JOIN compounds As l
ON (p.the_geom && b.the_geom
AND ST_Relate(l.the_geom, b.the_geom,'T********'));

SELECT ST_Relate(ST_GeometryFromText('POINT(1 2)'), ST_Buffer(ST_GeometryFromText('POINT(1 ↩
    2)'),2));
st_relate
-----------
0FFFFF212

SELECT ST_Relate(ST_GeometryFromText('LINESTRING(1 2, 3 4)'), ST_GeometryFromText(' ↩
    LINESTRING(5 6, 7 8)'));
st_relate
-----------
FF1FF0102


SELECT ST_Relate(ST_GeometryFromText('POINT(1 2)'), ST_Buffer(ST_GeometryFromText('POINT(1 ↩
    2)'),2), '0FFFFF212');
st_relate
-----------
t

SELECT ST_Relate(ST_GeometryFromText('POINT(1 2)'), ST_Buffer(ST_GeometryFromText('POINT(1 ↩
    2)'),2), '*FF*FF212');
st_relate
-----------
t
```

See Also

ST_Crosses, Section 4.3.6, ST_Disjoint, ST_Intersects, ST_Touches

8.8.45 ST_RelateMatch

ST_RelateMatch — Returns true if intersectionMattrixPattern1 implies intersectionMatrixPattern2

Synopsis

boolean **ST_RelateMatch**(text intersectionMatrix, text intersectionMatrixPattern);

Description

Takes intersectionMatrix and intersectionMatrixPattern and Returns true if the intersectionMatrix satisfies the intersectionMatrixPattern. For more information refer to Section 4.3.6.

Availability: 2.0.0 - requires GEOS >= 3.3.0.

Examples

```
SELECT ST_RelateMatch('101202FFF', 'TTTTTTFFF') ;
-- result --
t
--example of common intersection matrix patterns and example matrices
-- comparing relationships of involving one invalid geometry and ( a line and polygon that ↩
    intersect at interior and boundary)
SELECT mat.name, pat.name, ST_RelateMatch(mat.val, pat.val) As satisfied
    FROM
        ( VALUES ('Equality', 'T1FF1FFF1'),
                ('Overlaps', 'T*T***T**'),
                ('Within', 'T*F**F***'),
                ('Disjoint', 'FF*FF****') As pat(name,val)
        CROSS JOIN
            ( VALUES ('Self intersections (invalid)', '111111111'),
                    ('IE2_BI1_BB0_BE1_EI1_EE2', 'FF2101102'),
                    ('IB1_IE1_BB0_BE0_EI2_EI1_EE2', 'F11F00212')
            ) As mat(name,val);
```

See Also

Section 4.3.6, ST_Relate

8.8.46 ST_ShortestLine

ST_ShortestLine — Returns the 2-dimensional shortest line between two geometries

Synopsis

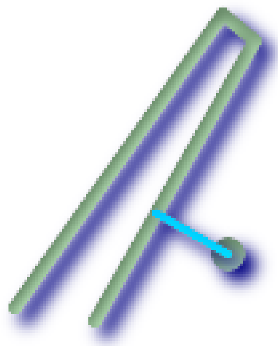
geometry **ST_ShortestLine**(geometry g1, geometry g2);

Description

Returns the 2-dimensional shortest line between two geometries. The function will only return the first shortest line if more than one, that the function finds. If g1 and g2 intersects in just one point the function will return a line with both start and end in that intersection-point. If g1 and g2 are intersecting with more than one point the function will return a line with start and end in the same point but it can be any of the intersecting points. The line returned will always start in g1 and end in g2. The length of the line this function returns will always be the same as st_distance returns for g1 and g2.

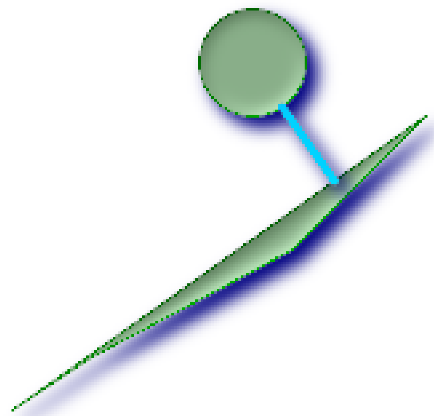
Availability: 1.5.0

Examples



Shortest line between point and linestring

```
SELECT ST_AsText(
        ST_ShortestLine('POINT(100 100) ↩
                ':geometry,
                'LINESTRING (20 80, 98 ↩
                190, 110 180, 50 75 )'::geometry)
        ) As sline;


   sline
-----------------
LINESTRING(100 100,73.0769230769231 ↩
                115.384615384615)
```



shortest line between polygon and polygon

```
SELECT ST_AsText(
                ST_ShortestLine(
                        ST_GeomFromText(' ↩
                POLYGON((175 150, 20 40, 50 60, 125
                        ST_Buffer( ↩
                ST_GeomFromText('POINT(110 170)'), 2
                        )
                ) As slinewkt;

 LINESTRING(140.752120669087 ↩
                125.695053378061,121.111404660392 15
```

See Also

ST_ClosestPoint, ST_Distance, ST_LongestLine, ST_MaxDistance

8.8.47 ST_Touches

ST_Touches — Returns `TRUE` if the geometries have at least one point in common, but their interiors do not intersect.

Synopsis

boolean **ST_Touches**(geometry g1, geometry g2);

Description

Returns `TRUE` if the only points in common between *g1* and *g2* lie in the union of the boundaries of *g1* and *g2*. The `ST_Touches` relation applies to all Area/Area, Line/Line, Line/Area, Point/Area and Point/Line pairs of relationships, but *not* to the Point/Point pair.

In mathematical terms, this predicate is expressed as:

$$a.Touches(b) \Leftrightarrow (I(a) \cap I(b) = \emptyset) \wedge (a \cap b) \neq \emptyset$$

The allowable DE-9IM Intersection Matrices for the two geometries are:

- FT*******
- F**T*****
- F***T****

Important
Do not call with a `GEOMETRYCOLLECTION` as an argument

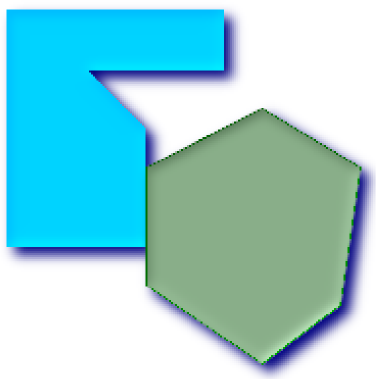
Note
This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid using an index, use `_ST_Touches` instead.

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3

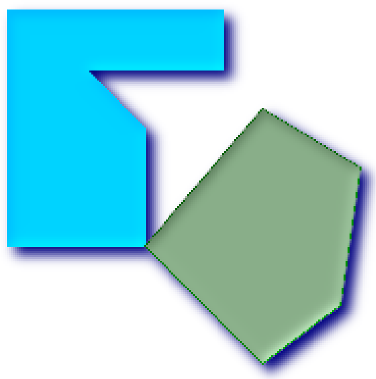
This method implements the SQL/MM specification. SQL-MM 3: 5.1.28

Examples

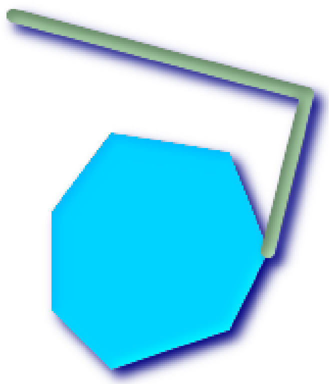
The `ST_Touches` predicate returns `TRUE` in all the following illustrations.



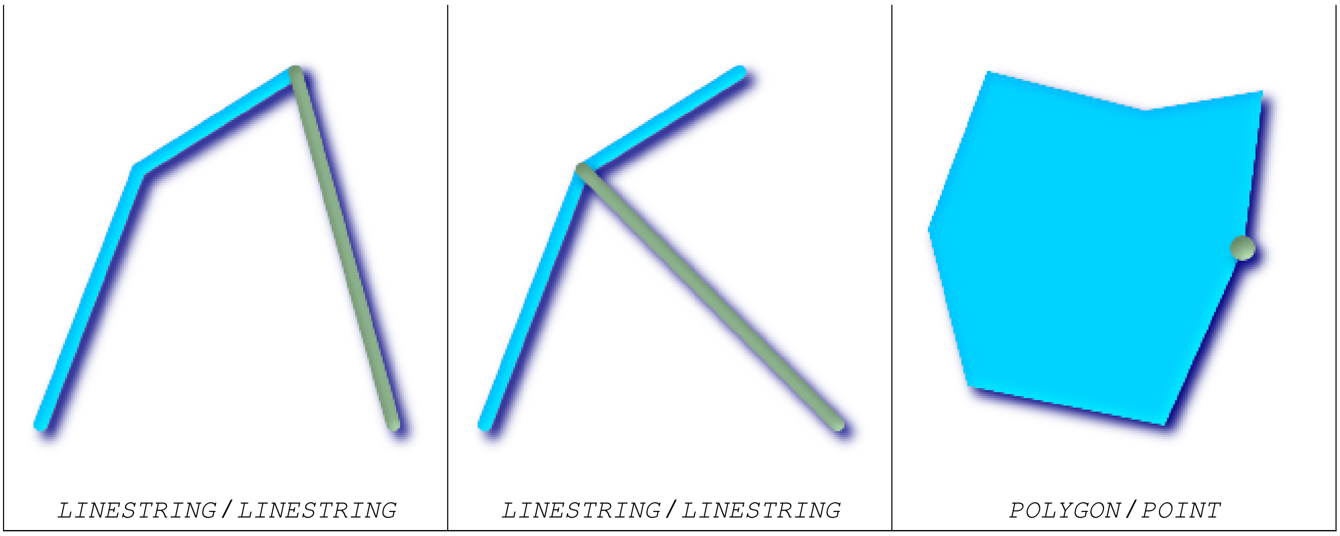
POLYGON / POLYGON



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)
```

8.8.48 ST_Within

ST_Within — Returns true if the geometry A is completely inside geometry B

Synopsis

boolean **ST_Within**(geometry A, geometry B);

Description

Returns TRUE if geometry A is completely inside geometry B. For this function to make sense, the source geometries must both be of the same coordinate projection, having the same SRID. It is a given that if ST_Within(A,B) is true and ST_Within(B,A) is true, then the two geometries are considered spatially equal.

Performed by the GEOS module

> **Important**
> Do not call with a `GEOMETRYCOLLECTION` as an argument

> **Important**
> Do not use this function with invalid geometries. You will get unexpected results.

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_Within.

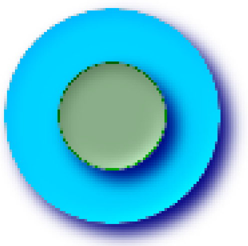
NOTE: this is the "allowable" version that returns a boolean, not an integer.

This method implements the OpenGIS 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

Examples

```
--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)
```



See Also

ST_Contains, ST_Equals, ST_IsValid

8.9 SFCGAL Functions

8.9.1 postgis_sfcgal_version

postgis_sfcgal_version — Returns the version of SFCGAL in use

Synopsis

text **postgis_sfcgal_version**(void);

Description

Availability: 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).

8.9.2 ST_Extrude

ST_Extrude — Extrude a surface to a related volume

Synopsis

geometry **ST_Extrude**(geometry geom, float x, float y, float z);

Description

Availability: 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).

8.9.3 ST_StraightSkeleton

ST_StraightSkeleton — Compute a straight skeleton from a geometry

Synopsis

geometry **ST_StraightSkeleton**(geometry geom);

Description

Availability: 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).

8.9.4 ST_Orientation

ST_Orientation — Determine surface orientation

Synopsis

integer **ST_Orientation**(geometry geom);

Description

Availability: 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).

8.9.5 ST_ForceLHR

ST_ForceLHR — Force LHR orientation

Synopsis

geometry **ST_ForceLHR**(geometry geom);

Description

Availability: 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).

8.9.6 ST_MinkowskiSum

ST_MinkowskiSum — Performs Minkowski sum

Synopsis

geometry **ST_MinkowskiSum**(geometry geom1, geometry geom2);

Description

This function performs a 2D minkowski sum of a point, line or polygon with a polygon.

The first parameter can be any 2D geometry (point, linestring, polygon). If a 3D geometry is passed, it will be converted to 2D by forcing Z to 0, leading to possible cases of invalidity. The second parameter must be a 2D polygon.

Availability: 2.1.0

This method needs SFCGAL backend.

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

8.9.7 ST_3DIntersection

ST_3DIntersection — Perform 3D intersection

Synopsis

geometry **ST_3DIntersection**(geometry geom1, geometry geom2);

Description

Availability: 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).

8.9.8 ST_3DArea

ST_3DArea — Computes area of 3D geometries

Synopsis

float**ST_3DArea**(geometry geom1);

Description

Availability: 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).

8.9.9 ST_Tesselate

ST_Tesselate — Perform surface Tesselation

Synopsis

geometry **ST_Tesselate**(geometry geom);

Description

Availability: 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).

8.10 Geometry Processing

8.10.1 ST_Buffer

ST_Buffer — (T) For geometry: Returns a geometry that represents all points whose distance from this Geometry is less than or equal to distance. Calculations are in the Spatial Reference System of this Geometry. For geography: Uses a planar transform wrapper. Introduced in 1.5 support for different end cap and mitre settings to control shape. buffer_style options: quad_segs=#,endcap=round|flat|square,join=round|mitre|bevel,mitre_limit=#.#

Synopsis

geometry **ST_Buffer**(geometry g1, float radius_of_buffer);
geometry **ST_Buffer**(geometry g1, float radius_of_buffer, integer num_seg_quarter_circle);
geometry **ST_Buffer**(geometry g1, float radius_of_buffer, text buffer_style_parameters);
geography **ST_Buffer**(geography g1, float radius_of_buffer_in_meters);

Description

Returns a geometry/geography that represents all points whose distance from this Geometry/geography is less than or equal to distance.

Geometry: Calculations are in the Spatial Reference System of the geometry. Introduced in 1.5 support for different end cap and mitre settings to control shape.

Note
Negative radii: For polygons, a negative radius can be used, which will shrink the polygon rather than expanding it.

Note
Geography: For geography this is really a thin wrapper around the geometry implementation. It first determines the best SRID that fits the bounding box of the geography object (favoring UTM, Lambert Azimuthal Equal Area (LAEA) north/south pole, and falling back on mercator in worst case scenario) and then buffers in that planar spatial ref and retransforms back to WGS84 geography.

For geography this may not behave as expected if object is sufficiently large that it falls between two UTM zones or crosses the dateline

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. - requires GEOS >= 3.2 to take advantage of advanced geometry functionality.

The optional third parameter (currently only applies to geometry) can either specify number of segments used to approximate a quarter circle (integer case, defaults to 8) or a list of blank-separated key=value pairs (string case) to tweak operations as follows:

- 'quad_segs=#' : number of segments used to approximate a quarter circle (defaults to 8).
- 'endcap=round|flat|square' : endcap style (defaults to "round", needs GEOS-3.2 or higher for a different value). 'butt' is also accepted as a synonym for 'flat'.
- 'join=round|mitre|bevel' : join style (defaults to "round", needs GEOS-3.2 or higher for a different value). 'miter' is also accepted as a synonym for 'mitre'.
- 'mitre_limit=#.#' : mitre ratio limit (only affects mitered join style). 'miter_limit' is also accepted as a synonym for 'mitre_limit'.

Units of radius are measured in units of the spatial reference system.

The inputs can be POINTS, MULTIPOINTS, LINESTRINGS, MULTILINESTRINGS, POLYGONS, MULTIPOLYGONS, and GeometryCollections.

Note
This function ignores the third dimension (z) and will always give a 2-d buffer even when presented with a 3d-geometry.

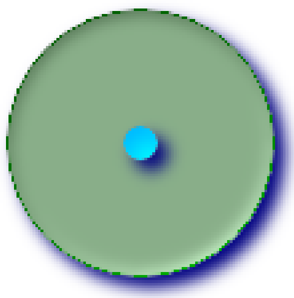
Performed by the GEOS module.

This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s2.1.1.3

This method implements the SQL/MM specification. SQL-MM 3: 5.1.17

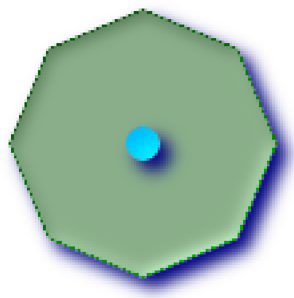
> **Note**
> People often make the mistake of using this function to try to do radius searches. Creating a buffer to to a radius search is slow and pointless. Use ST_DWithin instead.

Examples



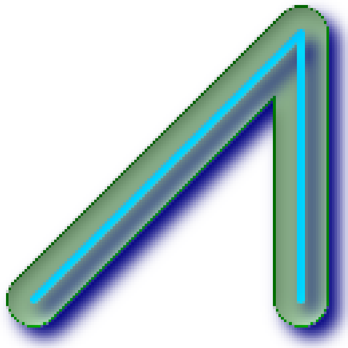
quad_segs=8 (default)

```
SELECT ST_Buffer(
 ST_GeomFromText('POINT(100 90)'),
 50, 'quad_segs=8');
```



quad_segs=2 (lame)

```
SELECT ST_Buffer(
 ST_GeomFromText('POINT(100 90)'),
 50, 'quad_segs=2');
```

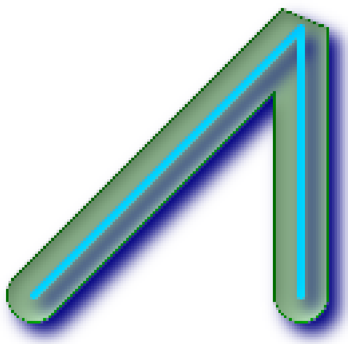


endcap=round join=round (default)

```
SELECT ST_Buffer(
 ST_GeomFromText(
  'LINESTRING(50 50,150 150,150 50)'
 ), 10, 'endcap=round join=round');
```

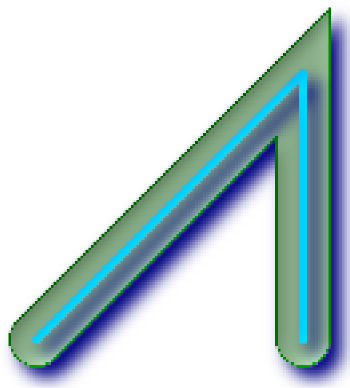
endcap=square

```
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 (default mitre limit)

```
SELECT ST_Buffer(
 ST_GeomFromText(
  'LINESTRING(50 50,150 150,150 50)'
 ), 10, 'join=mitre mitre_limit=5.0');
```

```
--A buffered point approximates a circle
-- A buffered point forcing approximation of (see diagram)
-- 2 points per 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_MakePoint(-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))
```

See Also

ST_Collect, ST_DWithin, ST_SetSRID, ST_Transform, ST_Union

8.10.2 ST_BuildArea

ST_BuildArea — Creates an areal geometry formed by the constituent linework of given geometry

Synopsis

geometry **ST_BuildArea**(geometry A);

Description

Creates an areal geometry formed by the constituent linework of given geometry. The return type can be a Polygon or MultiPolygon, depending on input. If the input lineworks do not form polygons NULL is returned. The inputs can be LINESTRINGS, MULTILINESTRINGS, POLYGONS, MULTIPOLYGONS, and GeometryCollections.

This function will assume all inner geometries represent holes

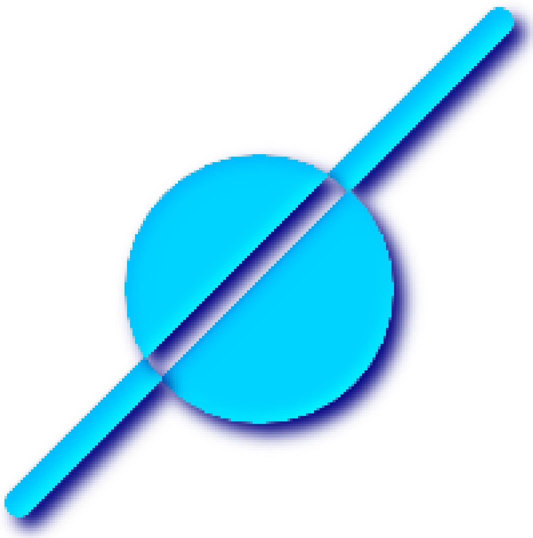
Note
Input linework must be correctly noded for this function to work properly

Availability: 1.1.0 - requires GEOS >= 2.1.0.

Examples

This will create a donut

```
SELECT ST_BuildArea(ST_Collect(smallc,bigc))
FROM (SELECT
        ST_Buffer(
          ST_GeomFromText('POINT(100 90)'), 25) As smallc,
        ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50) As bigc) As foo;
```



This will create a gaping hole inside the circle with prongs sticking out

```
SELECT ST_BuildArea(ST_Collect(line,circle))
FROM (SELECT
        ST_Buffer(
                ST_MakeLine(ST_MakePoint(10, 10),ST_MakePoint(190, 190)),
                                5)  As line,
        ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50) As circle) As foo;

--this creates the same gaping hole
--but using linestrings instead of polygons
SELECT ST_BuildArea(
        ST_Collect(ST_ExteriorRing(line),ST_ExteriorRing(circle))
        )
FROM (SELECT ST_Buffer(
        ST_MakeLine(ST_MakePoint(10, 10),ST_MakePoint(190, 190))
                ,5)  As line,
        ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50) As circle) As foo;
```

See Also

ST_Node, ST_MakePolygon, ST_BdPolyFromText, ST_BdMPolyFromTextwrappers to this function with standard OGC interface

8.10.3 ST_Collect

ST_Collect — Return a specified ST_Geometry value from a collection of other geometries.

Synopsis

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

Description

Output type can be a MULTI* or a GEOMETRYCOLLECTION. Comes in 2 variants. Variant 1 collects 2 geometries. Variant 2 is an aggregate function that takes a set of geometries and collects them into a single ST_Geometry.

Aggregate version: This function returns a GEOMETRYCOLLECTION or a MULTI object from a set of geometries. The ST_Collect() 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. For example, "SELECT ST_Collect(GEOM) FROM GEOMTABLE GROUP BY ATTRCOLUMN" will return a separate GEOMETRYCOLLECTION for each distinct value of ATTRCOLUMN.

Non-Aggregate version: This function returns a geometry being a collection of two input geometries. Output type can be a MULTI* or a GEOMETRYCOLLECTION.

Note
ST_Collect and ST_Union are often interchangeable. ST_Collect is in general orders of magnitude faster than ST_Union because it does not try to dissolve boundaries or validate that a constructed MultiPolgon doesn't have overlapping regions. It merely rolls up single geometries into MULTI and MULTI or mixed geometry types into Geometry Collections. Unfortunately geometry collections are not well-supported by GIS tools. To prevent ST_Collect from returning a Geometry Collection when collecting MULTI geometries, one can use the below trick that utilizes ST_Dump to expand the MULTIs out to singles and then regroup them.

Availability: 1.4.0 - ST_Collect(geomarray) was introduced. ST_Collect was enhanced to handle more geometries faster.

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

This method supports Circular Strings and Curves This method supports Circular Strings and Curves, but will never return a MULTICURVE or MULTI as one would expect and PostGIS does not currently support those.

Examples

Aggregate example (http://postgis.refractions.net/pipermail/postgis-users/2008-June/020331.html)

```
SELECT stusps,
     ST_Multi(ST_Collect(f.the_geom)) as singlegeom
   FROM (SELECT stusps, (ST_Dump(the_geom)).geom As the_geom
        FROM
        somestatetable ) As f
GROUP BY stusps
```

Non-Aggregate example

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

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

--Collect 2 d points
SELECT ST_AsText(ST_Collect(ST_GeomFromText('POINT(1 2)'),
    ST_GeomFromText('POINT(1 2)') ) );

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

--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)

 --Example with curves
SELECT ST_AsText(ST_Collect(ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 ←
    150505,220227 150406)'),
ST_GeomFromText('CIRCULARSTRING(220227 150406,2220227 150407,220227 150406)')));
                                st_astext
------------------------------------------------------------------------------------
 GEOMETRYCOLLECTION(CIRCULARSTRING(220268 150415,220227 150505,220227 150406),
 CIRCULARSTRING(220227 150406,2220227 150407,220227 150406))

--New ST_Collect array construct
SELECT ST_Collect(ARRAY(SELECT the_geom FROM sometable));

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))
```

See Also

ST_Dump, ST_Union

8.10.4 ST_ConcaveHull

ST_ConcaveHull — The concave hull of a geometry represents a possibly concave geometry that encloses all geometries within the set. You can think of it as shrink wrapping.

Synopsis

geometry **ST_ConcaveHull**(geometry geomA, float target_percent, boolean allow_holes=false);

Description

The concave hull of a geometry represents a possibly concave geometry that encloses all geometries within the set. Defaults to false for allowing polygons with holes. The result is never higher than a single polygon.

The target_percent is the target percent of area of convex hull the PostGIS solution will try to approach before giving up or exiting. One can think of the concave hull as the geometry you get by vacuum sealing a set of geometries. The target_percent of 1 will give you the same answer as the convex hull. A target_percent between 0 and 0.99 will give you something that should have a smaller area than the convex hull. This is different from a convex hull which is more like wrapping a rubber band around the set of geometries.

It is usually used with MULTI and Geometry Collections. Although it is not an aggregate - you can use it in conjunction with ST_Collect or ST_Union to get the concave hull of a set of points/linestring/polygons ST_ConcaveHull(ST_Collect(somepointfield), 0.80).

It is much slower to compute than convex hull but encloses the geometry better and is also useful for image recognition.

Performed by the GEOS module

Note

Note - If you are using with points, linestrings, or geometry collections use ST_Collect. If you are using with polygons, use ST_Union since it may fail with invalid geometries.

Note

Note - The smaller you make the target percent, the longer it takes to process the concave hull and more likely to run into topological exceptions. Also the more floating points and number of points you accrue. First try a 0.99 which does a first hop, is usually very fast, sometimes as fast as computing the convex hull, and usually gives much better than 99% of shrink since it almost always overshoots. Second hope of 0.98 it slower, others get slower usually quadratically. To reduce precision and float points, use ST_SimplifyPreserveTopology or ST_SnapToGrid after ST_ConcaveHull. ST_SnapToGrid is a bit faster, but could result in invalid geometries where as ST_SimplifyPreserveTopology almost always preserves the validity of the geometry.

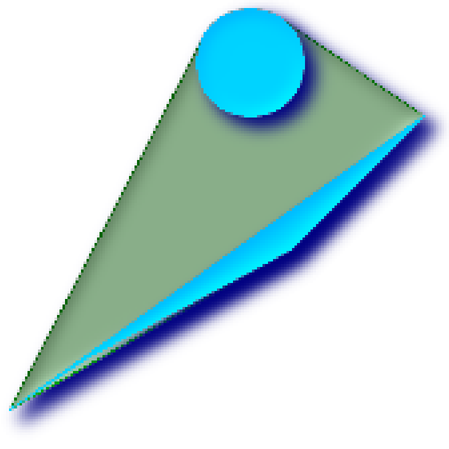
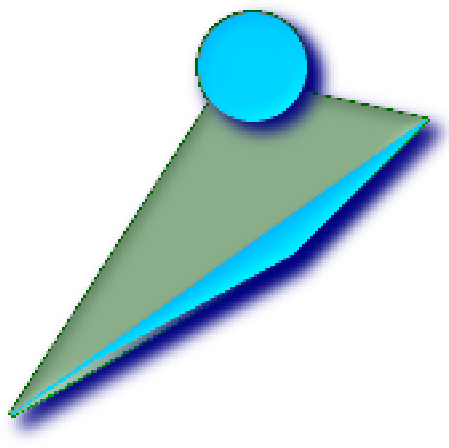
More real world examples and brief explanation of the technique are shown http://www.bostongis.com/postgis_concavehull.snippet

Also check out Simon Greener's article on demonstrating ConcaveHull introduced in Oracle 11G R2. http://www.spatialdbadvisor.com/-oracle_spatial_tips_tricks/172/concave-hull-geometries-in-oracle-11gr2. The solution we get at 0.75 target percent of convex hull is similar to the shape Simon gets with Oracle SDO_CONCAVEHULL_BOUNDARY.

Availability: 2.0.0

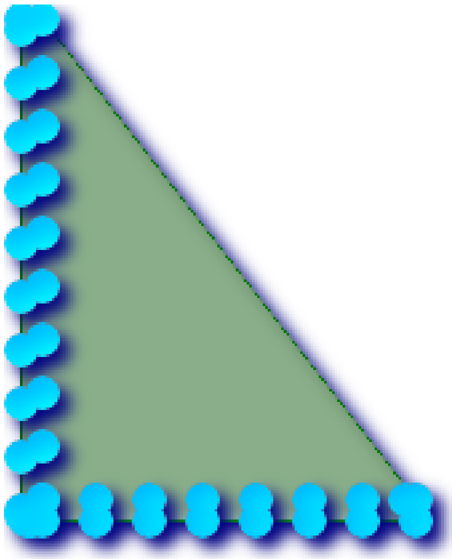
Examples

```
--Get estimate of infected area based on point observations
SELECT d.disease_type,
  ST_ConcaveHull(ST_Collect(d.pnt_geom), 0.99) As geom
  FROM disease_obs As d
  GROUP BY d.disease_type;
```

 *ST_ConcaveHull of 2 polygons encased in target 100% shrink concave hull*	 *-- geometries overlaid with concavehull at target 90% of convex hull area*

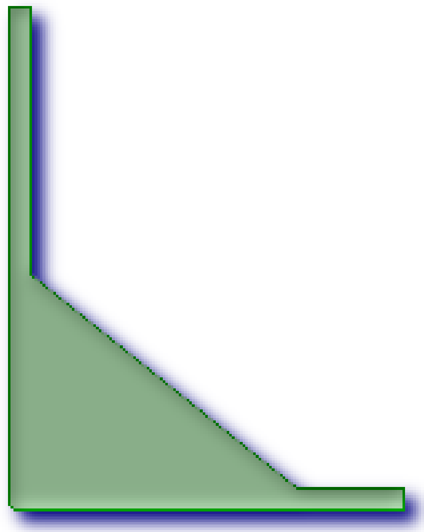
```
-- geometries overlaid with concavehull
-- at target 100% shrink (this is the ↩
      same as convex hull - since no shrink)
SELECT
        ST_ConcaveHull(
                ST_Union(ST_GeomFromText ↩
      ('POLYGON((175 150, 20 40,
                        50 60, 125 100, ↩
      175 150))'),
                ST_Buffer(ST_GeomFromText ↩
      ('POINT(110 170)'), 20)
                ), 1)
         As convexhull;
```

```
-- geometries overlaid with concavehull ↩
      at target 90% shrink
SELECT
        ST_ConcaveHull(
                ST_Union(ST_GeomFromText ↩
      ('POLYGON((175 150, 20 40,
                        50 60, 125 100, ↩
      175 150))'),
                ST_Buffer(ST_GeomFromText ↩
      ('POINT(110 170)'), 20)
                ), 0.9)
         As target_90;
```



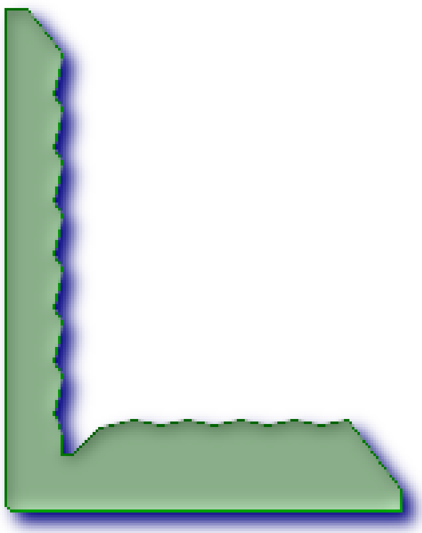
L Shape points overlaid with convex hull

```
-- 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;

SELECT ST_ConvexHull(ST_Collect(geom))
FROM l_shape;
```



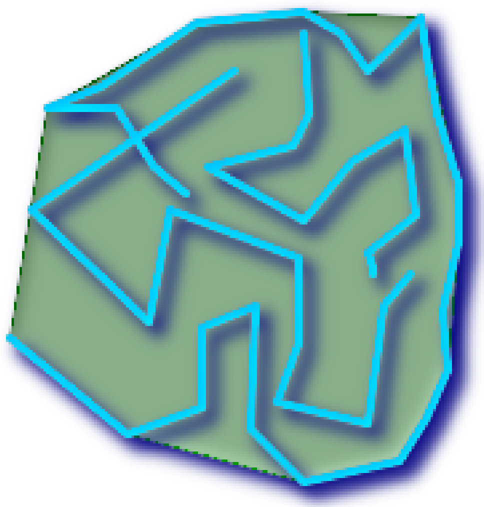
ST_ConcaveHull of L points at target 99% of convex hull

```
SELECT ST_ConcaveHull(ST_Collect(geom), ↩
      0.99)
        FROM l_shape;
```

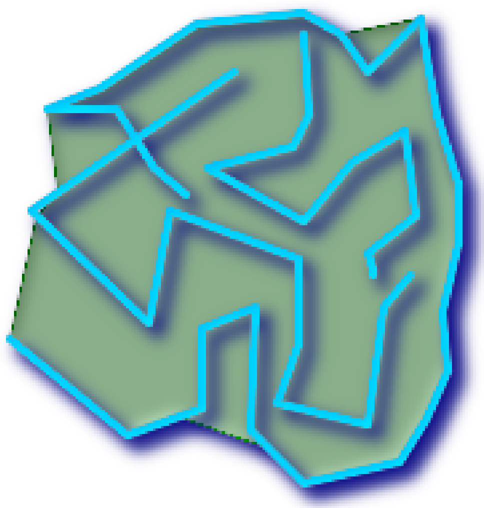


Concave Hull of L points at target 80% convex hull area

```
-- Concave Hull L shape points
-- at target 80% of convexhull
SELECT ST_ConcaveHull(ST_Collect( ↩
geom), 0.80)
FROM l_shape;
```



multilinestring overlaid with Convex hull



multilinestring with overlaid with Concave hull of linestrings at 99% target -- first hop

```
SELECT ST_ConcaveHull(ST_GeomFromText(' ↩
      MULTILINESTRING((106 164,30 112,74 70,82 112,1
        130 62,122 40,156 32,162 76,172 ↩
      88),
(132 178,134 148,128 136,96 128,132 ↩
      108,150 130,
170 142,174 110,156 96,158 90,158 88),
(22 64,66 28,94 38,94 68,114 76,112 30,
132 10,168 18,178 34,186 52,184 74,190 ↩
      100,
190 122,182 148,178 170,176 184,156 ↩
      164,146 178,
132 186,92 182,56 158,36 150,62 150,76 ↩
      128,88 118))'),0.99)
```

See Also

ST_Collect, ST_ConvexHull, ST_SimplifyPreserveTopology, ST_SnapToGrid

8.10.5 ST_ConvexHull

ST_ConvexHull — The convex hull of a geometry represents the minimum convex geometry that encloses all geometries within the set.

Synopsis

geometry **ST_ConvexHull**(geometry geomA);

Description

The convex hull of a geometry represents the minimum convex geometry that encloses all geometries within the set.

One can think of the convex hull as the geometry you get by wrapping an elastic band around a set of geometries. This is different from a concave hull which is analogous to shrink-wrapping your geometries.

It is usually used with MULTI and Geometry Collections. Although it is not an aggregate - you can use it in conjunction with ST_Collect to get the convex hull of a set of points. ST_ConvexHull(ST_Collect(somepointfield)).

It is often used to determine an affected area based on a set of point observations.

Performed by the GEOS module

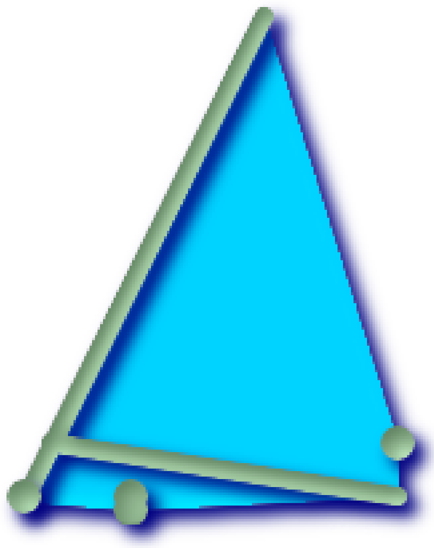
This method implements the OpenGIS Simple Features Implementation Specification for SQL 1.1. s2.1.1.3

This method implements the SQL/MM specification. SQL-MM 3: 5.1.16

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

Examples

```
--Get estimate of infected area based on point observations
SELECT d.disease_type,
  ST_ConvexHull(ST_Collect(d.the_geom)) As the_geom
  FROM disease_obs As d
  GROUP BY d.disease_type;
```



Convex Hull of a MultiLinestring and a MultiPoint seen together with the MultiLinestring and 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))
```

See Also

ST_Collect, ST_ConcaveHull, ST_MinimumBoundingCircle

8.10.6 ST_CurveToLine

ST_CurveToLine — Converts a CIRCULARSTRING/CURVEPOLYGON to a LINESTRING/POLYGON

Synopsis

geometry **ST_CurveToLine**(geometry curveGeom);
geometry **ST_CurveToLine**(geometry curveGeom, integer segments_per_qtr_circle);

Description

Converst a CIRCULAR STRING to regular LINESTRING or CURVEPOLYGON to POLYGON. 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 default value of 32 segments per quarter circle

Availability: 1.2.2?

This method implements the OpenGIS 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

Examples

```
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)
```

See Also

ST_LineToCurve

8.10.7 ST_DelaunayTriangles

ST_DelaunayTriangles — Return a Delaunay triangulation around the given input points.

Synopsis

geometry **ST_DelaunayTriangles**(geometry g1, float tolerance, int4 flags);

Description

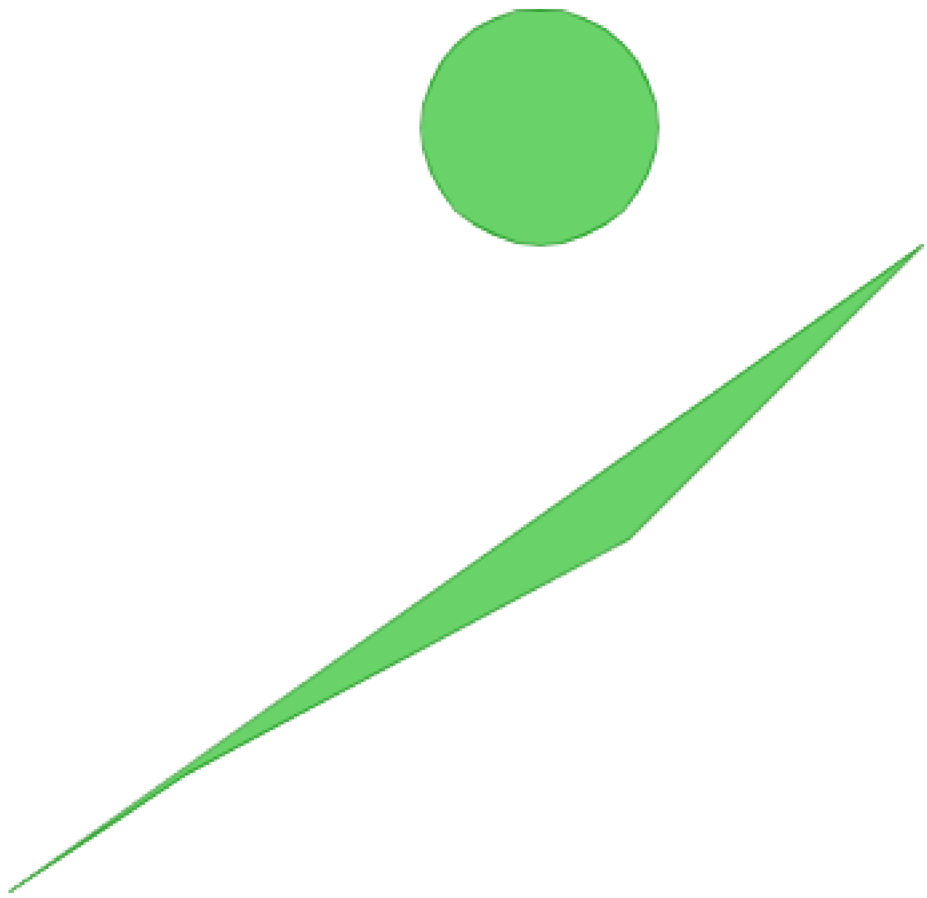
Return a Delaunay triangulation around the vertices of the input geometry. Output is a COLLECTION of polygons (for flags=0) or a MULTILINESTRING (for flags=1) or TIN (for flags=2). The tolerance, if any, is used to snap input vertices togheter.

Availability: 2.1.0 - requires GEOS >= 3.4.0.

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

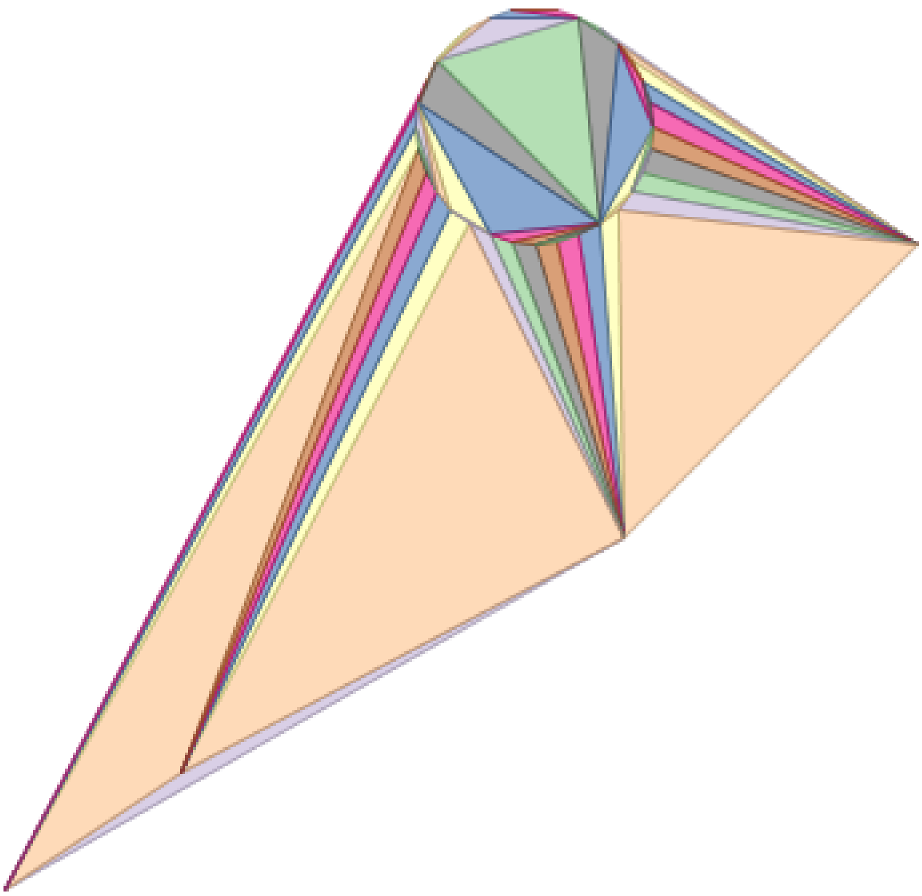
This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

2D Examples



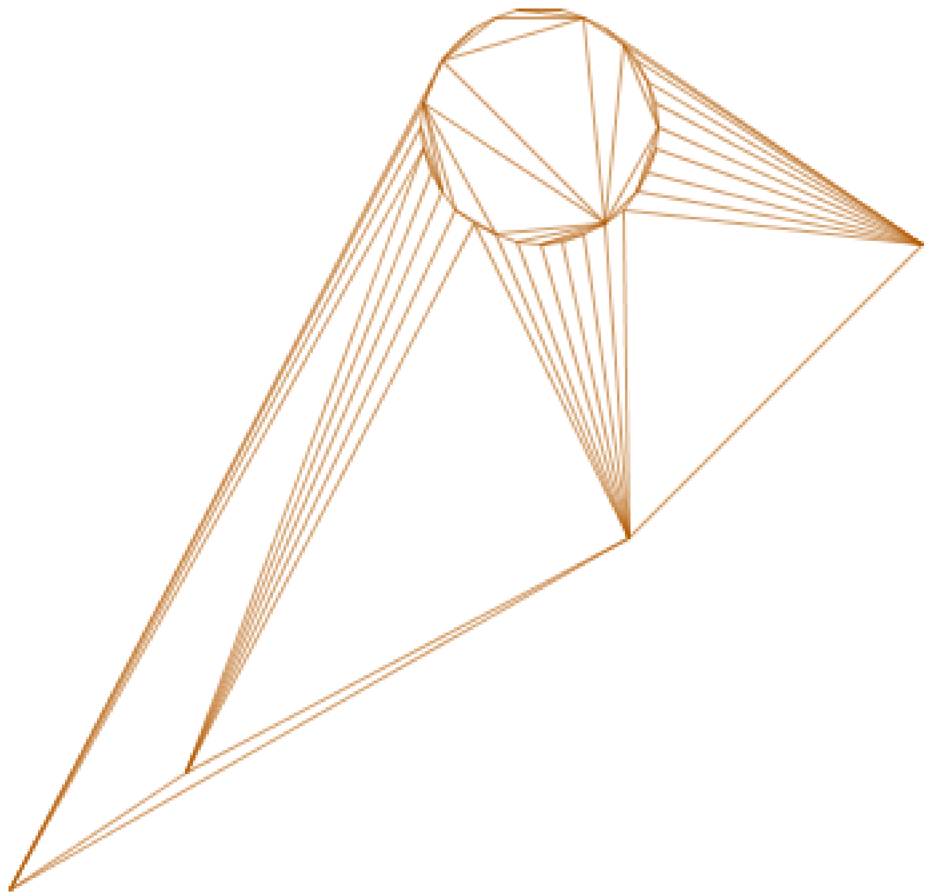
Original polygons

```
-- 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)
                )
```



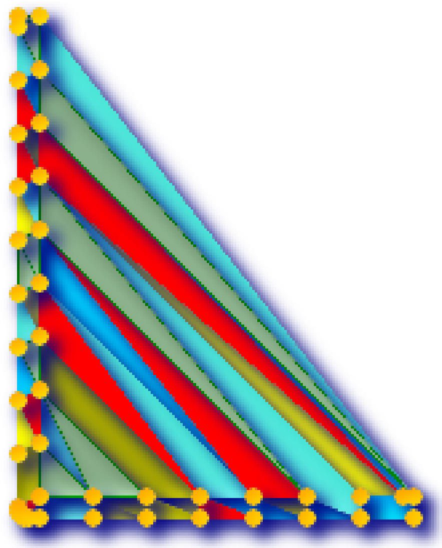
ST_DelaunayTriangles of 2 polygons: delaunay triangle polygons each triangle themed in different color

```
-- 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;
```



-- delaunay triangles as multilinestring

```
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;
```



-- delaunay triangles of 45 points as 55 triangle polygons

```
-- 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))
:
:
```

3D Examples

```
-- 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)))
```

See Also

ST_ConcaveHull, ST_Dump

8.10.8 ST_Difference

ST_Difference — Returns a geometry that represents that part of geometry A that does not intersect with geometry B.

Synopsis

geometry **ST_Difference**(geometry geomA, geometry geomB);

Description

Returns a geometry that represents that part of geometry A that does not intersect with geometry B. One can think of this as GeometryA - ST_Intersection(A,B). If A is completely contained in B then an empty geometry collection is returned.

> **Note**
> Note - order matters. B - A will always return a portion of B

Performed by the GEOS module

> **Note**
> Do not call with a GeometryCollection as an argument

This method implements the OpenGIS 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 it seems to only consider x y when doing the difference and tacks back on the Z-Index

Examples

	
The original linestrings shown together.	*The difference of the two linestrings*

```
--Safe for 2d. This is same geometries as what is shown for st_symdifference
SELECT ST_AsText(
  ST_Difference(
      ST_GeomFromText('LINESTRING(50 100, 50 200)'),
      ST_GeomFromText('LINESTRING(50 50, 50 150)')
    )
  );

st_astext
---------
LINESTRING(50 150,50 200)
```

```

--When used in 3d doesn't quite do the right thing
SELECT ST_AsEWKT(ST_Difference(ST_GeomFromEWKT('MULTIPOINT(-118.58 38.38 5,-118.60 38.329 ↩
    6,-118.614 38.281 7)'), ST_GeomFromEWKT('POINT(-118.614 38.281 5)')));
st_asewkt
---------
MULTIPOINT(-118.6 38.329 6,-118.58 38.38 5)
```

See Also

ST_SymDifference

8.10.9 ST_Dump

ST_Dump — Returns a set of geometry_dump (geom,path) rows, that make up a geometry g1.

Synopsis

geometry_dump[] **ST_Dump**(geometry g1);

Description

This is a set-returning function (SRF). It returns a set of geometry_dump rows, formed by a geometry (geom) and an array of integers (path). When the input geometry is a simple type (POINT,LINESTRING,POLYGON) a single record will be returned with an empty path array and the input geometry as geom. When the input geometry is a collection or multi it will return a record for each of the collection components, and the path will express the position of the component inside the collection.

ST_Dump is useful for expanding geometries. It is the reverse of a GROUP BY in that it creates new rows. For example it can be use to expand MULTIPOLYGONS into POLYGONS.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

Availability: PostGIS 1.0.0RC1. Requires PostgreSQL 7.3 or higher.

Note
Prior to 1.3.4, this function crashes if used with geometries that contain CURVES. This is fixed in 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.

Standard Examples

```
SELECT sometable.field1, sometable.field1,
      (ST_Dump(sometable.the_geom)).geom AS the_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)
```

Polyhedral Surfaces, TIN and Triangle Examples

```
-- 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))
```

See Also

geometry_dump, Section 13.5, ST_Collect, ST_Collect, ST_GeometryN

8.10.10 ST_DumpPoints

ST_DumpPoints — Returns a set of geometry_dump (geom,path) rows of all points that make up a geometry.

Synopsis

geometry_dump[]**ST_DumpPoints**(geometry geom);

Description

This set-returning function (SRF) returns a set of `geometry_dump` rows formed by a geometry (`geom`) and an array of integers (`path`).

The *geom* component of `geometry_dump` are all the `POINT`s that make up the supplied geometry

The *path* component of `geometry_dump` (an `integer[]`) is an index reference enumerating the `POINT`s of the supplied geometry. For example, if a `LINESTRING` is supplied, a path of `{i}` is returned where `i` is the `nth` coordinate in the `LINESTRING`. If a `POLYGON` is supplied, a path of `{i,j}` is returned where `i` is the ring number (1 is outer; inner rings follow) and `j` enumerates the `POINT`s (again 1-based index).

Enhanced: 2.1.0 Faster speed. Reimplemented as native-C.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

Availability: 1.5.0

This method supports Circular Strings and Curves

This function supports Polyhedral surfaces.

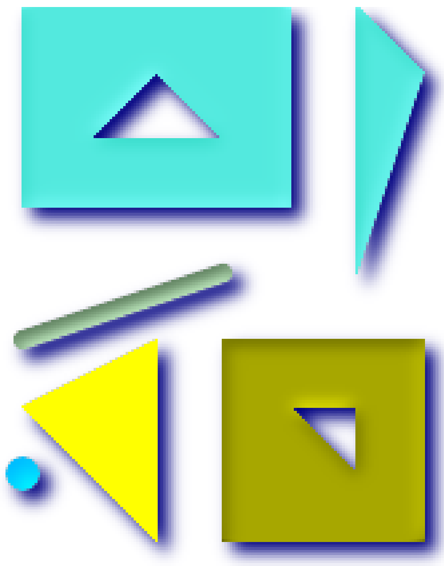
This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

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)
```

Standard Geometry Examples



```
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)
```

Polyhedral Surfaces, TIN and Triangle Examples

```
-- 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)
```

See Also

geometry_dump, Section 13.5, ST_Dump, ST_DumpRings

8.10.11 ST_DumpRings

ST_DumpRings — Returns a set of `geometry_dump` rows, representing the exterior and interior rings of a polygon.

Synopsis

geometry_dump[] **ST_DumpRings**(geometry a_polygon);

Description

This is a set-returning function (SRF). It returns a set of `geometry_dump` rows, defined as an `integer[]` and a `geometry`, aliased "path" and "geom" respectively. The "path" field holds the polygon ring index containing a single integer: 0 for the shell, >0 for holes. The "geom" field contains the corresponding ring as a polygon.

Availability: PostGIS 1.1.3. Requires PostgreSQL 7.3 or higher.

Note
This only works for POLYGON geometries. It will not work for MULTIPOLYGONS

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

Examples

```
SELECT sometable.field1, sometable.field1,
    (ST_DumpRings(sometable.the_geom)).geom As the_geom
FROM sometableOfpolys;

SELECT ST_AsEWKT(geom) As the_geom, path
  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 |                                            the_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))
```

See Also

geometry_dump, Section 13.5, ST_Dump, ST_ExteriorRing, ST_InteriorRingN

8.10.12 ST_FlipCoordinates

ST_FlipCoordinates — Returns a version of the given geometry with X and Y axis flipped. Useful for people who have built latitude/longitude features and need to fix them.

Synopsis

geometry **ST_FlipCoordinates**(geometry geom);

Description

Returns a version of the given geometry with X and Y axis flipped.

✓ This method supports Circular Strings and Curves

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

✓ This function supports M coordinates.

Availability: 2.0.0

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Example

```
SELECT ST_AsEWKT(ST_FlipCoordinates(GeomFromEWKT('POINT(1 2)')));
 st_asewkt
------------
POINT(2 1)
```

8.10.13 ST_Intersection

ST_Intersection — (T) Returns a geometry that represents the shared portion of geomA and geomB. The geography implementation does a transform to geometry to do the intersection and then transform back to WGS84.

Synopsis

geometry **ST_Intersection**(geometry geomA , geometry geomB);
geography **ST_Intersection**(geography geogA , geography geogB);

Description

Returns a geometry that represents the point set intersection of the Geometries.

In other words - that portion of geometry A and geometry B that is shared between the two geometries.

If the geometries do not share any space (are disjoint), then an empty geometry collection is returned.

ST_Intersection in conjunction with ST_Intersects is very useful for clipping geometries such as in bounding box, buffer, region queries where you only want to return that portion of a geometry that sits in a country or region of interest.

Note
Geography: For geography this is really 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.

Important
Do not call with a `GEOMETRYCOLLECTION` as an argument

Performed by the GEOS module

This method is also provided by SFCGAL backend.

Availability: 1.5 support for geography data type was introduced.

This method implements the OpenGIS 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

Examples

```
SELECT ST_AsText(ST_Intersection('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )':: ↵
    geometry));
 st_astext
---------------
GEOMETRYCOLLECTION EMPTY
(1 row)
SELECT ST_AsText(ST_Intersection('POINT(0 0)'::geometry, 'LINESTRING ( 0 0, 0 2 )':: ↵
    geometry));
 st_astext
---------------
POINT(0 0)
(1 row)

---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.the_geom, trails. ↵
    the_geom))).geom As clipped_geom
FROM country
  INNER JOIN trails
  ON ST_Intersects(country.the_geom, trails.the_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.the_geom, poly.the_geom),
        0.0)
        ) As clipped_geom
FROM country
  INNER JOIN poly
  ON ST_Intersects(country.the_geom, poly.the_geom)
  WHERE Not ST_IsEmpty(ST_Buffer(ST_Intersection(country.the_geom, poly.the_geom),0.0));
```

See Also

ST_Difference, ST_Dimension, ST_Dump, ST_SymDifference, ST_Intersects, ST_Multi

8.10.14 ST_LineToCurve

ST_LineToCurve — Converts a LINESTRING/POLYGON to a CIRCULARSTRING, CURVEPOLYGON

Synopsis

geometry **ST_LineToCurve**(geometry geomANoncircular);

Description

Converts plain LINESTRING/POLYGONS to CIRCULAR STRINGs and Curved Polygons. Note much fewer points are needed to describe the curved equivalent.

Availability: 1.2.2?

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

This method supports Circular Strings and Curves

Examples

```
SELECT ST_AsText(ST_LineToCurve(foo.the_geom)) As curvedastext,ST_AsText(foo.the_geom) As ↵
    non_curvedastext
  FROM (SELECT ST_Buffer('POINT(1 3)'::geometry, 3) As the_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,-1.77163859
                                                                         1.85194970290472
                                                                    |  --ETC--  ↵
                                                                        ,3.94235584120969  ↵
                                                                        3.58527096604839,4  ↵
                                                                        3))
--3D example
SELECT ST_AsEWKT(ST_LineToCurve(ST_GeomFromEWKT('LINESTRING(1 2 3, 3 4 8, 5 6 4, 7 8 4, 9  ↵
    10 4)')));

       st_asewkt
------------------------------------
 CIRCULARSTRING(1 2 3,5 6 4,9 10 4)
```

See Also

ST_CurveToLine

8.10.15 ST_MakeValid

ST_MakeValid — Attempts to make an invalid geometry valid without losing vertices.

Synopsis

geometry **ST_MakeValid**(geometry input);

Description

The function attempts to create a valid representation of a given invalid geometry without losing any of the input vertices. Already-valid geometries are returned without further intervention.

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.

Availability: 2.0.0, requires GEOS-3.3.0

Enhanced: 2.0.1, speed improvements requires GEOS-3.3.4

Enhanced: 2.1.0 added support for GEOMETRYCOLLECTION and MULTIPOINT.

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

See Also

ST_IsValid ST_CollectionExtract

8.10.16 ST_MemUnion

ST_MemUnion — Same as ST_Union, only memory-friendly (uses less memory and more processor time).

Synopsis

geometry **ST_MemUnion**(geometry set geomfield);

Description

Some useful description here.

> **Note**
> Same as ST_Union, only memory-friendly (uses less memory and more processor time). This aggregate function works by unioning the geometries one at a time to previous result as opposed to ST_Union aggregate which first creates an array and then unions

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

Examples

```
See ST_Union
```

See Also

ST_Union

8.10.17 ST_MinimumBoundingCircle

ST_MinimumBoundingCircle — Returns the smallest circle polygon that can fully contain a geometry. Default uses 48 segments per quarter circle.

Synopsis

geometry **ST_MinimumBoundingCircle**(geometry geomA, integer num_segs_per_qt_circ=48);

Description

Returns the smallest circle polygon that can fully contain a geometry.

> **Note**
> The circle is approximated by a polygon with a default of 48 segments per quarter circle. This number can be increased with little performance penalty to obtain a more accurate result.

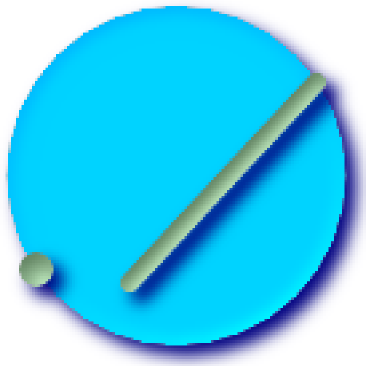
It is often used with MULTI and Geometry Collections. Although it is not an aggregate - you can use it in conjunction with ST_Collect to get the minimum bounding circle of a set of geometries. ST_MinimumBoundingCircle(ST_Collect(somepointfield)).

The ratio of the area of a polygon divided by the area of its Minimum Bounding Circle is often referred to as the Roeck test.

Availability: 1.4.0 - requires GEOS

Examples

```
SELECT d.disease_type,
  ST_MinimumBoundingCircle(ST_Collect(d.the_geom)) As the_geom
  FROM disease_obs As d
  GROUP BY d.disease_type;
```



Minimum bounding circle of a point and linestring. Using 8 segs to approximate a quarter circle

```
SELECT ST_AsText(ST_MinimumBoundingCircle(
    ST_Collect(
      ST_GeomFromEWKT('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))
```

See Also

ST_Collect, ST_ConvexHull

8.10.18 ST_Polygonize

ST_Polygonize — Aggregate. Creates a GeometryCollection containing possible polygons formed from the constituent linework of a set of geometries.

Synopsis

geometry **ST_Polygonize**(geometry set geomfield);
geometry **ST_Polygonize**(geometry[] geom_array);

Description

Creates a GeometryCollection containing possible polygons formed from the constituent linework of a set of geometries.

Note
Geometry Collections are often difficult to deal with with third party tools, so use ST_Polygonize in conjunction with ST_Dump to dump the polygons out into individual polygons.

Note
Input linework must be correctly noded for this function to work properly

Availability: 1.0.0RC1 - requires GEOS >= 2.1.0.

Examples: Polygonizing single linestrings

```
SELECT ST_AsEWKT(ST_Polygonize(the_geom_4269)) As geomtextrep
FROM (SELECT the_geom_4269 FROM ma.suffolk_edges ORDER BY tlid LIMIT 45) As foo;

geomtextrep
-------------------------------------
 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)))
(1 row)

--Use ST_Dump to dump out the polygonize geoms into individual polygons
SELECT ST_AsEWKT((ST_Dump(foofoo.polycoll)).geom) As geomtextrep
FROM (SELECT ST_Polygonize(the_geom_4269) As polycoll
  FROM (SELECT the_geom_4269 FROM ma.suffolk_edges
    ORDER BY tlid LIMIT 45) As foo) As foofoo;

geomtextrep
------------------------
 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))
(2 rows)
```

See Also

ST_Node, ST_Dump

8.10.19 ST_Node

ST_Node — Node a set of linestrings.

Synopsis

geometry **ST_Node**(geometry geom);

Description

Fully node a set of linestrings using the least possible number of nodes while preserving all of the input ones.

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

Availability: 2.0.0 - requires GEOS >= 3.3.0.

> **Note**
> Due to a bug in GEOS up to 3.3.1 this function fails to node self-intersecting lines. This is fixed with GEOS 3.3.2 or higher.

Examples

```
SELECT ST_AsEWKT(
    ST_Node('LINESTRINGZ(0 0 0, 10 10 10, 0 10 5, 10 0 3)'::geometry)
  ) As  output;
output
-----------
MULTILINESTRING((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))
```

See Also

ST_UnaryUnion

8.10.20 ST_OffsetCurve

ST_OffsetCurve — Return an offset line at a given distance and side from an input line. Useful for computing parallel lines about a center line

Synopsis

geometry **ST_OffsetCurve**(geometry line, float signed_distance, text style_parameters='');

Description

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.

For positive distance the offset will be at the left side of the input line and retain the same direction. For a negative distance it'll be at the right side and in the opposite direction.

Availability: 2.0 - requires GEOS >= 3.2, improved with GEOS >= 3.3

The optional third parameter allows specifying a list of blank-separated key=value pairs to tweak operations as follows:

- 'quad_segs=#' : number of segments used to approximate a quarter circle (defaults to 8).

- 'join=round|mitre|bevel' : join style (defaults to "round"). 'miter' is also accepted as a synonym for 'mitre'.
- 'mitre_limit=#.#' : mitre ratio limit (only affects mitred join style). 'miter_limit' is also accepted as a synonym for 'mitre_limit'.

Units of distance are measured in units of the spatial reference system.

The inputs can only be LINESTRINGS.

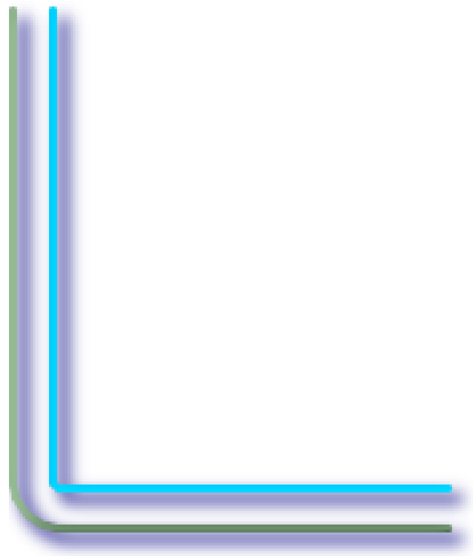
Performed by the GEOS module.

Note
This function ignores the third dimension (z) and will always give a 2-d result even when presented with a 3d-geometry.

Examples

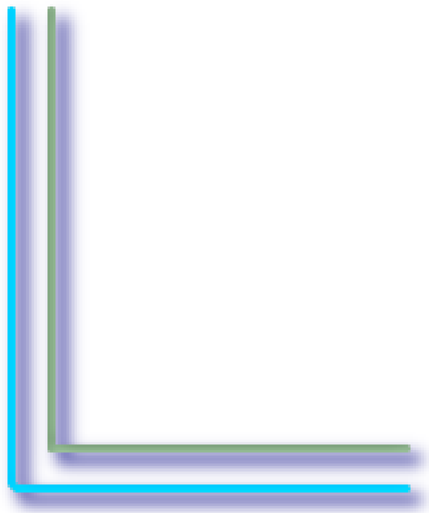
Compute an open buffer around roads

```
SELECT ST_Union(
 ST_OffsetCurve(f.the_geom,  f.width/2, 'quad_segs=4 join=round'),
 ST_OffsetCurve(f.the_geom, -f.width/2, 'quad_segs=4 join=round')
) as track
FROM someroadstable;
```



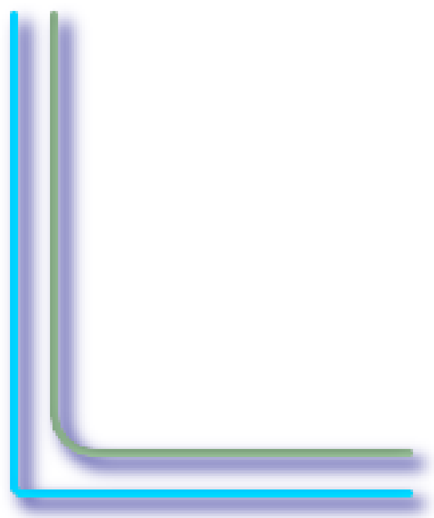
15, 'quad_segs=4 join=round' original line and its offset 15 units.

```
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)
```



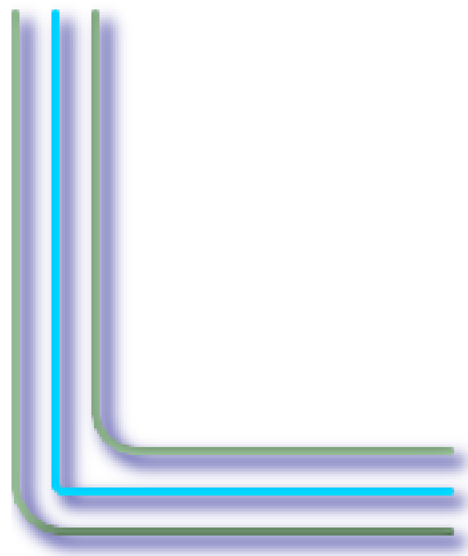
-15, 'quad_segs=4 join=round' original line and its offset -15 units

```
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)
```



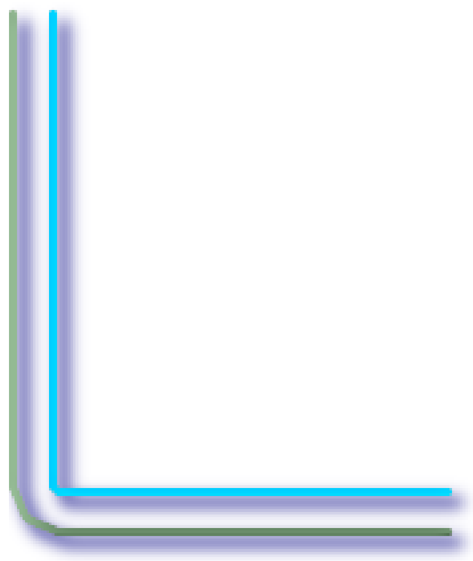
double-offset to get more curvy, note the first reverses direction, so -30 + 15 = -15

```
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)
```



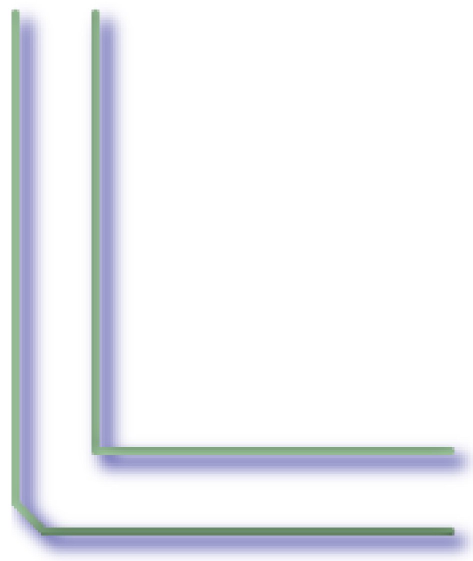
double-offset to get more curvy,combined with regular offset 15 to get parallel lines. Overlaid with original.

```
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 7.39339828220179,
2.14180701233067 12.2597485145237,1 18,1
    195),
(164 31,46 31,40.2597485145236
    32.1418070123307,35.3933982822018 35.3933982822018,
32.1418070123307 40.2597485145237,31
    46,31 195))
```



15, 'quad_segs=4 join=bevel' shown with original line

```
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 collected, 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))
```

See Also

ST_Buffer

8.10.21 ST_RemoveRepeatedPoints

ST_RemoveRepeatedPoints — Returns a version of the given geometry with duplicated points removed.

Synopsis

geometry **ST_RemoveRepeatedPoints**(geometry geom);

Description

Returns a version of the given geometry with duplicated points removed. Will actually do something only with (multi)lines, (multi)polygons and multipoints but you can safely call it with any kind of geometry. Since simplification occurs on a object-by-object basis you can also feed a GeometryCollection to this function.

Availability: 2.0.0

This function supports Polyhedral surfaces.

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

See Also

ST_Simplify

8.10.22 ST_SharedPaths

ST_SharedPaths — Returns a collection containing paths shared by the two input linestrings/multilinestrings.

Synopsis

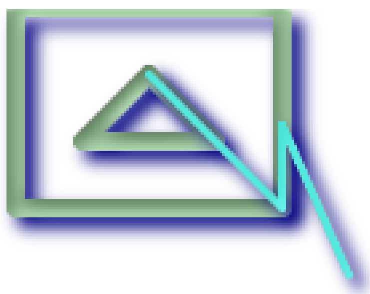
geometry **ST_SharedPaths**(geometry lineal1, geometry lineal2);

Description

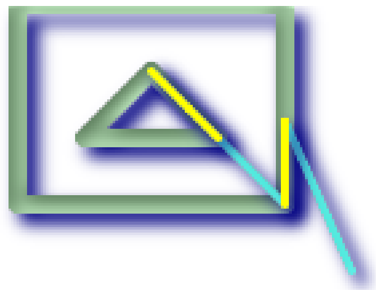
Returns a collection containing paths shared by the two input geometries. Those going in the same direction are in the first element of the collection, those going in the opposite direction are in the second element. The paths themselves are given in the direction of the first geometry.

Availability: 2.0.0 requires GEOS >= 3.3.0.

Examples: Finding shared paths



A multilinestring and a linestring



The shared path of multilinestring and linestring overlaid with original geometries.

```
 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)))
```

See Also

ST_Dump, ST_GeometryN, ST_NumGeometries

8.10.23 ST_Shift_Longitude

ST_Shift_Longitude — Reads every point/vertex in every component of every feature in a geometry, and if the longitude coordinate is <0, adds 360 to it. The result would be a 0-360 version of the data to be plotted in a 180 centric map

Synopsis

geometry **ST_Shift_Longitude**(geometry geomA);

Description

Reads every point/vertex in every component of every feature in a geometry, and if the longitude coordinate is <0, adds 360 to it. The result would be a 0-360 version of the data to be plotted in a 180 centric map

Note
This is only useful for data in long lat e.g. 4326 (WGS 84 long lat)

Pre-1.3.4 bug prevented this from working for MULTIPOINT. 1.3.4+ works with MULTIPOINT as well.

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

Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Examples

```
--3d points
SELECT ST_AsEWKT(ST_Shift_Longitude(ST_GeomFromEWKT('SRID=4326;POINT(-118.58 38.38 10)'))) ↩
    As geomA,
  ST_AsEWKT(ST_Shift_Longitude(ST_GeomFromEWKT('SRID=4326;POINT(241.42 38.38 10)'))) As ↩
      geomb
geomA                  geomB
----------                 -----------
SRID=4326;POINT(241.42 38.38 10) SRID=4326;POINT(-118.58 38.38 10)

--regular line string
SELECT ST_AsText(ST_Shift_Longitude(ST_GeomFromText('LINESTRING(-118.58 38.38, -118.20 ↩
    38.45)')))

st_astext
----------
LINESTRING(241.42 38.38,241.8 38.45)
```

See Also

ST_GeomFromEWKT, ST_GeomFromText, ST_AsEWKT

8.10.24 ST_Simplify

ST_Simplify — Returns a "simplified" version of the given geometry using the Douglas-Peucker algorithm.

Synopsis

geometry **ST_Simplify**(geometry geomA, float tolerance);

Description

Returns a "simplified" version of the given geometry using the Douglas-Peucker algorithm. Will actually do something only with (multi)lines and (multi)polygons but you can safely call it with any kind of geometry. Since simplification occurs on a object-by-object basis you can also feed a GeometryCollection to this function.

> **Note**
> Note that returned geometry might loose its simplicity (see ST_IsSimple)

> **Note**
> Note topology may not be preserved and may result in invalid geometries. Use (see ST_SimplifyPreserveTopology) to preserve topology.

Performed by the GEOS module.

Availability: 1.2.2

Examples

A circle simplified too much becomes a triangle, medium an octagon,

```
SELECT ST_Npoints(the_geom) As np_before, ST_NPoints(ST_Simplify(the_geom,0.1)) As ↩
    np01_notbadcircle, ST_NPoints(ST_Simplify(the_geom,0.5)) As np05_notquitecircle,
ST_NPoints(ST_Simplify(the_geom,1)) As np1_octagon, ST_NPoints(ST_Simplify(the_geom,10)) As ↩
     np10_triangle,
(ST_Simplify(the_geom,100) is null) As  np100_geometrygoesaway
FROM (SELECT ST_Buffer('POINT(1 3)', 10,12) As the_geom) As foo;
-result
 np_before | np01_notbadcircle | np05_notquitecircle | np1_octagon | np10_triangle |  ↩
     np100_geometrygoesaway
-----------+-------------------+---------------------+-------------+---------------+-----------------

    49 |                33 |                  17 |           9 |             4 | t
```

See Also

ST_IsSimple, ST_SimplifyPreserveTopology, Topology ST_Simplify

8.10.25 ST_SimplifyPreserveTopology

ST_SimplifyPreserveTopology — Returns a "simplified" version of the given geometry using the Douglas-Peucker algorithm. Will avoid creating derived geometries (polygons in particular) that are invalid.

Synopsis

geometry **ST_SimplifyPreserveTopology**(geometry geomA, float tolerance);

Description

Returns a "simplified" version of the given geometry using the Douglas-Peucker algorithm. Will avoid creating derived geometries (polygons in particular) that are invalid. Will actually do something only with (multi)lines and (multi)polygons but you can safely call it with any kind of geometry. Since simplification occurs on a object-by-object basis you can also feed a GeometryCollection to this function.

Performed by the GEOS module.

> **Note**
> Requires GEOS 3.0.0+

Availability: 1.3.3

Examples

Same example as Simplify, but we see Preserve Topology prevents oversimplification. The circle can at most become a square.

```
SELECT ST_Npoints(the_geom) As np_before, ST_NPoints(ST_SimplifyPreserveTopology(the_geom ↩
    ,0.1)) As np01_notbadcircle, ST_NPoints(ST_SimplifyPreserveTopology(the_geom,0.5)) As  ↩
    np05_notquitecircle,
ST_NPoints(ST_SimplifyPreserveTopology(the_geom,1)) As np1_octagon, ST_NPoints( ↩
    ST_SimplifyPreserveTopology(the_geom,10)) As np10_square,
ST_NPoints(ST_SimplifyPreserveTopology(the_geom,100)) As  np100_stillsquare
FROM (SELECT ST_Buffer('POINT(1 3)', 10,12) As the_geom) As foo;

--result--
 np_before | np01_notbadcircle | np05_notquitecircle | np1_octagon | np10_square |  ↩
     np100_stillsquare
-----------+-------------------+---------------------+-------------+---------------+-----------------

    49 |                33 |                  17 |           9 |             5 |  ↩
                       5
```

See Also

ST_Simplify

8.10.26 ST_Split

ST_Split — Returns a collection of geometries resulting by splitting a geometry.

Synopsis

geometry **ST_Split**(geometry input, geometry blade);

Description

The function supports splitting a line by point, a line by line, a polygon by line. The returned geometry is always a collection.

Think of this function as the opposite of ST_Union. Theoretically applying ST_Union to the elements of the returned collection should always yield the original geometry.

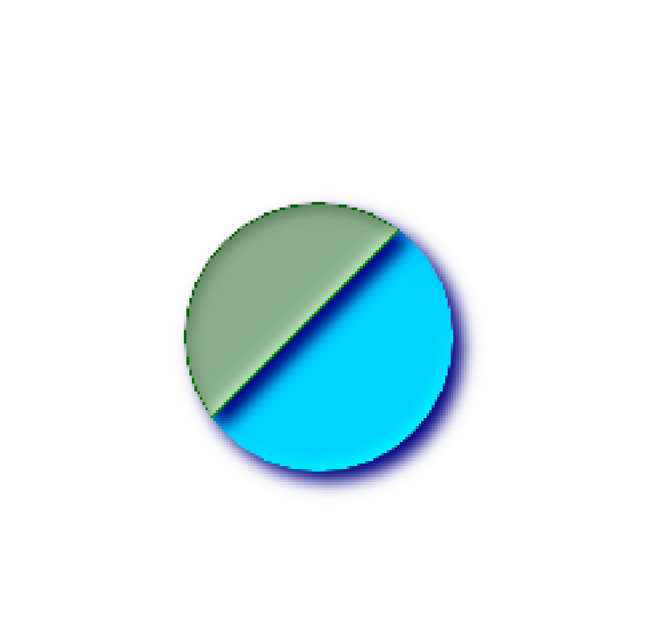
Availability: 2.0.0

> **Note**
> To improve the robustness of ST_Split it may be convenient to ST_Snap the input to the blade in advance using a very low tolerance. Otherwise the internally used coordinate grid may cause tolerance problems, where coordinates of input and blade do not fall onto each other and the input is not being split correctly (see #2192).

Examples

Polygon Cut by Line

Before Split



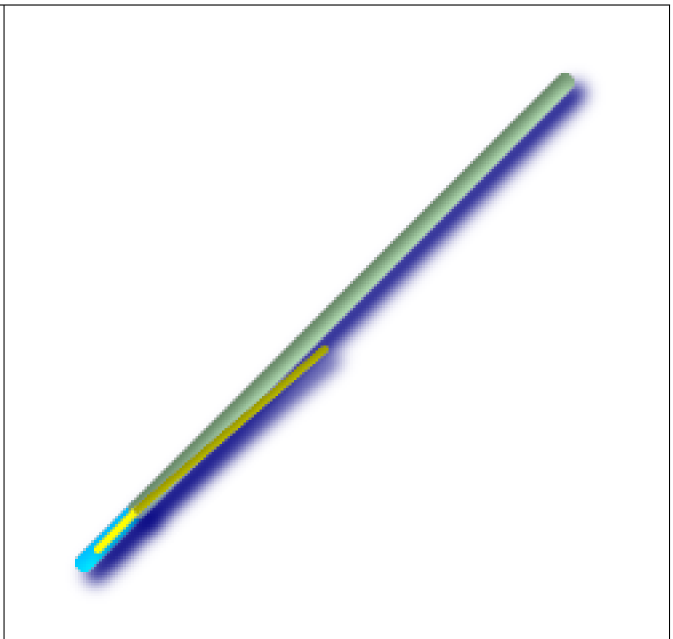
After split

```
-- this creates a geometry collection consisting of the 2 halves of the polygon
-- this is similar to the example we demonstrated in ST_BuildArea
SELECT ST_Split(circle, line)
FROM (SELECT
    ST_MakeLine(ST_MakePoint(10, 10),ST_MakePoint(190, 190)) As line,
    ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50) As circle) As foo;

-- result --
 GEOMETRYCOLLECTION(POLYGON((150 90,149.039264020162 80.2454838991936,146.193976625564 ↩
    70.8658283817455,..), POLYGON(..)))

-- To convert to individual polygons, you can use ST_Dump or ST_GeometryN
SELECT ST_AsText((ST_Dump(ST_Split(circle, line))).geom) As wkt
FROM (SELECT
    ST_MakeLine(ST_MakePoint(10, 10),ST_MakePoint(190, 190)) As line,
    ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50) As circle) As foo;
```

```
-- result --
wkt
---------------
POLYGON((150 90,149.039264020162 80.2454838991936,..))
POLYGON((60.1371179574584 60.1371179574584,58.4265193848728 ↩
    62.2214883490198,53.8060233744357 ..))
```

Multilinestring Cut by point

Before Split



After split

```
SELECT ST_AsText(ST_Split(mline, pt)) As wktcut
        FROM (SELECT
    ST_GeomFromText('MULTILINESTRING((10 10, 190 190), (15 15, 30 30, 100 90))') As mline,
    ST_Point(30,30) As pt) As foo;

wktcut
------
GEOMETRYCOLLECTION(
    LINESTRING(10 10,30 30),
    LINESTRING(30 30,190 190),
    LINESTRING(15 15,30 30),
    LINESTRING(30 30,100 90)
)
```

See Also

ST_AsText, ST_BuildArea, ST_Dump, ST_GeometryN, ST_Union

8.10.27 ST_SymDifference

ST_SymDifference — Returns a geometry that represents the portions of A and B that do not intersect. It is called a symmetric difference because ST_SymDifference(A,B) = ST_SymDifference(B,A).

Synopsis

geometry **ST_SymDifference**(geometry geomA, geometry geomB);

Description

Returns a geometry that represents the portions of A and B that do not intersect. It is called a symmetric difference because ST_SymDifference(A,B) = ST_SymDifference(B,A). One can think of this as ST_Union(geomA,geomB) - ST_Intersection(A,B).

Performed by the GEOS module

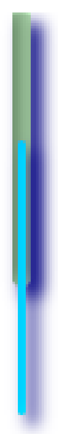
> **Note**
> Do not call with a GeometryCollection as an argument

This method implements the OpenGIS 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 it seems to only consider x y when doing the difference and tacks back on the Z-Index

Examples



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))
```

See Also

ST_Difference, ST_Intersection, ST_Union

8.10.28 ST_Union

ST_Union — Returns a geometry that represents the point set union of the Geometries.

Synopsis

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

Description

Output type can be a MULTI*, single geometry, or Geometry Collection. Comes in 2 variants. Variant 1 unions 2 geometries resulting in a new geometry with no intersecting regions. Variant 2 is an aggregate function that takes a set of geometries and unions them into a single ST_Geometry resulting in no intersecting regions.

Aggregate version: This function returns a MULTI geometry or NON-MULTI geometry from a set 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.

Non-Aggregate version: This function returns a geometry being a union of two input geometries. Output type can be a MULTI*, NON-MULTI or GEOMETRYCOLLECTION. If any are NULL, then NULL is returned.

> **Note**
> ST_Collect and ST_Union are often interchangeable. ST_Union is in general orders of magnitude slower than ST_Collect because it tries to dissolve boundaries and reorder geometries to ensure that a constructed Multi* doesn't have intersecting regions.

Performed by the GEOS module.

NOTE: this function was formerly called GeomUnion(), which was renamed from "Union" because UNION is an SQL reserved word.

Availability: 1.4.0 - ST_Union was enhanced. ST_Union(geomarray) was introduced and also faster aggregate collection in PostgreSQL. If you are using GEOS 3.1.0+ ST_Union will use the faster Cascaded Union algorithm described in http://blog.cleverelephant.ca/2009/01/must-faster-unions-in-postgis-14.html

This method implements the OpenGIS 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.

Examples

Aggregate example

```
SELECT stusps,
     ST_Multi(ST_Union(f.the_geom)) as singlegeom
   FROM sometable As f
GROUP BY stusps
```

Non-Aggregate example

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

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


SELECT ST_AsText(ST_Union(ST_GeomFromText('POINT(1 2)'),
    ST_GeomFromText('POINT(1 2)') ) );
st_astext
----------
POINT(1 2)

--3d example - sort of supports 3d (and with mixed dimensions!)
SELECT ST_AsEWKT(st_union(the_geom))
FROM
(SELECT ST_GeomFromEWKT('POLYGON((-7 4.2,-7.1 4.2,-7.1 4.3,
-7 4.2))') as the_geom
UNION ALL
SELECT ST_GeomFromEWKT('POINT(5 5 5)') as the_geom
UNION ALL
  SELECT ST_GeomFromEWKT('POINT(-2 3 1)') as the_geom
UNION ALL
SELECT ST_GeomFromEWKT('LINESTRING(5 5 5, 10 10 10)') as the_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(the_geom))
```

```
FROM
(SELECT ST_GeomFromEWKT('POLYGON((-7 4.2 2,-7.1 4.2 3,-7.1 4.3 2,
-7 4.2 2))') as the_geom
UNION ALL
SELECT ST_GeomFromEWKT('POINT(5 5 5)') as the_geom
UNION ALL
  SELECT ST_GeomFromEWKT('POINT(-2 3 1)') as the_geom
UNION ALL
SELECT ST_GeomFromEWKT('LINESTRING(5 5 5, 10 10 10)') as the_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 the_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))
```

See Also

ST_Collect ST_UnaryUnion

8.10.29 ST_UnaryUnion

ST_UnaryUnion — Like ST_Union, but working at the geometry component level.

Synopsis

geometry **ST_UnaryUnion**(geometry geom);

Description

Unlike ST_Union, ST_UnaryUnion does dissolve boundaries between components of a multipolygon (invalid) and does perform union between the components of a geometrycollection. Each components of the input geometry is assumed to be valid, so you won't get a valid multipolygon out of a bow-tie polygon (invalid).

You may use this function to node a set of linestrings. You may mix ST_UnaryUnion with ST_Collect to fine-tune how many geometries at once you want to dissolve to be nice on both memory size and CPU time, finding the balance between ST_Union and ST_MemUnion.

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

Availability: 2.0.0 - requires GEOS >= 3.3.0.

See Also

ST_Union ST_MemUnion ST_Collect

8.11 Linear Referencing

8.11.1 ST_LineInterpolatePoint

ST_LineInterpolatePoint — Returns a point interpolated along a line. Second argument is a float8 between 0 and 1 representing fraction of total length of linestring the point has to be located.

Synopsis

geometry **ST_LineInterpolatePoint**(geometry a_linestring, float a_fraction);

Description

Returns a point interpolated along a line. First argument must be a LINESTRING. Second argument is a float8 between 0 and 1 representing fraction of total linestring length the point has to be located.

See ST_LineLocatePoint for computing the line location nearest to a Point.

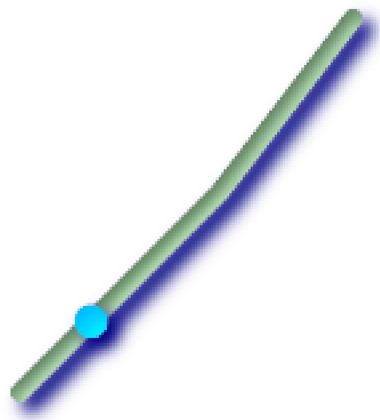
> **Note**
> Since release 1.1.1 this function also interpolates M and Z values (when present), while prior releases set them to 0.0.

Availability: 0.8.2, Z and M supported added in 1.1.1

Changed: 2.1.0. Up to 2.0.x this was called ST_Line_Interpolate_Point.

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

Examples



A linestring with the interpolated point at 20% position (0.20)

```
--Return point 20% along 2d line
SELECT ST_AsEWKT(ST_LineInterpolatePoint(the_line, 0.20))
  FROM (SELECT ST_GeomFromEWKT('LINESTRING(25 50, 100 125, 150 190)') as the_line) As foo;
   st_asewkt
----------------
 POINT(51.5974135047432 76.5974135047432)
```

```
--Return point mid-way of 3d line
SELECT ST_AsEWKT(ST_LineInterpolatePoint(the_line, 0.5))
  FROM (SELECT ST_GeomFromEWKT('LINESTRING(1 2 3, 4 5 6, 6 7 8)') as the_line) As foo;

  st_asewkt
--------------------
 POINT(3.5 4.5 5.5)


--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)
```

See Also

ST_AsText, ST_AsEWKT, ST_Length, ST_LineLocatePoint

8.11.2 ST_LineLocatePoint

ST_LineLocatePoint — Returns a float between 0 and 1 representing the location of the closest point on LineString to the given Point, as a fraction of total 2d line length.

Synopsis

float **ST_LineLocatePoint**(geometry a_linestring, geometry a_point);

Description

Returns a float between 0 and 1 representing the location of the closest point on LineString to the given Point, as a fraction of total 2d line length.

You can use the returned location to extract a Point (ST_LineInterpolatePoint) or a substring (ST_LineSubstring).

This is useful for approximating numbers of addresses

Availability: 1.1.0

Changed: 2.1.0. Up to 2.0.x this was called ST_Line_Locate_Point.

Examples

```
--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_MakePoint(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)
```

See Also

ST_DWithin, ST_Length2D, ST_LineInterpolatePoint, ST_LineSubstring

8.11.3 ST_LineSubstring

ST_LineSubstring — Return a linestring being a substring of the input one starting and ending at the given fractions of total 2d length. Second and third arguments are float8 values between 0 and 1.

Synopsis

geometry **ST_LineSubstring**(geometry a_linestring, float startfraction, float endfraction);

Description

Return a linestring being a substring of the input one starting and ending at the given fractions of total 2d length. Second and third arguments are float8 values between 0 and 1. This only works with LINESTRINGs. To use with contiguous MULTI-LINESTRINGs use in conjunction with ST_LineMerge.

If 'start' and 'end' have the same value this is equivalent to ST_LineInterpolatePoint.

See ST_LineLocatePoint for computing the line location nearest to a Point.

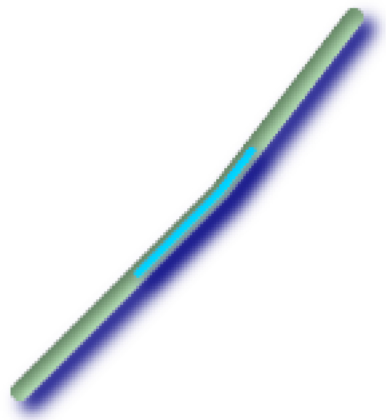
> **Note**
> Since release 1.1.1 this function also interpolates M and Z values (when present), while prior releases set them to unspecified values.

Availability: 1.1.0, Z and M supported added in 1.1.1

Changed: 2.1.0. Up to 2.0.x this was called ST_Line_Substring.

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

Examples



A linestring seen with 1/3 midrange overlaid (0.333, 0.666)

```
--Return the approximate 1/3 mid-range part of a linestring
SELECT ST_AsText(ST_Line_SubString(ST_GeomFromText('LINESTRING(25 50, 100 125, 150 190)'),  ↩
    0.333, 0.666));

                       st_astext
------------------------------------------------------------------------------------------------ ↩

LINESTRING(69.2846934853974 94.2846934853974,100 125,111.700356260683 140.210463138888)

--The below example simulates a while loop in
--SQL using PostgreSQL generate_series() to cut all
--linestrings in a table to 100 unit segments
-- of which no segment is longer than 100 units
-- units are measured in the SRID units of measurement
-- It also assumes all geometries are LINESTRING or contiguous MULTILINESTRING
--and no geometry is longer than 100 units*10000
--for better performance you can reduce the 10000
--to match max number of segments you expect

SELECT field1, field2, ST_LineSubstring(the_geom, 100.00*n/length,
  CASE
  WHEN 100.00*(n+1) < length THEN 100.00*(n+1)/length
  ELSE 1
  END) As the_geom
```

```
FROM
  (SELECT sometable.field1, sometable.field2,
  ST_LineMerge(sometable.the_geom) AS the_geom,
  ST_Length(sometable.the_geom) As length
  FROM sometable
  ) AS t
CROSS JOIN generate_series(0,10000) AS n
WHERE n*100.00/length < 1;
```

See Also

ST_Length, ST_LineInterpolatePoint, ST_LineMerge

8.11.4 ST_LocateAlong

ST_LocateAlong — Return a derived geometry collection value with elements that match the specified measure. Polygonal elements are not supported.

Synopsis

geometry **ST_LocateAlong**(geometry ageom_with_measure, float a_measure, float offset);

Description

Return a derived geometry collection value with elements that match the specified measure. Polygonal elements are not supported.

If an offset is provided, the resultant will be offset to the left or right of the input line by the specified number of units. A positive offset will be to the left, and a negative one to the right.

Semantic is specified by: ISO/IEC CD 13249-3:200x(E) - Text for Continuation CD Editing Meeting

Availability: 1.1.0 by old name ST_Locate_Along_Measure.

Changed: 2.0.0 in prior versions this used to be called ST_Locate_Along_Measure. The old name has been deprecated and will be removed in the future but is still available.

Note
Use this function only for geometries with an M component

This function supports M coordinates.

Examples

```
SELECT ST_AsText(the_geom)
    FROM
    (SELECT ST_LocateAlong(
      ST_GeomFromText('MULTILINESTRINGM((1 2 3, 3 4 2, 9 4 3),
    (1 2 3, 5 4 5))'),3) As the_geom) As foo;

             st_asewkt
-----------------------------------------------------------
```

```
 MULTIPOINT M (1 2 3)

--Geometry collections are difficult animals so dump them
--to make them more digestable
SELECT ST_AsText((ST_Dump(the_geom)).geom)
  FROM
  (SELECT ST_LocateAlong(
      ST_GeomFromText('MULTILINESTRINGM((1 2 3, 3 4 2, 9 4 3),
  (1 2 3, 5 4 5))'),3) As the_geom) As foo;

   st_asewkt
---------------
 POINTM(1 2 3)
 POINTM(9 4 3)
 POINTM(1 2 3)
```

See Also

ST_Dump, ST_LocateBetween

8.11.5 ST_LocateBetween

ST_LocateBetween — Return a derived geometry collection value with elements that match the specified range of measures inclusively. Polygonal elements are not supported.

Synopsis

geometry **ST_LocateBetween**(geometry geomA, float measure_start, float measure_end, float offset);

Description

Return a derived geometry collection value with elements that match the specified range of measures inclusively. Polygonal elements are not supported.

Semantic is specified by: ISO/IEC CD 13249-3:200x(E) - Text for Continuation CD Editing Meeting

Availability: 1.1.0 by old name ST_Locate_Between_Measures.

Changed: 2.0.0 - in prior versions this used to be called ST_Locate_Between_Measures. The old name has been deprecated and will be removed in the future but is still available for backward compatibility.

This function supports M coordinates.

Examples

```
SELECT ST_AsText(the_geom)
    FROM
    (SELECT ST_LocateBetween(
      ST_GeomFromText('MULTILINESTRING M ((1 2 3, 3 4 2, 9 4 3),
    (1 2 3, 5 4 5))'),1.5, 3) As the_geom) As foo;

               st_asewkt
------------------------------------------------------------------------
 GEOMETRYCOLLECTION M (LINESTRING M (1 2 3,3 4 2,9 4 3),POINT M (1 2 3))

--Geometry collections are difficult animals so dump them
```

```
--to make them more digestable
SELECT ST_AsText((ST_Dump(the_geom)).geom)
    FROM
    (SELECT ST_LocateBetween(
      ST_GeomFromText('MULTILINESTRING M ((1 2 3, 3 4 2, 9 4 3),
    (1 2 3, 5 4 5))'),1.5, 3) As the_geom) As foo;

       st_asewkt
--------------------------------
 LINESTRING M (1 2 3,3 4 2,9 4 3)
 POINT M (1 2 3)
```

See Also

ST_Dump, ST_LocateAlong

8.11.6 ST_LocateBetweenElevations

ST_LocateBetweenElevations — Return a derived geometry (collection) value with elements that intersect the specified range of elevations inclusively. Only 3D, 4D LINESTRINGS and MULTILINESTRINGS are supported.

Synopsis

geometry **ST_LocateBetweenElevations**(geometry geom_mline, float elevation_start, float elevation_end);

Description

Return a derived geometry (collection) value with elements that intersect the specified range of elevations inclusively. Only 3D, 3DM LINESTRINGS and MULTILINESTRINGS are supported.

Availability: 1.4.0

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

Examples

```
SELECT ST_AsEWKT(ST_LocateBetweenElevations(
      ST_GeomFromEWKT('LINESTRING(1 2 3, 4 5 6)'),2,4)) As ewelev;
                   ewelev
----------------------------------------------------------------
  MULTILINESTRING((1 2 3,2 3 4))

SELECT ST_AsEWKT(ST_LocateBetweenElevations(
      ST_GeomFromEWKT('LINESTRING(1 2 6, 4 5 -1, 7 8 9)'),6,9)) As ewelev;

        ewelev
----------------------------------------------------------------
GEOMETRYCOLLECTION(POINT(1 2 6),LINESTRING(6.1 7.1 6,7 8 9))

--Geometry collections are difficult animals so dump them
--to make them more digestable
SELECT ST_AsEWKT((ST_Dump(the_geom)).geom)
    FROM
    (SELECT ST_LocateBetweenElevations(
      ST_GeomFromEWKT('LINESTRING(1 2 6, 4 5 -1, 7 8 9)'),6,9) As the_geom) As foo;
```

```
       st_asewkt
--------------------------------
POINT(1 2 6)
LINESTRING(6.1 7.1 6,7 8 9)
```

See Also

ST_Dump

8.11.7 ST_InterpolatePoint

ST_InterpolatePoint — Return the value of the measure dimension of a geometry at the point closed to the provided point.

Synopsis

float **ST_InterpolatePoint**(geometry line, geometry point);

Description

Return the value of the measure dimension of a geometry at the point closed to the provided point.

Availability: 2.0.0

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

Examples

```
SELECT ST_InterpolatePoint('LINESTRING M (0 0 0, 10 0 20)', 'POINT(5 5)');
 st_interpolatepoint
 ---------------------
                  10
```

See Also

ST_AddMeasure, ST_LocateAlong, ST_LocateBetween

8.11.8 ST_AddMeasure

ST_AddMeasure — Return a derived geometry with measure elements linearly interpolated between the start and end points. If the geometry has no measure dimension, one is added. If the geometry has a measure dimension, it is over-written with new values. Only LINESTRINGS and MULTILINESTRINGS are supported.

Synopsis

geometry **ST_AddMeasure**(geometry geom_mline, float measure_start, float measure_end);

Description

Return a derived geometry with measure elements linearly interpolated between the start and end points. If the geometry has no measure dimension, one is added. If the geometry has a measure dimension, it is over-written with new values. Only LINESTRINGS and MULTILINESTRINGS are supported.

Availability: 1.5.0

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

Examples

```
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))
```

8.12 Long Transactions Support

This module and associated pl/pgsql functions have been implemented to provide long locking support required by Web Feature Service specification.

> **Note**
> Users must use serializable transaction level otherwise locking mechanism would break.

8.12.1 AddAuth

AddAuth — Add an authorization token to be used in current transaction.

Synopsis

boolean **AddAuth**(text auth_token);

Description

Add an authorization token to be used in current transaction.

Creates/adds to a temp table called temp_lock_have_table the current transaction identifier and authorization token key.

Availability: 1.1.3

Examples

```
SELECT LockRow('towns', '353', 'priscilla');
BEGIN TRANSACTION;
  SELECT AddAuth('joey');
  UPDATE towns SET the_geom = ST_Translate(the_geom,2,2) WHERE gid = 353;
COMMIT;


---Error--
ERROR:  UPDATE where "gid" = '353' requires authorization 'priscilla'
```

See Also

LockRow

8.12.2 CheckAuth

CheckAuth — Creates trigger on a table to prevent/allow updates and deletes of rows based on authorization token.

Synopsis

integer **CheckAuth**(text a_schema_name, text a_table_name, text a_key_column_name);
integer **CheckAuth**(text a_table_name, text a_key_column_name);

Description

Creates trigger on a table to prevent/allow updates and deletes of rows based on authorization token. Identify rows using <rowid_col> column.

If a_schema_name is not passed in, then searches for table in current schema.

> **Note**
> If an authorization trigger already exists on this table function errors.
> If Transaction support is not enabled, function throws an exception.

Availability: 1.1.3

Examples

```
  SELECT CheckAuth('public', 'towns', 'gid');
  result
  ------
  0
```

See Also

EnableLongTransactions

8.12.3 DisableLongTransactions

DisableLongTransactions — Disable long transaction support. This function removes the long transaction support metadata tables, and drops all triggers attached to lock-checked tables.

Synopsis

text **DisableLongTransactions**();

Description

Disable long transaction support. This function removes the long transaction support metadata tables, and drops all triggers attached to lock-checked tables.

Drops meta table called `authorization_table` and a view called `authorized_tables` and all triggers called `check authtrigger`

Availability: 1.1.3

Examples

```
SELECT DisableLongTransactions();
--result--
Long transactions support disabled
```

See Also

EnableLongTransactions

8.12.4 EnableLongTransactions

EnableLongTransactions — Enable long transaction support. This function creates the required metadata tables, needs to be called once before using the other functions in this section. Calling it twice is harmless.

Synopsis

text **EnableLongTransactions**();

Description

Enable long transaction support. This function creates the required metadata tables, needs to be called once before using the other functions in this section. Calling it twice is harmless.

Creates a meta table called `authorization_table` and a view called `authorized_tables`

Availability: 1.1.3

Examples

```
SELECT EnableLongTransactions();
--result--
Long transactions support enabled
```

See Also

DisableLongTransactions

8.12.5 LockRow

LockRow — Set lock/authorization for specific row in table

Synopsis

integer **LockRow**(text a_schema_name, text a_table_name, text a_row_key, text an_auth_token, timestamp expire_dt);
integer **LockRow**(text a_table_name, text a_row_key, text an_auth_token, timestamp expire_dt);
integer **LockRow**(text a_table_name, text a_row_key, text an_auth_token);

Description

Set lock/authorization for specific row in table <authid> is a text value, <expires> is a timestamp defaulting to now()+1hour. Returns 1 if lock has been assigned, 0 otherwise (already locked by other auth)

Availability: 1.1.3

Examples

```
SELECT LockRow('public', 'towns', '2', 'joey');
LockRow
-------
1

--Joey has already locked the record and Priscilla is out of luck
SELECT LockRow('public', 'towns', '2', 'priscilla');
LockRow
-------
0
```

See Also

UnlockRows

8.12.6 UnlockRows

UnlockRows — Remove all locks held by specified authorization id. Returns the number of locks released.

Synopsis

integer **UnlockRows**(text auth_token);

Description

Remove all locks held by specified authorization id. Returns the number of locks released.

Availability: 1.1.3

Examples

```
SELECT LockRow('towns', '353', 'priscilla');
SELECT LockRow('towns', '2', 'priscilla');
SELECT UnLockRows('priscilla');
UnLockRows
------------
2
```

See Also

LockRow

8.13 Miscellaneous Functions

8.13.1 ST_Accum

ST_Accum — Aggregate. Constructs an array of geometries.

Synopsis

geometry[] **ST_Accum**(geometry set geomfield);

Description

Aggregate. Constructs an array of geometries.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

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).

Examples

```
SELECT (ST_Accum(the_geom)) As all_em, ST_AsText((ST_Accum(the_geom))[1]) As grabone,
(ST_Accum(the_geom))[2:4] as grab_rest
      FROM (SELECT ST_MakePoint(a*CAST(random()*10 As integer), a*CAST(random()*10 As  ↩
          integer), a*CAST(random()*10 As integer)) As the_geom
        FROM generate_series(1,4) a) As foo;
```

```
all_em|grabone   | grab_rest

-------------------------------------------------------------------------------+

 {0101000080000000000000144000000000000024400000000000001040:
 0101000080000000000
0001840000000000002C400000000000003040:
0101000080000000000000354000000000000038400000000000001840:
010100008000000000000040400000000000003C400000000000003040} |
 POINT(5 10) | {0101000080000000000000184000000000000002C400000000000003040:
 0101000080000000000000354000000000000038400000000000001840:
 010100008000000000000040400000000000003C400000000000003040}
(1 row)
```

See Also

ST_Collect

8.13.2 Box2D

Box2D — Returns a BOX2D representing the maximum extents of the geometry.

Synopsis

box2d **Box2D**(geometry geomA);

Description

Returns a BOX2D representing the maximum extents of the geometry.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

This method supports Circular Strings and Curves

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Examples

```
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)
```

See Also

Box3D, ST_GeomFromText

8.13.3 Box3D

Box3D — Returns a BOX3D representing the maximum extents of the geometry.

Synopsis

box3d **Box3D**(geometry geomA);

Description

Returns a BOX3D representing the maximum extents of the geometry.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

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.

Examples

```
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)
```

See Also

Box2D, ST_GeomFromEWKT

8.13.4 ST_EstimatedExtent

ST_EstimatedExtent — Return the 'estimated' extent of the given spatial table. The estimated is taken from the geometry column's statistics. The current schema will be used if not specified.

Synopsis

box2d **ST_EstimatedExtent**(text schema_name, text table_name, text geocolumn_name);
box2d **ST_EstimatedExtent**(text table_name, text geocolumn_name);

Description

Return the 'estimated' extent of the given spatial table. The estimated is taken from the geometry column's statistics. The current schema will be used if not specified.

For PostgreSQL>=8.0.0 statistics are gathered by VACUUM ANALYZE and resulting extent will be about 95% of the real one.

> **Note**
> In absence of statistics (empty table or no ANALYZE called) this function returns NULL. Prior to version 1.5.4 an exception was thrown instead.

For PostgreSQL<8.0.0 statistics are gathered by update_geometry_stats() and resulting extent will be exact.

Availability: 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

Examples

```
SELECT ST_EstimatedExtent('ny', 'edges', 'the_geom');
--result--
BOX(-8877653 4912316,-8010225.5 5589284)

SELECT ST_EstimatedExtent('feature_poly', 'the_geom');
--result--
BOX(-124.659652709961 24.6830825805664,-67.7798080444336 49.0012092590332)
```

See Also

ST_Extent

8.13.5 ST_Expand

ST_Expand — Returns bounding box expanded in all directions from the bounding box of the input geometry. Uses double-precision

Synopsis

geometry **ST_Expand**(geometry g1, float units_to_expand);
box2d **ST_Expand**(box2d g1, float units_to_expand);
box3d **ST_Expand**(box3d g1, float units_to_expand);

Description

This function returns a bounding box expanded in all directions from the bounding box of the input geometry, by an amount specified in the second argument. Uses double-precision. Very useful for distance() queries, or bounding box queries to add an index filter to the query.

There are 3 variants of this. The one that takes a geometry will return a POLYGON geometry representation of the bounding box and is the most commonly used variant.

ST_Expand is similar in concept to ST_Buffer except while buffer expands the geometry in all directions, ST_Expand expands the bounding box an x,y,z unit amount.

Units are in the units of the spatial reference system in use denoted by the SRID

> **Note**
> Pre 1.3, ST_Expand was used in conjunction with distance to do indexable queries. Something of the form `the_geom && ST_Expand('POINT(10 20)', 10) AND ST_Distance(the_geom, 'POINT(10 20)') < 10` Post 1.2, this was replaced with the easier ST_DWithin construct.

> **Note**
> Availability: 1.5.0 behavior changed to output double precision instead of float4 coordinates.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Examples

> **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))
```

See Also

ST_AsEWKT, ST_Buffer, ST_DWithin, ST_GeomFromEWKT, ST_GeomFromText, ST_SRID

8.13.6 ST_Extent

ST_Extent — an aggregate function that returns the bounding box that bounds rows of geometries.

Synopsis

box2d **ST_Extent**(geometry set geomfield);

Description

ST_Extent returns a bounding box that encloses a set of geometries. The ST_Extent function is an "aggregate" function in the terminology of SQL. That means that it operates on lists of data, in the same way the SUM() and AVG() functions do.

Since it returns a bounding box, the spatial Units are in the units of the spatial reference system in use denoted by the SRID

ST_Extent is similar in concept to Oracle Spatial/Locator's SDO_AGGR_MBR

Note
Since ST_Extent returns a bounding box, the SRID meta-data is lost. Use ST_SetSRID to force it back into a geometry with SRID meta data. The coordinates are in the units of the spatial ref of the orginal geometries.

Note
ST_Extent will return boxes with only an x and y component even with (x,y,z) coordinate geometries. To maintain x,y,z use ST_3DExtent instead.

Note
Availability: 1.4.0

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

This function supports Polyhedral surfaces.

This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Examples

Note
Examples below use Massachusetts State Plane ft (SRID=2249)

```
SELECT ST_Extent(the_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(the_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(the_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))
```

See Also

ST_AsEWKT, ST_3DExtent, ST_SetSRID, ST_SRID

8.13.7 ST_3DExtent

ST_3DExtent — an aggregate function that returns the box3D bounding box that bounds rows of geometries.

Synopsis

box3d **ST_3DExtent**(geometry set geomfield);

Description

ST_3DExtent returns a box3d (includes Z coordinate) bounding box that encloses a set of geometries. The ST_3DExtent function is an "aggregate" function in the terminology of SQL. That means that it operates on lists of data, in the same way the SUM() and AVG() functions do.

Since it returns a bounding box, the spatial Units are in the units of the spatial reference system in use denoted by the SRID

Note
Since ST_3DExtent returns a bounding box, the SRID meta-data is lost. Use ST_SetSRID to force it back into a geometry with SRID meta data. The coordinates are in the units of the spatial ref of the orginal geometries.

Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.

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).

Examples

```
SELECT ST_3DExtent(foo.the_geom) As b3extent
FROM (SELECT ST_MakePoint(x,y,z) As the_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.the_geom) As b3extent
FROM (SELECT ST_Translate(ST_Force_3DZ(ST_LineToCurve(ST_Buffer(ST_MakePoint(x,y),1))),0,0, ↩
    z) As the_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)
```

See Also

ST_Extent, ST_Force3DZ

8.13.8 Find_SRID

Find_SRID — The syntax is find_srid(a_db_schema, a_table, a_column) and the function returns the integer SRID of the specified column by searching through the GEOMETRY_COLUMNS table.

Synopsis

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

Description

The syntax is find_srid(<db/schema>, <table>, <column>) and the function returns the integer SRID of the specified column by searching through the GEOMETRY_COLUMNS table. If the geometry column has not been properly added with the AddGeometryColumns() function, this function will not work either.

Examples

```
 SELECT Find_SRID('public', 'tiger_us_state_2007', 'the_geom_4269');
find_srid
----------
4269
```

See Also

ST_SRID

8.13.9 ST_Mem_Size

ST_Mem_Size — Returns the amount of space (in bytes) the geometry takes.

Synopsis

integer **ST_Mem_Size**(geometry geomA);

Description

Returns the amount of space (in bytes) the geometry takes.

This is a nice compliment to PostgreSQL built in functions 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_Mem_Size. This is because pg_relation_size does not add toasted table contribution and large geometries are stored in TOAST tables.
> pg_total_relation_size - includes, the table, the toasted tables, and the indexes.

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).

Examples

```
--Return how much byte space Boston takes up  in our Mass data set
SELECT pg_size_pretty(SUM(ST_Mem_Size(the_geom))) as totgeomsum,
pg_size_pretty(SUM(CASE WHEN town = 'BOSTON' THEN st_mem_size(the_geom) ELSE 0 END)) As ↩
    bossum,
CAST(SUM(CASE WHEN town = 'BOSTON' THEN st_mem_size(the_geom) ELSE 0 END)*1.00 /
    SUM(st_mem_size(the_geom))*100 As numeric(10,2)) As perbos
FROM towns;

totgeomsum  bossum  perbos
----------  ------  ------
1522 kB   30 kB 1.99


SELECT ST_Mem_Size(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_Mem_Size(the_geom)) As geomsize,
sum(ST_Mem_Size(the_geom))*1.00/pg_total_relation_size('public.neighborhoods')*100 As pergeom
FROM neighborhoods;
fulltable_size geomsize  pergeom
------------------------------------------------
262144         96238   36.71188354492187500000
```

See Also

8.13.10 ST_Point_Inside_Circle

ST_Point_Inside_Circle — Is the point geometry insert circle defined by center_x, center_y, radius

Synopsis

boolean **ST_Point_Inside_Circle**(geometry a_point, float center_x, float center_y, float radius);

Description

The syntax for this functions is point_inside_circle(<geometry>,<circle_center_x>,<circle_center_y>,<radius>). Returns the true if the geometry is a point and is inside the circle. Returns false otherwise.

Note
This only works for points as the name suggests

Examples

```
SELECT ST_Point_Inside_Circle(ST_Point(1,2), 0.5, 2, 3);
 st_point_inside_circle
------------------------
 t
```

See Also

ST_DWithin

8.14 Exceptional Functions

These functions are rarely used functions that should only be used if your data is corrupted in someway. They are used for troubleshooting corruption and also fixing things that should under normal circumstances, never happen.

8.14.1 PostGIS_AddBBox

PostGIS_AddBBox — Add bounding box to the geometry.

Synopsis

geometry **PostGIS_AddBBox**(geometry geomA);

Description

Add bounding box to the geometry. This would make bounding box based queries faster, but will increase the size of the geometry.

> **Note**
> Bounding boxes are automatically added to geometries so in general this is not needed unless the generated bounding box somehow becomes corrupted or you have an old install that is lacking bounding boxes. Then you need to drop the old and readd.

This method supports Circular Strings and Curves

Examples

```
UPDATE sometable
 SET the_geom =  PostGIS_AddBBox(the_geom)
 WHERE PostGIS_HasBBox(the_geom) = false;
```

See Also

PostGIS_DropBBox, PostGIS_HasBBox

8.14.2 PostGIS_DropBBox

PostGIS_DropBBox — Drop the bounding box cache from the geometry.

Synopsis

geometry **PostGIS_DropBBox**(geometry geomA);

Description

Drop the bounding box cache from the geometry. This reduces geometry size, but makes bounding-box based queries slower. It is also used to drop a corrupt bounding box. A tale-tell sign of a corrupt cached bounding box is when your ST_Intersects and other relation queries leave out geometries that rightfully should return true.

> **Note**
> Bounding boxes are automatically added to geometries and improve speed of queries so in general this is not needed unless the generated bounding box somehow becomes corrupted or you have an old install that is lacking bounding boxes. Then you need to drop the old and readd. This kind of corruption has been observed in 8.3-8.3.6 series whereby cached bboxes were not always recalculated when a geometry changed and upgrading to a newer version without a dump reload will not correct already corrupted boxes. So one can manually correct using below and readd the bbox or do a dump reload.

This method supports Circular Strings and Curves

Examples

```
--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 the_geom =  PostGIS_DropBBox(the_geom)
 WHERE Not (Box2D(ST_AsBinary(the_geom)) = Box2D(the_geom));

  UPDATE sometable
 SET the_geom =  PostGIS_AddBBox(the_geom)
 WHERE Not PostGIS_HasBBOX(the_geom);
```

See Also

PostGIS_AddBBox, PostGIS_HasBBox, Box2D

8.14.3 PostGIS_HasBBox

PostGIS_HasBBox — Returns TRUE if the bbox of this geometry is cached, FALSE otherwise.

Synopsis

boolean **PostGIS_HasBBox**(geometry geomA);

Description

Returns TRUE if the bbox of this geometry is cached, FALSE otherwise. Use PostGIS_AddBBox and PostGIS_DropBBox to control caching.

This method supports Circular Strings and Curves

Examples

```
SELECT the_geom
FROM sometable WHERE PostGIS_HasBBox(the_geom) = false;
```

See Also

PostGIS_AddBBox, PostGIS_DropBBox

Chapter 9

Raster Reference

The functions given below are the ones which a user of PostGIS Raster is likely to need and which are currently available in PostGIS Raster. There are other functions which are required support functions to the raster objects which are not of use to a general user.

`raster` is a new PostGIS type for storing and analyzing raster data.

For loading rasters from raster files please refer to Section 5.1

For the examples in this reference we will be using a raster table of dummy rasters - Formed with the following code

```
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);
```

9.1 Raster Support Data types

9.1.1 geomval

geomval — A spatial datatype with two fields - geom (holding a geometry object) and val (holding a double precision pixel value from a raster band).

Description

geomval is a compound data type consisting of a geometry object referenced by the .geom field and val, a double precision value that represents the pixel value at a particular geometric location in a raster band. It is used by the ST_DumpAsPolygon and Raster intersection family of functions as an output type to explode a raster band into geometry polygons.

See Also

Section 13.5

9.1.2 addbandarg

addbandarg — A composite type used as input into the ST_AddBand function defining the attributes and initial value of the new band.

Description

A composite type used as input into the ST_AddBand function defining the attributes and initial value of the new band.

index **integer** 1-based value indicating the position where the new band will be added amongst the raster's bands. If NULL, the new band will be added at the end of the raster's bands.

pixeltype **text** Pixel type of the new band. One of defined pixel types as described in ST_BandPixelType.

initialvalue **double precision** Initial value that all pixels of new band will be set to.

nodataval **double precision** NODATA value of the new band. If NULL, the new band will not have a NODATA value assigned.

See Also

ST_AddBand

9.1.3 rastbandarg

rastbandarg — A composite type for use when needing to express a raster and a band index of that raster.

Description

A composite type for use when needing to express a raster and a band index of that raster.

rast **raster** The raster in question/

nband **integer** 1-based value indicating the band of raster

See Also

ST_MapAlgebra

9.1.4 raster

raster — raster spatial data type.

Description

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**
> Requires PostGIS be compiled with GDAL support. Currently rasters can be implicitly converted to geometry type, but the conversion returns the ST_ConvexHull of the raster. This auto casting may be removed in the near future so don't rely on it.

Casting Behavior

This section lists the automatic as well as explicit casts allowed for this data type

Cast To	Behavior
geometry	automatic

See Also

Chapter 9

9.1.5 reclassarg

reclassarg — A composite type used as input into the ST_Reclass function defining the behavior of reclassification.

Description

A composite type used as input into the ST_Reclass function defining the behavior of reclassification.

nband **integer** The band number of band to reclassify.

reclassexpr **text** range expression consisting of comma delimited range:map_range mappings. : to define mapping that defines how to map old band values to new band values. (means >,) means less than,] < or equal, [means > or equal

```
1. [a-b] = a <= x <= b

2. (a-b] = a < x <= b

3. [a-b) = a <= x < b

4. (a-b) = a < x < b
```

(notation is optional so a-b means the same as (a-b)

pixeltype **text** One of defined pixel types as described in ST_BandPixelType

nodataval **double precision** Value to treat as no data. For image outputs that support transparency, these will be blank.

Example: Reclassify band 2 as an 8BUI where 255 is nodata value

```
SELECT ROW(2, '0-100:1-10, 101-500:11-150,501 - 10000: 151-254', '8BUI', 255)::reclassarg;
```

Example: Reclassify band 1 as an 1BB and no nodata value defined

```
SELECT ROW(1, '0-100]:0, (100-255:1', '1BB', NULL)::reclassarg;
```

See Also

ST_Reclass

9.1.6 unionarg

unionarg — A composite type used as input into the ST_Union function defining the bands to be processed and behavior of the UNION operation.

Description

A composite type used as input into the ST_Union function defining the bands to be processed and behavior of the UNION operation.

nband **integer** 1-based value indicating the band of each input raster to be processed.

uniontype **text** Type of UNION operation. One of defined types as described in ST_Union.

See Also

ST_Union

9.2 Raster Management

9.2.1 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 of the constraint setting was accomplished and if issues a notice.

Synopsis

boolean **AddRasterConstraints**(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 **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=fa
boolean num_bands=true, boolean pixel_types=true, boolean nodata_values=true , boolean out_db=true , boolean extent=true);

Description

Generates constraints on a raster column that are used to display information in the `raster_columns` raster catalog. The `rastschema` is the name of the table schema the table resides in. The `srid` must be an integer value reference to an entry in the SPATIAL_REF_SYS table.

`raster2pgsql` loader uses this function to register raster tables

Valid constraint names to pass in: refer to Section 5.2.1 for more details.

- `blocksize` sets both X and Y blocksize
- `blocksize_x` sets X tile (width in pixels of each tile)
- `blocksize_y` sets Y tile (height in pixels of each tile)
- `extent` computes extent of whole table and applys constraint all rasters must be within that extent
- `num_bands` number of bands
- `pixel_types` reads array of pixel types for each band ensure all band n have same pixel type
- `regular_blocking` sets spatially unique (no two rasters can be spatially the same) and coverage tile (raster is aligned to a coverage) constraints
- `same_alignment` ensures they all have same alignment meaning any two tiles you compare will return true for. Refer to ST_SameAlignment
- `srid` ensures all have same srid
- More -- any listed as inputs into the above functions

Note
This function infers the constraints from the data already present in the table. As such for it to work, you must create the raster column first and then load it with data.

Note
If you need to load more data in your tables after you have already applied constraints, you may want to run the DropRasterConstraints if the extent of your data has changed.

Availability: 2.0.0

Examples: Apply all possible constraints on column based on data

```
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}
```

Examples: Apply single constraint

```
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
```

See Also

Section 5.2.1, ST_AddBand, ST_MakeEmptyRaster, DropRasterConstraints, ST_BandPixelType, ST_SRID

9.2.2 DropRasterConstraints

DropRasterConstraints — Drops PostGIS raster constraints that refer to a raster table column. Useful if you need to reload data or update your raster column data.

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=t
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=fa
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);

Description

Drops PostGIS raster constraints that refer to a raster table column that were added by AddRasterConstraints. Useful if you need to load more data or update your raster column data. You do not need to do this if you want to get rid of a raster table or a raster column.

To drop a raster table use the standard

```
DROP TABLE mytable
```

To drop just a raster column and leave the rest of the table, use standard SQL

```
ALTER TABLE mytable DROP COLUMN rast
```

the table will disappear from the `raster_columns` catalog if the column or table is dropped. However if only the constraints are dropped, the raster column will still be listed in the `raster_columns` catalog, but there will be no other information about it aside from the column name and table.

Availability: 2.0.0

Examples

```
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 |         |         |             |             |           |             |
```

See Also

AddRasterConstraints

9.2.3 AddOverviewConstraints

AddOverviewConstraints — Tag a raster column as being an overview of another.

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);

Description

Adds constraints on a raster column that are used to display information in the `raster_overviews` raster catalog.

The `ovfactor` parameter represents the scale multiplier in the overview column: higher overview factors have lower resolution.

When the `ovschema` and `refschema` parameters are omitted, the first table found scanning the `search_path` will be used.

Availability: 2.0.0

Examples

```
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)
```

See Also

Section 5.2.2, DropOverviewConstraints, AddRasterConstraints

9.2.4 DropOverviewConstraints

DropOverviewConstraints — Untag a raster column from being an overview of another.

Synopsis

boolean **DropOverviewConstraints**(name ovschema, name ovtable, name ovcolumn);
boolean **DropOverviewConstraints**(name ovtable, name ovcolumn);

Description

Remove from a raster column the constraints used to show it as being an overview of another in the `raster_overviews` raster catalog.

When the `ovschema` parameter is omitted, the first table found scanning the `search_path` will be used.

Availability: 2.0.0

See Also

Section 5.2.2, AddOverviewConstraints, DropRasterConstraints

9.2.5 PostGIS_Raster_Lib_Build_Date

PostGIS_Raster_Lib_Build_Date — Reports full raster library build date.

Synopsis

text **PostGIS_Raster_Lib_Build_Date**();

Description

Reports raster build date

Examples

```
SELECT PostGIS_Raster_Lib_Build_Date();
postgis_raster_lib_build_date
-----------------------------
2010-04-28 21:15:10
```

See Also

PostGIS_Raster_Lib_Version

9.2.6 PostGIS_Raster_Lib_Version

PostGIS_Raster_Lib_Version — Reports full raster version and build configuration infos.

Synopsis

text **PostGIS_Raster_Lib_Version**();

Description

Reports full raster version and build configuration infos.

Examples

```
SELECT PostGIS_Raster_Lib_Version();
postgis_raster_lib_version
-----------------------------
 2.0.0
```

See Also

PostGIS_Lib_Version

9.2.7 ST_GDALDrivers

ST_GDALDrivers — Returns a list of raster formats supported by your lib gdal. These are the formats you can output your raster using ST_AsGDALRaster.

Synopsis

setof record **ST_GDALDrivers**(integer OUT idx, text OUT short_name, text OUT long_name, text OUT create_options);

Description

Returns a list of raster formats short_name,long_name and creator options of each format supported by your lib 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.

Availability: 2.0.0 - requires GDAL >= 1.6.0.

Examples: List of Drivers

```
SELECT short_name, long_name
FROM st_gdaldrivers()
ORDER BY short_name;
  short_name    |              long_name
----------------+--------------------------------------
AAIGrid         | Arc/Info ASCII Grid
DTED            | DTED Elevation Raster
EHdr            | ESRI .hdr Labelled
FIT             | FIT Image
GIF             | Graphics Interchange Format (.gif)
GSAG            | Golden Software ASCII Grid (.grd)
GSBG            | Golden Software Binary Grid (.grd)
GTiff           | GeoTIFF
HF2             | HF2/HFZ heightfield raster
HFA             | Erdas Imagine Images (.img)
ILWIS           | ILWIS Raster Map
INGR            | Intergraph Raster
JPEG            | JPEG JFIF
KMLSUPEROVERLAY | Kml Super Overlay
NITF            | National Imagery Transmission Format
PNG             | Portable Network Graphics
R               | R Object Data Store
SAGA            | SAGA GIS Binary Grid (.sdat)
SRTMHGT         | SRTMHGT File Format
USGSDEM         | USGS Optional ASCII DEM (and CDED)
VRT             | Virtual Raster
XPM             | X11 PixMap Format
```

Example: List of options for each driver

```
-- 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 |
 QUALITY     | int     | good=100, bad=0, default=75
 WORLDFILE   | boolean |
```

```
-- 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)
```

See Also

ST_AsGDALRaster, ST_SRID

9.2.8 UpdateRasterSRID

UpdateRasterSRID — Change the SRID of all rasters in the user-specified column and table.

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);

Description

Change the SRID of all rasters in the user-specified column and table. The function will drop all appropriate column constraints (extent, alignment and SRID) before changing the SRID of the specified column's rasters.

> **Note**
> The data (band pixel values) of the rasters are not touched by this function. Only the raster's metadata is changed.

Availability: 2.1.0

9.3 Raster Constructors

9.3.1 ST_AddBand

ST_AddBand — Returns a raster with the new band(s) of given type added with given initial value in the given index location. If no index is specified, the band is added to the end.

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);

Description

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.

For the variant that takes an array of addbandarg (Variant 1), a specific addbandarg's index value is relative to the raster at the time when the band described by that addbandarg is being added to the raster. See the Multiple New Bands example below.

For the variant that takes an array of rasters (Variant 5), if `torast` is NULL then the `fromband` band of each raster in the array is accumulated into a new raster.

For the variants that take `outdbfile` (Variants 6 and 7), the value must include the full path to the raster file. The file must also be accessible to the postgres server process.

Enhanced: 2.1.0 support for addbandarg added.

Enhanced: 2.1.0 support for new out-db bands added.

Examples: Single New Band

```
-- 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
```

Examples: Multiple New Bands

```
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;
```

Examples: New Out-db band

```
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
```

See Also

ST_BandMetaData, ST_BandPixelType, ST_MakeEmptyRaster, ST_MetaData, ST_NumBands, ST_Reclass

9.3.2 ST_AsRaster

ST_AsRaster — Converts a PostGIS geometry to a PostGIS raster.

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);

Description

Converts a PostGIS geometry to a PostGIS raster. The many variants offers three groups of possibilities for setting the alignment and pixelsize of the resulting raster.

The first group, composed of the two first variants, produce a raster having the same alignment (`scalex`, `scaley`, `gridx` and `gridy`), pixel type and nodata value as the provided reference raster. You generally pass this reference raster by joining the table containing the geometry with the table containing the reference raster.

The second group, composed of four variants, let you set the dimensions of the raster by providing the parameters of a pixel size (`scalex` & `scaley` and `skewx` & `skewy`). The `width` & `height` of the resulting raster will be adjusted to fit the extent of the geometry. In most cases, you must cast integer `scalex` & `scaley` arguments to double precision so that PostgreSQL choose the right variant.

The third group, composed of four variants, let you fix the dimensions of the raster by providing the dimensions of the raster (`width` & `height`). The parameters of the pixel size (`scalex` & `scaley` and `skewx` & `skewy`) of the resulting raster will be adjusted to fit the extent of the geometry.

The two first variants of each of those two last groups let you specify the alignment with an arbitrary corner of the alignment grid (`gridx` & `gridy`) and the two last variants takes the upper left corner (`upperleftx` & `upperlefty`).

Each group of variant allows producing a one band raster or a multiple bands raster. To produce a multiple bands raster, you must provide an array of pixel types (`pixeltype[]`), an array of initial values (`value`) and an array of nodata values (`nodataval`). If not provided pixeltyped defaults to 8BUI, values to 1 and nodataval to 0.

The output raster will be in the same spatial reference as the source geometry. The only exception is for variants with a reference raster. In this case the resulting raster will get the same SRID as the reference raster.

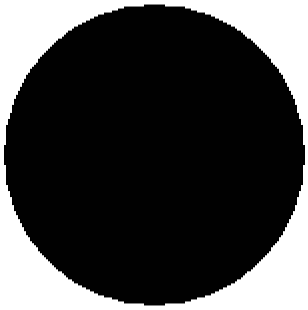
The optional `touched` parameter defaults to false and maps to the GDAL ALL_TOUCHED rasterization option, which determines if pixels touched by lines or polygons will be burned. Not just those on the line render path, or whose center point is within the polygon.

This is particularly useful for rendering jpegs and pngs of geometries directly from the database when using in combination with ST_AsPNG and other ST_AsGDALRaster family of functions.

Availability: 2.0.0 - requires GDAL >= 1.6.0.

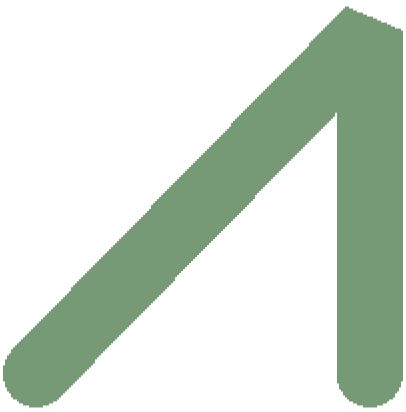
Note
Not yet capable of rendering complex geometry types such as curves, TINS, and PolyhedralSurfaces, but should be able too once GDAL can.

Examples: Output geometries as PNG files



black circle

```
-- 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, '2BUI'));
```



example from buffer rendered with just 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]));
```

See Also

ST_BandPixelType, ST_Buffer, ST_GDALDrivers, ST_AsGDALRaster, ST_AsPNG, ST_AsJPEG, ST_SRID

9.3.3 ST_Band

ST_Band — Returns one or more bands of an existing raster as a new raster. Useful for building new rasters from existing rasters.

Synopsis

raster **ST_Band**(raster rast, integer[] nbands = ARRAY[1]);
raster **ST_Band**(raster rast, text nbands, character delimiter=,);
raster **ST_Band**(raster rast, integer nband);

Description

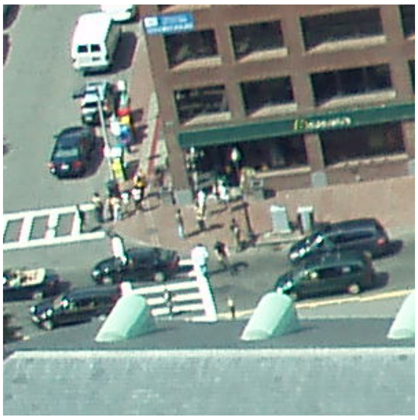
Returns a single band of an existing raster as a new raster. Useful for building new rasters from existing rasters or export of only selected bands of a raster. If no band is specified, band 1 is assumed. Used as a helper function in various functions such as for deleting a band.

Availability: 2.0.0

Examples

```
-- 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. Use text to define bands
SELECT ST_NumBands(ST_Band(rast, '2,3')) 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;
```

		
original (column 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;
```

See Also

ST_AddBand, ST_NumBands, , ST_Reclass

9.3.4 ST_MakeEmptyRaster

ST_MakeEmptyRaster — Returns an empty raster (having no bands) of given dimensions (width & height), upperleft X and Y, pixel size and rotation (scalex, scaley, skewx & skewy) and reference system (srid). If a raster is passed in, returns a new raster with the same size, alignment and SRID. If srid is left out, the spatial ref is set to unknown (0).

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);

Description

Returns an empty raster (having no band) of given dimensions (width & height) and georeferenced in spatial (or world) coordinates with upper left X (upperleftx), upper left Y (upperlefty), pixel size and rotation (scalex, scaley, skewx & skewy) and reference system (srid).

The last version use a single parameter to specify the pixel size (pixelsize). scalex is set to this argument and scaley is set to the negative value of this argument. skewx and skewy are set to 0.

If an existing raster is passed in, it returns a new raster with the same meta data settings (without the bands).

If no srid is specified it defaults to 0. After you create an empty raster you probably want to add bands to it and maybe edit it. Refer to ST_AddBand to define bands and ST_SetValue to set initial pixel values.

Examples

```
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
```

See Also

ST_AddBand, ST_MetaData, ST_ScaleX, ST_ScaleY, ST_SetValue, ST_SkewX, , ST_SkewY

9.3.5 ST_Tile

ST_Tile — Returns a set of rasters resulting from the split of the input raster based upon the desired dimensions of the output rasters.

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);

Description

Returns a set of rasters resulting from the split of the input raster based upon the desired dimensions of the output rasters.

If `padwithnodata` = FALSE, edge tiles on the right and bottom sides of the raster may have different dimensions than the rest of the tiles. If `padwithnodata` = TRUE, all tiles will have the same dimensions with the possibilty that edge tiles being padded with NODATA values. If raster band(s) do not have NODATA value(s) specified, one can be specified by setting `nodataval`.

> **Note**
> If a specified band of the input raster is out-of-db, the corresponding band in the output rasters will also be out-of-db.

Availability: 2.1.0

Examples

```
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)
```

See Also

ST_Union

9.3.6 ST_FromGDALRaster

ST_FromGDALRaster — Returns a raster from a supported GDAL raster file.

Synopsis

raster **ST_FromGDALRaster**(bytea gdaldata, integer srid=NULL);

Description

Returns a raster from a supported GDAL raster file. `gdaldata` is of type bytea and should be the contents of the GDAL raster file.

If `srid` is NULL, the function will try to autmatically assign the SRID from the GDAL raster. If `srid` is provided, the value provided will override any automatically assigned SRID.

Availability: 2.1.0

Examples

```
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)
```

See Also

ST_AsGDALRaster

9.4 Raster Accessors

9.4.1 ST_GeoReference

ST_GeoReference — Returns the georeference meta data in GDAL or ESRI format as commonly seen in a world file. Default is GDAL.

Synopsis

text **ST_GeoReference**(raster rast, text format=GDAL);

Description

Returns the georeference meta data including carriage return in GDAL or ESRI format as commonly seen in a world file. Default is GDAL if no type specified. type is string 'GDAL' or 'ESRI'.

Difference between format representations is as follows:

GDAL:

```
scalex
skewy
skewx
scaley
upperleftx
upperlefty
```

```
ESRI:
```

```
scalex
skewy
skewx
scaley
upperleftx + scalex*0.5
upperlefty + scaley*0.5
```

Examples

```
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
```

See Also

ST_SetGeoReference, ST_ScaleX, ST_ScaleY

9.4.2 ST_Height

ST_Height — Returns the height of the raster in pixels.

Synopsis

integer **ST_Height**(raster rast);

Description

Returns the height of the raster.

Examples

```
SELECT rid, ST_Height(rast) As rastheight
FROM dummy_rast;

 rid | rastheight
-----+------------
   1 |         20
   2 |          5
```

See Also

ST_Width

9.4.3 ST_IsEmpty

ST_IsEmpty — Returns true if the raster is empty (width = 0 and height = 0). Otherwise, returns false.

Synopsis

boolean **ST_IsEmpty**(raster rast);

Description

Returns true if the raster is empty (width = 0 and height = 0). Otherwise, returns false.

Availability: 2.0.0

Examples

```
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          |
```

See Also

ST_HasNoBand

9.4.4 ST_MetaData

ST_MetaData — Returns basic meta data about a raster object such as pixel size, rotation (skew), upper, lower left, etc.

Synopsis

record **ST_MetaData**(raster rast);

Description

Returns basic meta data about a raster object such as pixel size, rotation (skew), upper, lower left, etc. Columns returned: upperleftx | upperlefty | width | height | scalex | scaley | skewx | skewy | srid | numbands

Examples

```
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
```

See Also

ST_BandMetaData, ST_NumBands

9.4.5 ST_NumBands

ST_NumBands — Returns the number of bands in the raster object.

Synopsis

integer **ST_NumBands**(raster rast);

Description

Returns the number of bands in the raster object.

Examples

```
SELECT rid, ST_NumBands(rast) As numbands
FROM dummy_rast;

rid | numbands
----+----------
  1 |        0
  2 |        3
```

See Also

ST_Value

9.4.6 ST_PixelHeight

ST_PixelHeight — Returns the pixel height in geometric units of the spatial reference system.

Synopsis

double precision **ST_PixelHeight**(raster rast);

Description

Returns the height of a pixel in geometric units of the spatial reference system. In the common case where there is no skew, the pixel height is just the scale ratio between geometric coordinates and raster pixels.

Refer to ST_PixelWidth for a diagrammatic visualization of the relationship.

Examples: Rasters with no skew

```
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
```

Examples: Rasters with skew different than 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
```

See Also

ST_PixelWidth, ST_ScaleX, ST_ScaleY, ST_SkewX, ST_SkewY

9.4.7 ST_PixelWidth

ST_PixelWidth — Returns the pixel width in geometric units of the spatial reference system.

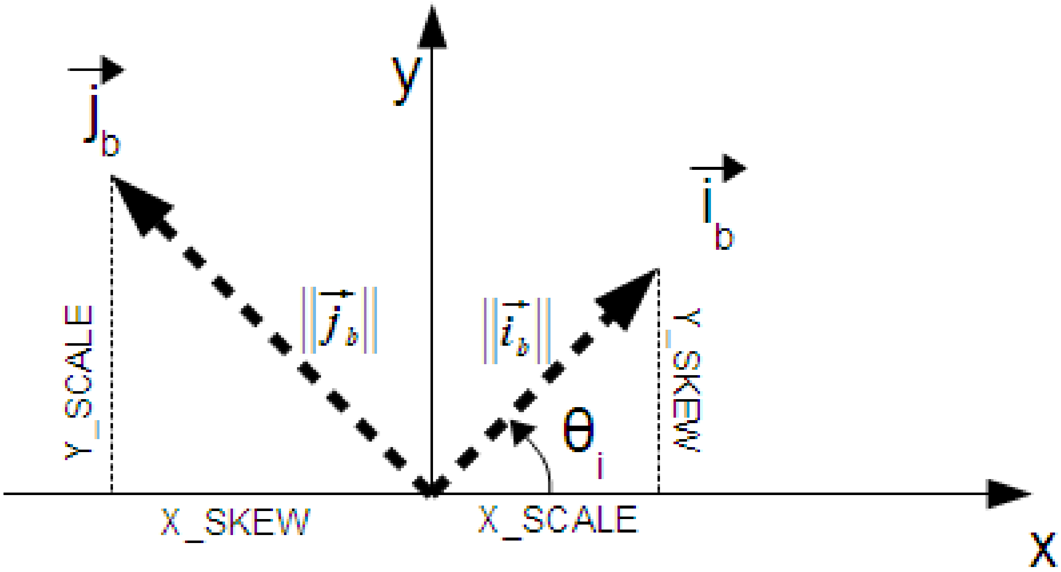
Synopsis

double precision **ST_PixelWidth**(raster rast);

Description

Returns the width of a pixel in geometric units of the spatial reference system. In the common case where there is no skew, the pixel width is just the scale ratio between geometric coordinates and raster pixels.

The following diagram demonstrates the relationship:



Pixel Width: Pixel size in the i direction
Pixel Height: Pixel size in the j direction

Examples: Rasters with no skew

```
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
```

Examples: Rasters with skew different than 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
```

See Also

ST_PixelHeight, ST_ScaleX, ST_ScaleY, ST_SkewX, ST_SkewY

9.4.8 ST_ScaleX

ST_ScaleX — Returns the X component of the pixel width in units of coordinate reference system.

Synopsis

float8 **ST_ScaleX**(raster rast);

Description

Returns the X component of the pixel width in units of coordinate reference system. Refer to World File for more details.

Changed: 2.0.0. In WKTRaster versions this was called ST_PixelSizeX.

Examples

```
SELECT rid, ST_ScaleX(rast) As rastpixwidth
FROM dummy_rast;

 rid | rastpixwidth
-----+--------------
   1 |            2
   2 |         0.05
```

See Also

ST_Width

9.4.9 ST_ScaleY

ST_ScaleY — Returns the Y component of the pixel height in units of coordinate reference system.

Synopsis

float8 **ST_ScaleY**(raster rast);

Description

Returns the Y component of the pixel height in units of coordinate reference system. May be negative. Refer to World File for more details.

Changed: 2.0.0. In WKTRaster versions this was called ST_PixelSizeY.

Examples

```
SELECT rid, ST_ScaleY(rast) As rastpixheight
FROM dummy_rast;

 rid | rastpixheight
-----+---------------
   1 |             3
   2 |         -0.05
```

See Also

ST_Height

9.4.10 ST_RasterToWorldCoord

ST_RasterToWorldCoord — Returns the raster's upper left corner as geometric X and Y (longitude and latitude) given a column and row. Column and row starts at 1.

Synopsis

record **ST_RasterToWorldCoord**(raster rast, integer xcolumn, integer yrow);

Description

Returns the upper left corner as geometric X and Y (longitude and latitude) given a column and row. Returned X and Y are in geometric units of the georeferenced raster. Numbering of column and row starts at 1 but if either parameter is passed a zero, a negative number or a number greater than the respective dimension of the raster, it will return coordinates outside of the raster assuming the raster's grid is applicable outside the raster's bounds.

Availability: 2.1.0

Examples

```
-- 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
```

See Also

ST_RasterToWorldCoordX, ST_RasterToWorldCoordY, ST_SetSkew

9.4.11 ST_RasterToWorldCoordX

ST_RasterToWorldCoordX — Returns the geometric X coordinate upper left of a raster, column and row. Numbering of columns and rows starts at 1.

Synopsis

float8 **ST_RasterToWorldCoordX**(raster rast, integer xcolumn);
float8 **ST_RasterToWorldCoordX**(raster rast, integer xcolumn, integer yrow);

Description

Returns the upper left X coordinate of a raster column row in geometric units of the georeferenced raster. Numbering of columns and rows starts at 1 but if you pass in a negative number or number higher than number of columns in raster, it will give you coordinates outside of the raster file to left or right with the assumption that the skew and pixel sizes are same as selected raster.

> **Note**
> For non-skewed rasters, providing the X column is sufficient. For skewed rasters, the georeferenced coordinate is a function of the ST_ScaleX and ST_SkewX and row and column. An error will be raised if you give just the X column for a skewed raster.

Changed: 2.1.0 In prior versions, this was called ST_Raster2WorldCoordX

Examples

```
-- 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
```

See Also

ST_ScaleX, ST_RasterToWorldCoordY, ST_SetSkew, ST_SkewX

9.4.12 ST_RasterToWorldCoordY

ST_RasterToWorldCoordY — Returns the geometric Y coordinate upper left corner of a raster, column and row. Numbering of columns and rows starts at 1.

Synopsis

float8 **ST_RasterToWorldCoordY**(raster rast, integer yrow);
float8 **ST_RasterToWorldCoordY**(raster rast, integer xcolumn, integer yrow);

Description

Returns the upper left Y coordinate of a raster column row in geometric units of the georeferenced raster. Numbering of columns and rows starts at 1 but if you pass in a negative number or number higher than number of columns/rows in raster, it will give you coordinates outside of the raster file to left or right with the assumption that the skew and pixel sizes are same as selected raster tile.

> **Note**
> For non-skewed rasters, providing the Y column is sufficient. For skewed rasters, the georeferenced coordinate is a function of the ST_ScaleY and ST_SkewY and row and column. An error will be raised if you give just the Y row for a skewed raster.

Changed: 2.1.0 In prior versions, this was called ST_Raster2WorldCoordY

Examples

```
-- 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
```

See Also

ST_ScaleY, ST_RasterToWorldCoordX, ST_SetSkew, ST_SkewY

9.4.13 ST_Rotation

ST_Rotation — Returns the rotation of the raster in radian.

Synopsis

float8 **ST_Rotation**(raster rast);

Description

Returns the uniform rotation of the raster in radian. If a raster does not have uniform rotation, NaN is returned. Refer to World File for more details.

Examples

```
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
```

See Also

ST_SetRotation, ST_SetScale, ST_SetSkew

9.4.14 ST_SkewX

ST_SkewX — Returns the georeference X skew (or rotation parameter).

Synopsis

float8 **ST_SkewX**(raster rast);

Description

Returns the georeference X skew (or rotation parameter). Refer to World File for more details.

Examples

```
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
```

See Also

ST_GeoReference, ST_SkewY, ST_SetSkew

9.4.15 ST_SkewY

ST_SkewY — Returns the georeference Y skew (or rotation parameter).

Synopsis

float8 **ST_SkewY**(raster rast);

Description

Returns the georeference Y skew (or rotation parameter). Refer to World File for more details.

Examples

```
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
```

See Also

ST_GeoReference, ST_SkewX, ST_SetSkew

9.4.16 ST_SRID

ST_SRID — Returns the spatial reference identifier of the raster as defined in spatial_ref_sys table.

Synopsis

integer **ST_SRID**(raster rast);

Description

Returns the spatial reference identifier of the raster object as defined in the spatial_ref_sys table.

> **Note**
> From PostGIS 2.0+ the srid of a non-georeferenced raster/geometry is 0 instead of the prior -1.

Examples

```
SELECT ST_SRID(rast) As srid
FROM dummy_rast WHERE rid=1;

srid
----------------
0
```

See Also

Section 4.3.1, ST_SRID

9.4.17 ST_Summary

ST_Summary — Returns a text summary of the contents of the raster.

Synopsis

text **ST_Summary**(raster rast);

Description

Returns a text summary of the contents of the raster.

Availability: 2.1.0

Examples

```
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)
```

See Also

ST_MetaData, ST_BandMetaData, ST_Summary ST_Extent

9.4.18 ST_UpperLeftX

ST_UpperLeftX — Returns the upper left X coordinate of raster in projected spatial ref.

Synopsis

float8 **ST_UpperLeftX**(raster rast);

Description

Returns the upper left X coordinate of raster in projected spatial ref.

Examples

```
SELECt rid, ST_UpperLeftX(rast) As ulx
FROM dummy_rast;

 rid |    ulx
-----+------------
   1 |         0.5
   2 | 3427927.75
```

See Also

ST_UpperLeftY, ST_GeoReference, Box3D

9.4.19 ST_UpperLeftY

ST_UpperLeftY — Returns the upper left Y coordinate of raster in projected spatial ref.

Synopsis

float8 **ST_UpperLeftY**(raster rast);

Description

Returns the upper left Y coordinate of raster in projected spatial ref.

Examples

```
SELECT rid, ST_UpperLeftY(rast) As uly
FROM dummy_rast;

 rid |   uly
-----+---------
   1 |     0.5
   2 | 5793244
```

See Also

ST_UpperLeftX, ST_GeoReference, Box3D

9.4.20 ST_Width

ST_Width — Returns the width of the raster in pixels.

Synopsis

integer **ST_Width**(raster rast);

Description

Returns the width of the raster in pixels.

Examples

```
SELECT ST_Width(rast) As rastwidth
FROM dummy_rast WHERE rid=1;

rastwidth
----------------
10
```

See Also

ST_Height

9.4.21 ST_WorldToRasterCoord

ST_WorldToRasterCoord — Returns the upper left corner as column and row given geometric X and Y (longitude and latitude) or a point geometry expressed in the spatial reference coordinate system of the raster.

Synopsis

record **ST_WorldToRasterCoord**(raster rast, geometry pt);
record **ST_WorldToRasterCoord**(raster rast, double precision longitude, double precision latitude);

Description

Returns the upper left corner as column and row given geometric X and Y (longitude and latitude) or a point geometry. This function works regardless of whether or not the geometric X and Y or point geometry is outside the extent of the raster. Geometric X and Y must be expressed in the spatial reference coordinate system of the raster.

Availability: 2.1.0

Examples

```
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
```

See Also

ST_WorldToRasterCoordX, ST_WorldToRasterCoordY, ST_RasterToWorldCoordX, ST_RasterToWorldCoordY, ST_SRID

9.4.22 ST_WorldToRasterCoordX

ST_WorldToRasterCoordX — Returns the column in the raster of the point geometry (pt) or a X and Y world coordinate (xw, yw) represented in world spatial reference system of raster.

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);

Description

Returns the column in the raster of the point geometry (pt) or a X and Y world coordinate (xw, yw). A point, or (both xw and yw world coordinates are required if a raster is skewed). If a raster is not skewed then xw is sufficient. World coordinates are in the spatial reference coordinate system of the raster.

Changed: 2.1.0 In prior versions, this was called ST_World2RasterCoordX

Examples

```
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
```

See Also

ST_RasterToWorldCoordX, ST_RasterToWorldCoordY, ST_SRID

9.4.23 ST_WorldToRasterCoordY

ST_WorldToRasterCoordY — Returns the row in the raster of the point geometry (pt) or a X and Y world coordinate (xw, yw) represented in world spatial reference system of raster.

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);

Description

Returns the row in the raster of the point geometry (pt) or a X and Y world coordinate (xw, yw). A point, or (both xw and yw world coordinates are required if a raster is skewed). If a raster is not skewed then xw is sufficient. World coordinates are in the spatial reference coordinate system of the raster.

Changed: 2.1.0 In prior versions, this was called ST_World2RasterCoordY

Examples

```
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
```

See Also

ST_RasterToWorldCoordX, ST_RasterToWorldCoordY, ST_SRID

9.5 Raster Band Accessors

9.5.1 ST_BandMetaData

ST_BandMetaData — Returns basic meta data for a specific raster band. band num 1 is assumed if none-specified.

Synopsis

record **ST_BandMetaData**(raster rast, integer bandnum=1);

Description

Returns basic meta data about a raster band. Columns returned pixeltype | nodatavalue | isoutdb | path.

> **Note**
> If raster contains no bands then an error is thrown.

> **Note**
> If band has no NODATA value, nodatavalue will be NULL.

Examples

```
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
-----+-----------+----------------+-------------+---------+------
   2 | 8BUI      |            0 | f       |
```

See Also

ST_MetaData, ST_BandPixelType

9.5.2 ST_BandNoDataValue

ST_BandNoDataValue — Returns the value in a given band that represents no data. If no band num 1 is assumed.

Synopsis

double precision **ST_BandNoDataValue**(raster rast, integer bandnum=1);

Description

Returns the value that represents no data for the band

Examples

```
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
```

See Also

ST_NumBands

9.5.3 ST_BandIsNoData

ST_BandIsNoData — Returns true if the band is filled with only nodata values.

Synopsis

boolean **ST_BandIsNoData**(raster rast, integer band, boolean forceChecking=true);
boolean **ST_BandIsNoData**(raster rast, boolean forceChecking=true);

Description

Returns true if the band is filled with only nodata values. Band 1 is assumed if not specified. If the last argument is TRUE, the entire band is checked pixel by pixel. Otherwise, the function simply returns the value of the isnodata flag for the band. The default value for this parameter is FALSE, if not specified.

Availability: 2.0.0

> **Note**
> If the flag is dirty (this is, the result is different using TRUE as last parameter and not using it) you should update the raster to set this flag to true, by using ST_SetBandIsNodata(), or ST_SetBandNodataValue() with TRUE as last argument. See ST_SetBandIsNoData.

Examples

```
-- 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
```

See Also

ST_BandNoDataValue, ST_NumBands, ST_SetBandNoDataValue, ST_SetBandIsNoData

9.5.4 ST_BandPath

ST_BandPath — Returns system file path to a band stored in file system. If no bandnum specified, 1 is assumed.

Synopsis

text **ST_BandPath**(raster rast, integer bandnum=1);

Description

Returns system file path to a band. Throws an error if called with an in db band.

Examples

```

```

See Also

9.5.5 ST_BandPixelType

ST_BandPixelType — Returns the type of pixel for given band. If no bandnum specified, 1 is assumed.

Synopsis

text **ST_BandPixelType**(raster rast, integer bandnum=1);

Description

Returns the value that represents no data for the band

There are 11 pixel types. Pixel Types supported are as follows:

- 1BB - 1-bit boolean
- 2BUI - 2-bit unsigned integer
- 4BUI - 4-bit unsigned integer
- 8BSI - 8-bit signed integer
- 8BUI - 8-bit unsigned integer
- 16BSI - 16-bit signed integer
- 16BUI - 16-bit unsigned integer
- 32BSI - 32-bit signed integer
- 32BUI - 32-bit unsigned integer
- 32BF - 32-bit float
- 64BF - 64-bit float

Examples

```
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
```

See Also

ST_NumBands

9.5.6 ST_HasNoBand

ST_HasNoBand — Returns true if there is no band with given band number. If no band number is specified, then band number 1 is assumed.

Synopsis

boolean **ST_HasNoBand**(raster rast, integer bandnum=1);

Description

Returns true if there is no band with given band number. If no band number is specified, then band number 1 is assumed.

Availability: 2.0.0

Examples

```
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
```

See Also

ST_NumBands

9.6 Raster Pixel Accessors and Setters

9.6.1 ST_PixelAsPolygon

ST_PixelAsPolygon — Returns the polygon geometry that bounds the pixel for a particular row and column.

Synopsis

geometry **ST_PixelAsPolygon**(raster rast, integer columnx, integer rowy);

Description

Returns the polygon geometry that bounds the pixel for a particular row and column.

Availability: 2.0.0

Examples

```
-- 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, ..
```

See Also

ST_DumpAsPolygons, ST_PixelAsPolygons, ST_PixelAsPoint, ST_PixelAsPoints, ST_PixelAsCentroid, ST_PixelAsCentroids, ST_Intersection, ST_AsText

9.6.2 ST_PixelAsPolygons

ST_PixelAsPolygons — Returns the polygon geometry that bounds every pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel.

Synopsis

setof record **ST_PixelAsPolygons**(raster rast, integer band=1, boolean exclude_nodata_value=TRUE);

Description

Returns the polygon geometry that bounds every pixel of a raster band along with the value (double precision), the X and the Y raster coordinates (integers) of each pixel.

> **Note**
> ST_PixelAsPolygons returns one polygon geometry for every pixel. This is different than ST_DumpAsPolygons where each geometry represents one or more pixels with the same pixel value.

> **Note**
> When exclude_nodata_value = TRUE, only those pixels whose values are not NODATA are returned as polygons.

Availability: 2.0.0

Enhanced: 2.1.0 exclude_nodata_value optional argument was added.

Changed: 2.1.1 Changed behavior of exclude_nodata_value.

Examples

```
-- 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))
```

See Also

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPoint, ST_PixelAsPoints, ST_PixelAsCentroid, ST_PixelAsCentroids, ST_AsText

9.6.3 ST_PixelAsPoint

ST_PixelAsPoint — Returns a point geometry of the pixel's upper-left corner.

Synopsis

geometry **ST_PixelAsPoint**(raster rast, integer columnx, integer rowy);

Description

Returns a point geometry of the pixel's upper-left corner.

Availability: 2.1.0

Examples

```
SELECT ST_AsText(ST_PixelAsPoint(rast, 1, 1)) FROM dummy_rast WHERE rid = 1;

   st_astext
----------------
 POINT(0.5 0.5)
```

See Also

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPolygons, ST_PixelAsPoints, ST_PixelAsCentroid, ST_PixelAsCentroids

9.6.4 ST_PixelAsPoints

ST_PixelAsPoints — Returns a point geometry for each pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel. The coordinates of the point geometry are of the pixel's upper-left corner.

Synopsis

geometry **ST_PixelAsPoints**(raster rast, integer band=1, boolean exclude_nodata_value=TRUE);

Description

Returns a point geometry for each pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel. The coordinates of the point geometry are of the pixel's upper-left corner.

> **Note**
> When exclude_nodata_value = TRUE, only those pixels whose values are not NODATA are returned as points.

Availability: 2.1.0

Changed: 2.1.1 Changed behavior of exclude_nodata_value.

Examples

```
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)
```

See Also

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPolygons, ST_PixelAsPoint, ST_PixelAsCentroid, ST_PixelAsCentroids

9.6.5 ST_PixelAsCentroid

ST_PixelAsCentroid — Returns the centroid (point geometry) of the area represented by a pixel.

Synopsis

geometry **ST_PixelAsCentroid**(raster rast, integer x, integer y);

Description

Returns the centroid (point geometry) of the area represented by a pixel.

Availability: 2.1.0

Examples

```
SELECT ST_AsText(ST_PixelAsCentroid(rast, 1, 1)) FROM dummy_rast WHERE rid = 1;

  st_astext
--------------
 POINT(1.5 2)
```

See Also

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPolygons, ST_PixelAsPoint, ST_PixelAsPoints, ST_PixelAsCentroids

9.6.6 ST_PixelAsCentroids

ST_PixelAsCentroids — Returns the centroid (point geometry) for each pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel. The point geometry is the centroid of the area represented by a pixel.

Synopsis

geometry **ST_PixelAsCentroids**(raster rast, integer band=1, boolean exclude_nodata_value=TRUE);

Description

Returns the centroid (point geometry) for each pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel. The point geometry is the centroid of the area represented by a pixel.

Note
When exclude_nodata_value = TRUE, only those pixels whose values are not NODATA are returned as points.

Availability: 2.1.0

Changed: 2.1.1 Changed behavior of exclude_nodata_value.

Examples

```
SELECT x, y, val, ST_AsText(geom) FROM (SELECT (ST_PixelAsCentroids(rast, 1)).* FROM ↩
    dummy_rast 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)
```

See Also

ST_DumpAsPolygons, ST_PixelAsPolygon, ST_PixelAsPolygons, ST_PixelAsPoint, ST_PixelAsPoints, ST_PixelAsCentroid

9.6.7 ST_Value

ST_Value — Returns the value of a given band in a given columnx, rowy pixel or at a particular geometric point. Band numbers start at 1 and assumed to be 1 if not specified. If `exclude_nodata_value` is set to false, then all pixels include `nodata` pixels are considered to intersect and return value. If `exclude_nodata_value` is not passed in then reads it from metadata of raster.

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);
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=true);

Description

Returns the value of a given band in a given columnx, rowy pixel or at a given geometry point. Band numbers start at 1 and band is assumed to be 1 if not specified. If `exclude_nodata_value` is set to true, then only non `nodata` pixels are considered. If `exclude_nodata_value` is set to false, then all pixels are considered.

Enhanced: 2.0.0 exclude_nodata_value optional argument was added.

Examples

```
-- 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)))
```

See Also

ST_DumpAsPolygons, ST_NumBands, ST_PixelAsPolygon, ST_ScaleX, , ST_ScaleY, ST_UpperLeftX, ST_UpperLeftY, ST_SRID, ST_AsText, , ST_Point, ST_MakeEnvelope, ST_Intersects, ST_Intersection

9.6.8 ST_NearestValue

ST_NearestValue — Returns the nearest non-NODATA value of a given band's pixel specified by a columnx and rowy or a geometric point expressed in the same spatial reference coordinate system as the raster.

Synopsis

double precision **ST_NearestValue**(raster rast, integer bandnum, geometry pt, boolean exclude_nodata_value=true);
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_value=true);

Description

Returns the nearest non-`NODATA` value of a given band in a given columnx, rowy pixel or at a specific geometric point. If the columnx, rowy pixel or the pixel at the specified geometric point is `NODATA`, the function will find the nearest pixel to the columnx, rowy pixel or geometric point whose value is not `NODATA`.

Band numbers start at 1 and `bandnum` is assumed to be 1 if not specified. If `exclude_nodata_value` is set to false, then all pixels include `nodata` pixels are considered to intersect and return value. If `exclude_nodata_value` is not passed in then reads it from metadata of raster.

Availability: 2.1.0

> **Note**
> ST_NearestValue is a drop-in replacement for ST_Value.

Examples

```
-- 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
```

See Also

ST_Neighborhood, ST_Value

9.6.9 ST_Neighborhood

ST_Neighborhood — Returns a 2-D double precision array of the non-NODATA values around a given band's pixel specified by either a columnX and rowY or a geometric point expressed in the same spatial reference coordinate system as the raster.

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=tru

Description

Returns a 2-D double precision array of the non-`NODATA` values around a given band's pixel specified by either a columnX and rowY or a geometric point expressed in the same spatial reference coordinate system as the raster. The `distanceX` and `distanceY` parameters define the number of pixels around the specified pixel in the X and Y axes, e.g. I want all values within 3 pixel distance along the X axis and 2 pixel distance along the Y axis around my pixel of interest. The center value of the 2-D array will be the value at the pixel specified by the columnX and rowY or the geometric point.

Band numbers start at 1 and `bandnum` is assumed to be 1 if not specified. If `exclude_nodata_value` is set to false, then all pixels include `nodata` pixels are considered to intersect and return value. If `exclude_nodata_value` is not passed in then reads it from metadata of raster.

Note
The number of elements along each axis of the returning 2-D array is 2 * (`distanceX`|`distanceY`) + 1. So for a `distanceX` and `distanceY` of 1, the returning array will be 3x3.

Note
The 2-D array output can be passed to any of the raster processing builtin functions, e.g. ST_Min4ma, ST_Sum4ma, ST_Mean4ma.

Availability: 2.1.0

Examples

```
-- 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,NULL},{1,1,1}}
```

```
-- 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
) AS foo

      st_neighborhood
---------------------------
 {{1,0,1},{1,1,1},{0,1,1}}
```

See Also

ST_NearestValue, ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Range4ma, ST_Distinct4ma, ST_StdDev4ma

9.6.10 ST_SetValue

ST_SetValue — Returns modified raster resulting from setting the value of a given band in a given columnx, rowy pixel or the pixels that intersect a particular geometry. Band numbers start at 1 and assumed to be 1 if not specified.

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);

Description

Returns modified raster resulting from setting the specified pixels' values to new value for the designed band given the raster's row and column or a geometry. If no band is specified, then band 1 is assumed.

Enhanced: 2.1.0 Geometry variant of ST_SetValue() now supports any geometry type, not just point. The geometry variant is a wrapper around the geomval[] variant of ST_SetValues()

Examples

```
        -- 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   ;
```

See Also

ST_Value, ST_DumpAsPolygons

9.6.11 ST_SetValues

ST_SetValues — Returns modified raster resulting from setting the values of a given band.

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);

Description

Returns modified raster resulting from setting specified pixels to new value(s) for the designated band.

If `keepnodata` is TRUE, those pixels whose values are NODATA will not be set with the corresponding value in `newvalueset`.

For Variant 1, the specific pixels to be set are determined by the `columnx`, `rowy` pixel coordinates and the dimensions of the `newvalueset` array. `noset` can be used to prevent pixels with values present in `newvalueset` from being set (due to PostgreSQL not permitting ragged/jagged arrays). See example Variant 1.

Variant 2 is like Variant 1 but with a simple double precision `nosetvalue` instead of a boolean `noset` array. Elements in `newvalueset` with the `nosetvalue` value with be skipped. See example Variant 2.

For Variant 3, the specific pixels to be set are determined by the `columnx`, `rowy` pixel coordinates, `width` and `height`. See example Variant 3.

Variant 4 is the same as Variant 3 with the exception that it assumes that the first band's pixels of `rast` will be set.

For Variant 5, an array of geomval is used to determine the specific pixels to be set. If all the geometries in the array are of type POINT or MULTIPOINT, the function uses a shortcut where the longitude and latitude of each point is used to set a pixel directly. Otherwise, the geometries are converted to rasters and then iterated through in one pass. See example Variant 5.

Availability: 2.1.0

Examples: Variant 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
```

Examples: Variant 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
```

Examples: Variant 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
```

Examples: Variant 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)
```

The following shows that geomvals later in the array can overwrite prior 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)
```

This example is the opposite of the prior example

```
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)
```

See Also

ST_Value, ST_SetValue, ST_PixelAsPolygons

9.6.12 ST_DumpValues

ST_DumpValues — Get the values of the specified band as a 2-dimension array.

Synopsis

setof record **ST_DumpValues**(raster rast , integer[] nband , boolean exclude_nodata_value=true);
double precision[][] **ST_DumpValues**(raster rast , integer nband , boolean exclude_nodata_value=true);

Description

Get the values of the specified band as a 2-dimension array. If `nband` is NULL or not provided, all raster bands are processed.

Availability: 2.1.0

Examples

```
WITH foo AS (
  SELECT ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),  ↩
      1, '8BUI', 1, 0), 2, '32BF', 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', 1, 0), 2, '32BF', 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)
```

See Also

ST_Value, ST_SetValue, ST_SetValues

9.6.13 ST_PixelOfValue

ST_PixelOfValue — Get the columnx, rowy coordinates of the pixel whose value equals the search value.

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);

Description

Get the columnx, rowy coordinates of the pixel whose value equals the search value. If no band is specified, then band 1 is assumed.

Availability: 2.1.0

Examples

```
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
```

9.7 Raster Editors

9.7.1 ST_SetGeoReference

ST_SetGeoReference — Set Georeference 6 georeference parameters in a single call. Numbers should be separated by white space. Accepts inputs in GDAL or ESRI format. Default is 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);

Description

Set Georeference 6 georeference parameters in a single call. Accepts inputs in 'GDAL' or 'ESRI' format. Default is GDAL. If 6 coordinates are not provided will return null.

Difference between format representations is as follows:

`GDAL`:

```
scalex skewy skewx scaley upperleftx upperlefty
```

`ESRI`:

```
scalex skewy skewx scaley upperleftx + scalex*0.5 upperlefty + scaley*0.5
```

> **Note**
> If the raster has out-db bands, changing the georeference may result in incorrect access of the band's externally stored data.

Enhanced: 2.1.0 Addition of ST_SetGeoReference(raster, double precision, ...) variant

Examples

```
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
```

See Also

ST_GeoReference, ST_ScaleX, ST_ScaleY, ST_UpperLeftX, ST_UpperLeftY

9.7.2 ST_SetRotation

ST_SetRotation — Set the rotation of the raster in radian.

Synopsis

float8 **ST_SetRotation**(raster rast, float8 rotation);

Description

Uniformly rotate the raster. Rotation is in radian. Refer to World File for more details.

Examples

```
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
```

See Also

ST_Rotation, ST_ScaleX, ST_ScaleY, ST_SkewX, ST_SkewY

9.7.3 ST_SetScale

ST_SetScale — Sets the X and Y size of pixels in units of coordinate reference system. Number units/pixel width/height.

Synopsis

raster **ST_SetScale**(raster rast, float8 xy);
raster **ST_SetScale**(raster rast, float8 x, float8 y);

Description

Sets the X and Y size of pixels in units of coordinate reference system. Number units/pixel width/height. If only one unit passed in, assumed X and Y are the same number.

> **Note**
> ST_SetScale is different from ST_Rescale in that ST_SetScale do not resample the raster to match the raster extent. It only changes the metadata (or georeference) of the raster to correct an originally mis-specified scaling. ST_Rescale results in a raster having different width and height computed to fit the geographic extent of the input raster. ST_SetScale do not modify the width, nor the height of the raster.

Changed: 2.0.0 In WKTRaster versions this was called ST_SetPixelSize. This was changed in 2.0.0.

Examples

```
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)
```

See Also

ST_ScaleX, ST_ScaleY, Box3D

9.7.4 ST_SetSkew

ST_SetSkew — Sets the georeference X and Y skew (or rotation parameter). If only one is passed in, sets X and Y to the same value.

Synopsis

raster **ST_SetSkew**(raster rast, float8 skewxy);
raster **ST_SetSkew**(raster rast, float8 skewx, float8 skewy);

Description

Sets the georeference X and Y skew (or rotation parameter). If only one is passed in, sets X and Y to the same value. Refer to World File for more details.

Examples

```
-- 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
```

See Also

ST_GeoReference, ST_SetGeoReference, ST_SkewX, ST_SkewY

9.7.5 ST_SetSRID

ST_SetSRID — Sets the SRID of a raster to a particular integer srid defined in the spatial_ref_sys table.

Synopsis

raster **ST_SetSRID**(raster rast, integer srid);

Description

Sets the SRID on a raster to a particular integer value.

> **Note**
> This function does not transform the raster in any way - it simply sets meta data defining the spatial ref of the coordinate reference system that it's currently in. Useful for transformations later.

See Also

Section 4.3.1, ST_SRID

9.7.6 ST_SetUpperLeft

ST_SetUpperLeft — Sets the value of the upper left corner of the pixel to projected X and Y coordinates.

Synopsis

raster **ST_SetUpperLeft**(raster rast, double precision x, double precision y);

Description

Set the value of the upper left corner of raster to the projected X coordinates

Examples

```
SELECT ST_SetUpperLeft(rast,-71.01,42.37)
FROM dummy_rast
WHERE rid = 2;
```

See Also

ST_UpperLeftX, ST_UpperLeftY

9.7.7 ST_Resample

ST_Resample — Resample a raster using a specified resampling algorithm, new dimensions, an arbitrary grid corner and a set of raster georeferencing attributes defined or borrowed from another raster.

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=NearestNeighbour, 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=NearestNeighbour, double precision maxerr=0.125, boolean usescale=true);
raster **ST_Resample**(raster rast, raster ref, boolean usescale, text algorithm=NearestNeighbour, double precision maxerr=0.125);

Description

Resample a raster using a specified resampling algorithm, new dimensions (width & height), a grid corner (gridx & gridy) and a set of raster georeferencing attributes (scalex, scaley, skewx & skewy) defined or borrowed from another raster. If using a reference raster, the two rasters must have the same SRID.

New pixel values are computed using the NearestNeighbor (English or American spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. Default is NearestNeighbor which is the fastest but produce the worst interpolation.

A maxerror percent of 0.125 is used if no `maxerr` is specified.

Note
Refer to: GDAL Warp resampling methods for more details.

Availability: 2.0.0 Requires GDAL 1.6.1+

Changed: 2.1.0 Parameter srid removed. Variants with a reference raster no longer applies the reference raster's SRID. Use ST_Transform() to reproject raster. Works on rasters with no SRID.

Examples

```
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
```

See Also

ST_Rescale, ST_Transform

9.7.8 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 or Lanczos resampling algorithm. Default is NearestNeighbor.

Synopsis

raster **ST_Rescale**(raster rast, double precision scalexy, text algorithm=NearestNeighbour, double precision maxerr=0.125);
raster **ST_Rescale**(raster rast, double precision scalex, double precision scaley, text algorithm=NearestNeighbour, double precision maxerr=0.125);

Description

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 or Lanczos resampling algorithm. 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.

When the new scalex or scaley is not a divisor of the raster width or height, the extent of the resulting raster is expanded to encompass the extent of the provided raster.

A maxerror percent of 0.125 is used if no `maxerr` is specified.

> **Note**
> Refer to: GDAL Warp resampling methods for more details.

> **Note**
> ST_Rescale is different from ST_SetScale in that ST_SetScale do not resample the raster to match the raster extent. ST_SetScale only changes the metadata (or georeference) of the raster to correct an originally mis-specified scaling. ST_Rescale results in a raster having different width and height computed to fit the geographic extent of the input raster. ST_SetScale do not modify the width, nor the height of the raster.

Availability: 2.0.0 Requires GDAL 1.6.1+

Changed: 2.1.0 Works on rasters with no SRID

Examples

A simple example rescaling a raster from a pixel size of 0.001 degree to a pixel size of 0.0015 degree.

```
-- 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
```

See Also

ST_SetScale, ST_ScaleX, ST_ScaleY, ST_Resample, ST_Transform

9.7.9 ST_Reskew

ST_Reskew — Resample a raster by adjusting only its skew (or rotation parameters). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. Default is NearestNeighbor.

Synopsis

raster **ST_Reskew**(raster rast, double precision skewxy, text algorithm=NearestNeighbour, double precision maxerr=0.125);
raster **ST_Reskew**(raster rast, double precision skewx, double precision skewy, text algorithm=NearestNeighbour, double precision maxerr=0.125);

Description

Resample a raster by adjusting only its skew (or rotation parameters). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. The default is NearestNeighbor which is the fastest but results in the worst interpolation.

`skewx` and `skewy` define the new skew.

The extent of the new raster will encompass the extent of the provided raster.

A maxerror percent of 0.125 if no `maxerr` is specified.

Note
Refer to: GDAL Warp resampling methods for more details.

Note
ST_Reskew is different from ST_SetSkew in that ST_SetSkew do not resample the raster to match the raster extent. ST_SetSkew only changes the metadata (or georeference) of the raster to correct an originally mis-specified skew. ST_Reskew results in a raster having different width and height computed to fit the geographic extent of the input raster. ST_SetSkew do not modify the width, nor the height of the raster.

Availability: 2.0.0 Requires GDAL 1.6.1+

Changed: 2.1.0 Works on rasters with no SRID

Examples

A simple example reskewing a raster from a skew of 0.0 to a skew of 0.0015.

```
-- the original raster pixel size
SELECT ST_Rotation(ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 0.001, -0.001, 0, 0, 4269) ↩
    , '8BUI'::text, 1, 0))

-- the rescaled raster raster pixel size
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))
```

See Also

ST_Resample, ST_Rescale, ST_SetSkew, ST_SetRotation, ST_SkewX, ST_SkewY, ST_Transform

9.7.10 ST_SnapToGrid

ST_SnapToGrid — Resample a raster by snapping it to a grid. New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. Default is NearestNeighbor.

Synopsis

raster **ST_SnapToGrid**(raster rast, double precision gridx, double precision gridy, text algorithm=NearestNeighbour, 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=NearestNeighbour, double precision maxerr=0.125);
raster **ST_SnapToGrid**(raster rast, double precision gridx, double precision gridy, double precision scalexy, text algorithm=NearestNeig
double precision maxerr=0.125);

Description

Resample a raster by snapping it to a grid defined by an arbitrary pixel corner (gridx & gridy) and optionally a pixel size (scalex & scaley). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. The default is NearestNeighbor which is the fastest but results in the worst interpolation.

`gridx` and `gridy` define any arbitrary pixel corner of the new grid. This is not necessarily the upper left corner of the new raster and it does not have to be inside or on the edge of the new raster extent.

You can optionnal define the pixel size of the new grid with `scalex` and `scaley`.

The extent of the new raster will encompass the extent of the provided raster.

A maxerror percent of 0.125 if no `maxerr` is specified.

Note
Refer to: GDAL Warp resampling methods for more details.

Note
Use ST_Resample if you need more control over the grid parameters.

Availability: 2.0.0 Requires GDAL 1.6.1+

Changed: 2.1.0 Works on rasters with no SRID

Examples

A simple example snapping a raster to a slightly different grid.

```
-- the original raster pixel size
SELECT ST_UpperLeftX(ST_AddBand(ST_MakeEmptyRaster(10, 10, 0, 0, 0.001, -0.001, 0, 0, 4269) ↩
    , '8BUI'::text, 1, 0))

-- the rescaled raster raster pixel size
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))
```

See Also

ST_Resample, ST_Rescale, ST_UpperLeftX, ST_UpperLeftY

9.7.11 ST_Resize

ST_Resize — Resize a raster to a new width/height

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);

Description

Resize a raster to a new width/height. The new width/height can be specified in exact number of pixels or a percentage of the raster's width/height.

New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. The default is NearestNeighbor which is the fastest but results in the worst interpolation.

Variant 1 expects the actual width/height of the output raster.

Variant 2 expects decimal values between zero (0) and one (1) indicating the percentage of the input raster's width/height.

Variant 3 takes either the actual width/height of the output raster or a textual percentage ("20%") indicating the percentage of the input raster's width/height.

Availability: 2.1.0 Requires GDAL 1.6.1+

Examples

```
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)
```

See Also

ST_Resample, ST_Rescale, ST_Reskew, ST_SnapToGrid

9.7.12 ST_Transform

ST_Transform — Reprojects a raster in a known spatial reference system to another known spatial reference system using specified resampling algorithm. Options are NearestNeighbor, Bilinear, Cubic, CubicSpline, Lanczos defaulting to 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);

Description

Reprojects a raster in a known spatial reference system to another known spatial reference system using specified pixel warping algorithm. Uses 'NearestNeighbor' if no algorithm is specified and maxerror percent of 0.125 if no maxerr is specified.

Algorithm options are: 'NearestNeighbor', 'Bilinear', 'Cubic', 'CubicSpline', and 'Lanczos'. Refer to: GDAL Warp resampling methods for more details.

ST_Transform is often confused with ST_SetSRID(). ST_Transform actually changes the coordinates of a raster (and resamples the pixel values) from one spatial reference system to another, while ST_SetSRID() simply changes the SRID identifier of the raster.

Unlike the other variants, Variant 3 requires a reference raster as `alignto`. The transformed raster will be transformed to the spatial reference system (SRID) of the reference raster and be aligned (ST_SameAlignment = TRUE) to the reference raster.

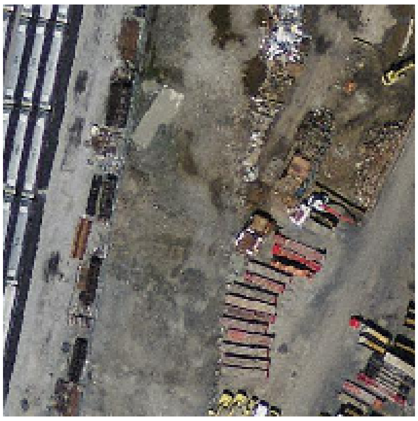
Note
If you find your transformation support is not working right, you may need to set the environment variable PROJSO to the .so or .dll projection library your PostGIS is using. This just needs to have the name of the file. So for example on windows, you would in Control Panel -> System -> Environment 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.

Availability: 2.0.0 Requires GDAL 1.6.1+

Enhanced: 2.1.0 Addition of ST_Transform(rast, alignto) variant

Examples

```
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
```



original mass state plane meters (mass_stm)

After transform to wgs 84 long lat (wgs_84)

After transform to wgs 84 long lat with bilinear algorithm instead of NN default (wgs_84_bilin)

Examples: Variant 3

The following shows the difference between using ST_Transform(raster, srid) and 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
```

See Also

ST_Transform, ST_SetSRID

9.8 Raster Band Editors

9.8.1 ST_SetBandNoDataValue

ST_SetBandNoDataValue — Sets the value for the given band that represents no data. Band 1 is assumed if no band is specified. To mark a band as having no nodata value, set the 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);

Description

Sets the value that represents no data for the band. Band 1 is assumed if not specified. This will affect results from ST_Polygon, ST_DumpAsPolygons, and the ST_PixelAs...() functions.

Examples

```
-- 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;
```

See Also

ST_BandNoDataValue, ST_NumBands

9.8.2 ST_SetBandIsNoData

ST_SetBandIsNoData — Sets the isnodata flag of the band to TRUE.

Synopsis

raster **ST_SetBandIsNoData**(raster rast, integer band=1);

Description

Sets the isnodata flag for the band to true. Band 1 is assumed if not specified. This function should be called only when the flag is considered dirty. That is, when the result calling ST_BandIsNoData is different using TRUE as last argument and without using it

Availability: 2.0.0

Examples

```
-- 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
```

See Also

ST_BandNoDataValue, ST_NumBands, ST_SetBandNoDataValue, ST_BandIsNoData

9.9 Raster Band Statistics and Analytics

9.9.1 ST_Count

ST_Count — Returns the number of pixels in a given band of a raster or raster coverage. If no band is specified defaults to band 1. If exclude_nodata_value is set to true, will only count pixels that are not equal to the nodata value.

Synopsis

bigint **ST_Count**(raster rast, integer nband=1, boolean exclude_nodata_value=true);
bigint **ST_Count**(raster rast, boolean exclude_nodata_value);
bigint **ST_Count**(text rastertable, text rastercolumn, integer nband=1, boolean exclude_nodata_value=true);
bigint **ST_Count**(text rastertable, text rastercolumn, boolean exclude_nodata_value);

Description

Returns the number of pixels in a given band of a raster or raster coverage. If no band is specified `nband` defaults to 1.

> **Note**
> If `exclude_nodata_value` is set to true, will only count pixels with value not equal to the `nodata` value of the raster. Set `exclude_nodata_value` to false to get count all pixels

Availability: 2.0.0

Examples

```
--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
```

See Also

ST_SetBandNoDataValue

9.9.2 ST_Histogram

ST_Histogram — Returns a set of record summarizing a raster or raster coverage data distribution separate bin ranges. Number of bins are autocomputed if not specified.

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);
SETOF record **ST_Histogram**(text rastertable, text rastercolumn, integer nband, integer bins, boolean right);
SETOF record **ST_Histogram**(text rastertable, text rastercolumn, integer nband, boolean exclude_nodata_value, integer bins, boolean right);
SETOF record **ST_Histogram**(text rastertable, text rastercolumn, integer nband=1, boolean exclude_nodata_value=true, integer bins=autocomputed, double precision[] width=NULL, boolean right=false);
SETOF record **ST_Histogram**(text rastertable, text rastercolumn, integer nband=1, integer bins, double precision[] width=NULL, boolean right=false);

Description

Returns set of records consisting of min, max, count, percent for a given raster band for each bin. If no band is specified `nband` defaults to 1.

> **Note**
> By default only considers pixel values not equal to the `nodata` value . Set `exclude_nodata_value` to false to get count all pixels.

***width* double precision[]** width: an array indicating the width of each category/bin. If the number of bins is greater than the number of widths, the widths are repeated.

Example: 9 bins, widths are [a, b, c] will have the output be [a, b, c, a, b, c, a, b, c]

***bins* integer** Number of breakouts -- this is the number of records you'll get back from the function if specified. If not specified then the number of breakouts is autocomputed.

***right* boolean** compute the histogram from the right rather than from the left (default). This changes the criteria for evaluating a value x from [a, b) to (a, b]

Availability: 2.0.0

Example: Single raster tile - compute histograms for bands 1, 2, 3 and autocompute bins

```
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
```

Example: Just band 2 but for 6 bins

```
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)
```

See Also

ST_Count, ST_SummaryStats

9.9.3 ST_Quantile

ST_Quantile — Compute quantiles for a raster or raster table coverage in the context of the sample or population. Thus, a value could be examined to be at the raster's 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);
SETOF record **ST_Quantile**(text rastertable, text rastercolumn, integer nband=1, boolean exclude_nodata_value=true, double precision[] quantiles=NULL);
SETOF record **ST_Quantile**(text rastertable, text rastercolumn, integer nband, double precision[] quantiles);

Description

Compute quantiles for a raster or raster table coverage in the context of the sample or population. Thus, a value could be examined to be at the raster's 25%, 50%, 75% percentile.

> **Note**
> If `exclude_nodata_value` is set to false, will also count pixels with no data.

Availability: 2.0.0

Examples

```
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
```

See Also

ST_Count, ST_SetBandNoDataValue

9.9.4 ST_SummaryStats

ST_SummaryStats — Returns record consisting of count, sum, mean, stddev, min, max for a given raster band of a raster or raster coverage. Band 1 is assumed is no band is specified.

Synopsis

record **ST_SummaryStats**(text rastertable, text rastercolumn, boolean exclude_nodata_value);
record **ST_SummaryStats**(raster rast, boolean exclude_nodata_value);
record **ST_SummaryStats**(text rastertable, text rastercolumn, integer nband=1, boolean exclude_nodata_value=true);
record **ST_SummaryStats**(raster rast, integer nband, boolean exclude_nodata_value);

Description

Returns record consisting of count, sum, mean, stddev, min, max for a given raster band of a raster or raster coverage. If no band is specified `nband` defaults to 1.

> **Note**
> By default only considers pixel values not equal to the `nodata` value. Set `exclude_nodata_value` to false to get count of all pixels.

> **Note**
> By default will sample all pixels. To get faster response, set `sample_percent` to lower than 1

Availability: 2.0.0

Example: Single raster tile

```
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
```

Example: Summarize pixels that intersect buildings of interest

This example took 574ms on PostGIS windows 64-bit with all of Boston Buildings and aerial Tiles (tiles each 150x150 pixels ~ 134,000 tiles), ~102,000 building records

```
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
```

Example: Raster coverage

```
-- 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
```

See Also

ST_Count, ST_Clip

9.9.5 ST_ValueCount

ST_ValueCount — Returns a set of records containing a pixel band value and count of the number of pixels in a given band of a raster (or a raster coverage) that have a given set of values. If no band is specified defaults to band 1. By default nodata value pixels are not counted. and all other values in the pixel are output and pixel band values are rounded to the nearest integer.

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);

Description

Returns a set of records with columns `value count` which contain the pixel band value and count of pixels in the raster tile or raster coverage of selected band.

If no band is specified `nband` defaults to 1. If no `searchvalues` are specified, will return all pixel values found in the raster or raster coverage. If one searchvalue is given, will return an integer instead of records denoting the count of pixels having that pixel band value

> **Note**
> If `exclude_nodata_value` is set to false, will also count pixels with no data.

Availability: 2.0.0

Examples

```
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
```

See Also

ST_Count, ST_SetBandNoDataValue

9.10 Raster Outputs

9.10.1 ST_AsBinary

ST_AsBinary — Return the Well-Known Binary (WKB) representation of the raster without SRID meta data.

Synopsis

bytea **ST_AsBinary**(raster rast, boolean outasin=FALSE);

Description

Returns the Binary representation of the raster. If `outasin` is TRUE, out-db bands are treated as in-db.

This is useful in binary cursors to pull data out of the database without converting it to a string representation.

> **Note**
> By default, 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.

Enhanced: 2.1.0 Addition of `outasin`

Examples

```
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\00
0\000\000\000\000\000\000\000\000\000\000\012\000\000\000\012\000\024\000
```

9.10.2 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_GDALRasters() to get a list of formats supported by your library.

Synopsis

bytea **ST_AsGDALRaster**(raster rast, text format, text[] options=NULL, integer srid=sameassource);

Description

Returns the raster tile in the designated format. Arguments are itemized below:

- `format` format to output. This is dependent on the drivers compiled in your libgdal library. Generally available are 'JPEG', 'GTIff', 'PNG'. Use ST_GDALDrivers to get a list of formats supported by your library.
- `options` text array of GDAL options. Valid options are dependent on the format. Refer to GDAL Raster format options for more details.
- `srs` The proj4text or srtext (from spatial_ref_sys) to embed in the image

Availability: 2.0.0 - requires GDAL >= 1.6.0.

JPEG Output Examples

```
SELECT ST_AsGDALRaster(rast, 'JPEG') As rastjpg
FROM dummy_rast WHERE rid=1;

SELECT ST_AsGDALRaster(rast, 'JPEG', ARRAY['QUALITY=50']) As rastjpg
FROM dummy_rast WHERE rid=2;
```

GTIFF Output Examples

```
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;
```

See Also

Section 5.3, ST_GDALDrivers, ST_SRID

9.10.3 ST_AsJPEG

ST_AsJPEG — Return the raster tile selected bands as a single Joint Photographic Exports Group (JPEG) image (byte array). If no band is specified and 1 or more than 3 bands, then only the first band is used. If only 3 bands then all 3 bands are used and mapped to 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);

Description

Returns the selected bands of the raster as a single Joint Photographic Exports Group Image (JPEG). Use ST_AsGDALRaster if you need to export as less common raster types. If no band is specified and 1 or more than 3 bands, then only the first band is used. If 3 bands then all 3 bands are used. There are many variants of the function with many options. These are itemized below:

- `nband` is for single band exports.
- `nbands` is an array of bands to export (note that max is 3 for JPEG) and the order of the bands is RGB. e.g ARRAY[3,2,1] means map band 3 to Red, band 2 to green and band 1 to blue
- `quality` number from 0 to 100. The higher the number the crisper the image.
- `options` text Array of GDAL options as defined for JPEG (look at create_options for JPEG ST_GDALDrivers). For JPEG valid ones are `PROGRESSIVE` ON or OFF and `QUALITY` a range from 0 to 100 and default to 75. Refer to GDAL Raster format options for more details.

Availability: 2.0.0 - requires GDAL >= 1.6.0.

Examples: Output

```
-- 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;
```

See Also

Section 5.3, ST_GDALDrivers, ST_AsGDALRaster, ST_AsPNG, ST_AsTIFF

9.10.4 ST_AsPNG

ST_AsPNG — Return the raster tile selected bands as a single portable network graphics (PNG) image (byte array). If 1, 3, or 4 bands in raster and no bands are specified, then all bands are used. If more 2 or more than 4 bands and no bands specified, then only band 1 is used. Bands are mapped to RGB or RGBA space.

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);

Description

Returns the selected bands of the raster as a single Portable Network Graphics Image (PNG). Use ST_AsGDALRaster if you need to export as less common raster types. If no band is specified, then the first 3 bands are exported. There are many variants of the function with many options. If no `srid` is specified then then srid of the raster is used. These are itemized below:

- `nband` is for single band exports.
- `nbands` is an array of bands to export (note that max is 3 for PNG) and the order of the bands is RGB. e.g ARRAY[3,2,1] means map band 3 to Red, band 2 to green and band 1 to blue
- `compression` number from 1 to 9. The higher the number the greater the compression.
- `options` text Array of GDAL options as defined for PNG (look at create_options for PNG of ST_GDALDrivers). For PNG valid one is only ZLEVEL (amount of time to spend on compression -- default 6) e.g. ARRAY['ZLEVEL=9']. WORLDFILE is not allowed since the function would have to output two outputs. Refer to GDAL Raster format options for more details.

Availability: 2.0.0 - requires GDAL >= 1.6.0.

Examples

```
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;
```

See Also

ST_AsGDALRaster, ST_ColorMap, ST_GDALDrivers, Section 5.3

9.10.5 ST_AsTIFF

ST_AsTIFF — Return the raster selected bands as a single TIFF image (byte array). If no band is specified, 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);

Description

Returns the selected bands of the raster as a single Tagged Image File Format (TIFF). If no band is specified, will try to use all bands. This is a wrapper around ST_AsGDALRaster. Use ST_AsGDALRaster if you need to export as less common raster types. There are many variants of the function with many options. If no spatial reference SRS text is present, the spatial reference of the raster is used. These are itemized below:

- `nbands` is an array of bands to export (note that max is 3 for PNG) and the order of the bands is RGB. e.g ARRAY[3,2,1] means map band 3 to Red, band 2 to green and band 1 to blue
- `compression` Compression expression -- JPEG90 (or some other percent), LZW, JPEG, DEFLATE9.
- `options` text Array of GDAL create options as defined for GTiff (look at create_options for GTiff of ST_GDALDrivers). or refer to GDAL Raster format options for more details.
- `srid` srid of spatial_ref_sys of the raster. This is used to populate the georeference information

Availability: 2.0.0 - requires GDAL >= 1.6.0.

Examples: Use jpeg compression 90%

```
SELECT ST_AsTIFF(rast, 'JPEG90') As rasttiff
FROM dummy_rast WHERE rid=2;
```

See Also

ST_GDALDrivers, ST_AsGDALRaster, ST_SRID

9.11 Raster Processing

9.11.1 Map Algebra

9.11.1.1 ST_Clip

ST_Clip — Returns the raster clipped by the input geometry. If band number not is specified, all bands are processed. If `crop` is not specified or TRUE, the output raster is cropped.

Synopsis

raster **ST_Clip**(raster rast, integer[] nband, geometry geom, double precision[] nodataval=NULL, boolean crop=TRUE);
raster **ST_Clip**(raster rast, integer nband, geometry geom, double precision nodataval, boolean crop=TRUE);
raster **ST_Clip**(raster rast, integer nband, geometry geom, boolean crop);
raster **ST_Clip**(raster rast, geometry geom, double precision[] nodataval=NULL, boolean crop=TRUE);
raster **ST_Clip**(raster rast, geometry geom, double precision nodataval, boolean crop=TRUE);
raster **ST_Clip**(raster rast, geometry geom, boolean crop);

Description

Returns a raster that is clipped by the input geometry `geom`. If band index is not specified, all bands are processed.

Rasters resulting from ST_Clip must have a nodata value assigned for areas clipped, one for each band. If none are provided and the input raster do not have a nodata value defined, nodata values of the resulting raster are set to ST_MinPossibleValue(ST_BandPixelTyp band)). When the number of nodata value in the array is smaller than the number of band, the last one in the array is used for the remaining bands. If the number of nodata value is greater than the number of band, the extra nodata values are ignored. All variants accepting an array of nodata values also accept a single value which will be assigned to each band.

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`.

Availability: 2.0.0

Enhanced: 2.1.0 Rewritten in C

Examples here use Massachusetts aerial data available on MassGIS site MassGIS Aerial Orthos. Coordinates are in Massachusetts State Plane Meters.

Examples: 1 band clipping

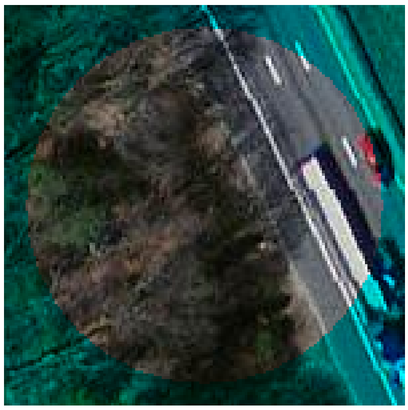
```
-- Clip the first band of an aerial tile by a 20 meter buffer.
SELECT ST_Clip(rast, 1,
    ST_Buffer(ST_Centroid(ST_Envelope(rast)),20)
  ) from aerials.boston
WHERE rid = 4;
```

```
-- 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
```

	
Full raster tile before clipping	*After Clipping*

Examples: 1 band clipping with no crop and add back other bands unchanged

```
-- 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;
```

	
Full raster tile before clipping	*After Clipping - surreal*

Examples: Clip all bands

```
-- 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;
```

Full raster tile before clipping

After Clipping

See Also

ST_AddBand, ST_MapAlgebra, ST_Intersection

9.11.1.2 ST_ColorMap

ST_ColorMap — Creates a new raster of up to four 8BUI bands (grayscale, RGB, RGBA) from the source raster and a specified band. Band 1 is assumed if not specified.

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);

Description

Apply a `colormap` to the band at `nband` of `rast` resulting a new raster comprised of up to four 8BUI bands. The number of 8BUI bands in the new raster is determined by the number of color components defined in `colormap`.

If `nband` is not specified, then band 1 is assumed.

`colormap` can be a keyword of a pre-defined colormap or a set of lines defining the value and the color components.

Valid pre-defined `colormap` keyword:

- `grayscale` or `greyscale` for a one 8BUI band raster of shades of gray.
- `pseudocolor` for a four 8BUI (RGBA) band raster with colors going from blue to green to red.
- `fire` for a four 8BUI (RGBA) band raster with colors going from black to red to pale yellow.

- bluered for a four 8BUI (RGBA) band raster with colors going from blue to pale white to red.

Users can pass a set of entries (one per line) to colormap to specify custom colormaps. Each entry generally consists of five values: the pixel value and corresponding Red, Green, Blue, Alpha components (color components between 0 and 255). Percent values can be used instead of pixel values where 0% and 100% are the minimum and maximum values found in the raster band. Values can be separated with commas (','), tabs, colons (':') and/or spaces. The pixel value can be set to *nv*, *null* or *nodata* for the NODATA value. An example is provided below.

```
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
```

The syntax of colormap is similar to that of the color-relief mode of GDAL gdaldem.

Valid keywords for method:

- INTERPOLATE to use linear interpolation to smoothly blend the colors between the given pixel values
- EXACT to strictly match only those pixels values found in the colormap. Pixels whose value does not match a colormap entry will be set to 0 0 0 0 (RGBA)
- NEAREST to use the colormap entry whose value is closest to the pixel value

Note
A great reference for colormaps is ColorBrewer.

Warning
The resulting bands of new raster will have no NODATA value set. Use ST_SetBandNoDataValue to set a NODATA value if one is needed.

Availability: 2.1.0

Examples

This is a junk table to play with

```
-- 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)'),
```

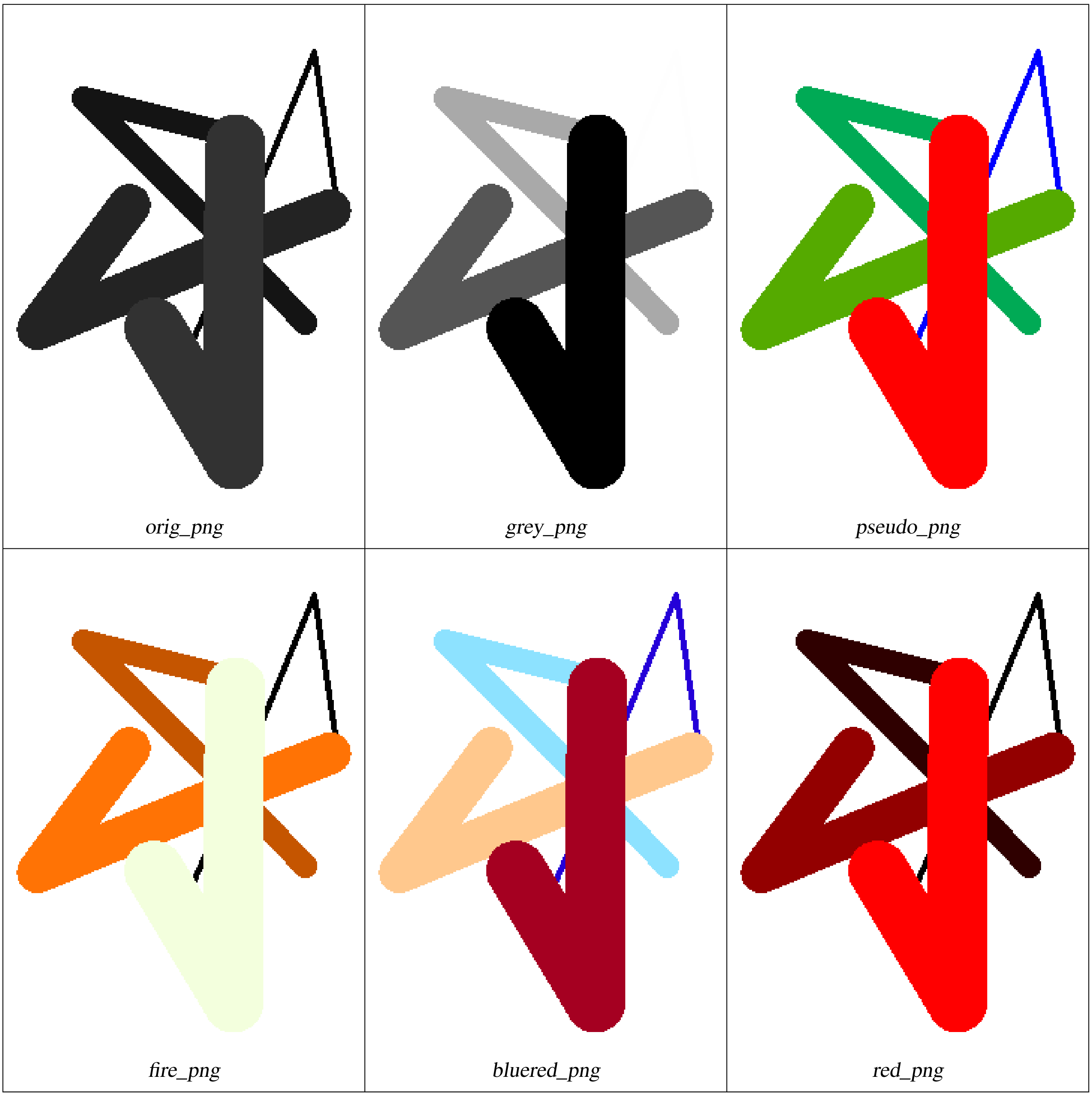
```
          i*2
        ),
        pi() * i * 0.125, ST_Point(50,50)
      ),
      ref.rast, '8BUI'::text, i * 5
    ) AS rast
  FROM ref
  CROSS JOIN generate_series(1, 10, 3) AS i
) AS shapes;
```

```
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
```

Examples: Compare different color map looks using 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

See Also

ST_AsPNG, ST_AsRaster ST_MapAlgebra, ST_NumBands, ST_Reclass, ST_SetBandNoDataValue, ST_Union

9.11.1.3 ST_Intersection

ST_Intersection — Returns a raster or a set of geometry-pixelvalue pairs representing the shared portion of two rasters or the geometrical intersection of a vectorization of the raster and a geometry.

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_num, geometry geom);
raster **ST_Intersection**(raster rast1, raster rast2, double precision[] nodataval);
raster **ST_Intersection**(raster rast1, raster rast2, text returnband='BOTH', double precision[] nodataval=NULL);
raster **ST_Intersection**(raster rast1, integer band_num1, raster rast2, integer band_num2, double precision[] nodataval);
raster **ST_Intersection**(raster rast1, integer band_num1, raster rast2, integer band_num2, text returnband='BOTH', double precision[] nodataval=NULL);

Description

Returns a raster or a set of geometry-pixelvalue pairs representing the shared portion of two rasters or the geometrical intersection of a vectorization of the raster and a geometry.

The first three variants, returning a setof geomval, works in vector space. The raster is first vectorized (using ST_DumpAsPolygon) into a set of geomval rows and those rows are then intersected with the geometry using the ST_Intersection(geometry, geometry) PostGIS function. Geometries intersecting only with a nodata value area of a raster returns an empty geometry. They are normally excluded from the results by the proper usage of ST_Intersect in the WHERE clause.

You can access the geometry and the value parts of the resulting set of geomval by surrounding them with parenthesis and adding '.geom' or '.val' at the end of the expression. e.g. (ST_Intersection(rast, geom)).geom

The other variants, returning a raster, works in raster space. They are using the two rasters version of ST_MapAlgebraExpr to perform the intersection.

The extent of the resulting raster corresponds to the geometrical intersection of the two raster extents. The resulting raster includes 'BAND1', 'BAND2' or 'BOTH' bands, following what is passed as the `returnband` parameter. Nodata value areas present in any band results in nodata value areas in every bands of the result. In other words, any pixel intersecting with a nodata value pixel becomes a nodata value pixel in the result.

Rasters resulting from ST_Intersection must have a nodata value assigned for areas not intersecting. You can define or replace the nodata value for any resulting band by providing a `nodataval[]` array of one or two nodata values depending if you request 'BAND1', 'BAND2' or 'BOTH' bands. The first value in the array replace the nodata value in the first band and the second value replace the nodata value in the second band. If one input band do not have a nodata value defined and none are provided as an array, one is chosen using the ST_MinPossibleValue function. All variant accepting an array of nodata value can also accept a single value which will be assigned to each requested band.

In all variants, if no band number is specified band 1 is assumed.

Note
To get more control on the resulting extent or on what to return when encountering a nodata value, use the two rasters version of ST_MapAlgebraExpr.

Note
To compute the intersection of a raster band with a geometry in raster space, use ST_Clip. ST_Clip works on multiple bands rasters and does not return a band corresponding to the rasterized geometry.

Note
ST_Intersection should be used in conjunction with ST_Intersects and an index on the raster column and/or the geometry column.

Enhanced: 2.0.0 - Intersection in the raster space was introduced. In earlier pre-2.0.0 versions, only intersection performed in vector space were supported.

Examples: Geometry, Raster -- resulting in geometry vals

```
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
```

Example: Raster, Geometry -- resulting is a raster

Examples coming soon

See Also

geomval, ST_Intersects, ST_MapAlgebraExpr, ST_Clip, ST_AsText

9.11.1.4 ST_MapAlgebra

ST_MapAlgebra — Callback function version - Returns a one-band raster given one or more input rasters, band indexes and one user-specified callback function.

Synopsis

raster **ST_MapAlgebra**(rastbandarg[] rastbandargset, regprocedure callbackfunc, text pixeltype=NULL, text extenttype=INTERSECTIO 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);

Description

Returns a one-band raster given one or more input rasters, band indexes and one user-specified callback function.

rast,rast1,rast2, rastbandargset Rasters on which the map algebra process is evaluated.

`rastbandargset` allows the use of a map algebra operation on many rasters and/or many bands. See example Variant 1.

nband, nband1, nband2 Band numbers of the raster to be evaluated. nband can be an integer or integer[] denoting the bands. nband1 is band on rast1 and nband2 is band on rast2 for hte 2 raster/2band case.

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.

pixeltype If `pixeltype` is passed in, the one band of the new raster will be of that pixeltype. If pixeltype is passed NULL or left out, the new raster band will have the same pixeltype as the specified band of the first raster (for extent types: INTERSECTION, UNION, FIRST, CUSTOM) or the specified band of the appropriate raster (for extent types: SECOND, LAST). If in doubt, always specify `pixeltype`.

The resulting pixel type of the output raster must be one listed in ST_BandPixelType or left out or set to NULL.

extenttype Possible values are INTERSECTION (default), UNION, FIRST (default for one raster variants), SECOND, LAST, CUSTOM.

customextent If `extentype` is CUSTOM, a raster must be provided for `customextent`. See example 4 of Variant 1.

distancex The distance in pixels from the reference cell. So width of resulting matrix would be `2*distancex + 1`.If not specified only the reference cell is considered (neighborhood of 0).

distancey The distance in pixels from reference cell in y direction. Height of resulting matrix would be `2*distancey + 1` .If not specified only the reference cell is considered (neighborhood of 0).

userargs The third argument to the `callbackfunc` is a variadic text array. All trailing text arguments are passed through to the specified `callbackfunc`, and are contained in the `userargs` argument.

Note
For more information about the VARIADIC keyword, please refer to the PostgreSQL documentation and the "SQL Functions with Variable Numbers of Arguments" section of Query Language (SQL) Functions.

Note
The text[] argument to the `callbackfunc` is required, regardless of whether you choose to pass any arguments to the callback function for processing or not.

Variant 1 accepts an array of `rastbandarg` allowing the use of a map algebra operation on many rasters and/or many bands. See example Variant 1.

Variants 2 and 3 operate upon one or more bands of one raster. See example Variant 2 and 3.

Variant 4 operate upon two rasters with one band per raster. See example Variant 4.

Availability: 2.1.0

Examples: Variant 1

One raster, one band

```
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
```

One raster, several bands

```
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
```

Several rasters, several bands

```
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
```

Complete example of tiles of a coverage with neighborhood. This query only works with PostgreSQL 9.1 or higher.

```
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
```

Example like the prior one for tiles of a coverage with neighborhood but works with PostgreSQL 9.0.

```
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;
```

Examples: Variants 2 and 3

One raster, several bands

```
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
```

One raster, one band

```
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
```

Examples: Variant 4

Two rasters, two bands

```
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
```

See Also

rastbandarg, ST_Union, ST_MapAlgebra

9.11.1.5 ST_MapAlgebra

ST_MapAlgebra — Expression version - Returns a one-band raster given one or two input rasters, band indexes and one or more user-specified SQL expressions.

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);

Description

Expression version - Returns a one-band raster given one or two input rasters, band indexes and one or more user-specified SQL expressions.

Availability: 2.1.0

Description: Variants 1 and 2 (one raster)

Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation defined by the `expression` on the input raster (`rast`). If `nband` is not provided, band 1 is assumed. The new raster will have the same georeference, width, and height as the original raster but will only have one band.

If `pixeltype` is passed in, then the new raster will have a band of that pixeltype. If pixeltype is passed NULL, then the new raster band will have the same pixeltype as the input `rast` band.

- Keywords permitted for `expression`
  1. `[rast]` - Pixel value of the pixel of interest
  2. `[rast.val]` - Pixel value of the pixel of interest
  3. `[rast.x]` - 1-based pixel column of the pixel of interest
  4. `[rast.y]` - 1-based pixel row of the pixel of interest

Description: Variants 3 and 4 (two raster)

Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation to the two bands defined by the `expression` on the two input raster bands `rast1`, (`rast2`). If no `band1`, `band2` is specified band 1 is assumed. The resulting raster will be aligned (scale, skew and pixel corners) on the grid defined by the first raster. The resulting raster will have the extent defined by the `extenttype` parameter.

expression A PostgreSQL algebraic expression involving the two rasters and PostgreSQL defined functions/operators that will define the pixel value when pixels intersect. e.g. (([rast1] + [rast2])/2.0)::integer

pixeltype The resulting pixel type of the output raster. Must be one listed in ST_BandPixelType, left out or set to NULL. If not passed in or set to NULL, will default to the pixeltype of the first raster.

extenttype Controls the extent of resulting raster

1. `INTERSECTION` - The extent of the new raster is the intersection of the two rasters. This is the default.
2. `UNION` - The extent of the new raster is the union of the two rasters.
3. `FIRST` - The extent of the new raster is the same as the one of the first raster.
4. `SECOND` - The extent of the new raster is the same as the one of the second raster.

nodata1expr An algebraic expression involving only `rast2` or a constant that defines what to return when pixels of `rast1` are nodata values and spatially corresponding rast2 pixels have values.

nodata2expr An algebraic expression involving only `rast1` or a constant that defines what to return when pixels of `rast2` are nodata values and spatially corresponding rast1 pixels have values.

nodatanodataval A numeric constant to return when spatially corresponding rast1 and rast2 pixels are both nodata values.

- Keywords permitted in `expression`, `nodata1expr` and `nodata2expr`
  1. `[rast1]` - Pixel value of the pixel of interest from `rast1`
  2. `[rast1.val]` - Pixel value of the pixel of interest from `rast1`
  3. `[rast1.x]` - 1-based pixel column of the pixel of interest from `rast1`
  4. `[rast1.y]` - 1-based pixel row of the pixel of interest from `rast1`
  5. `[rast2]` - Pixel value of the pixel of interest from `rast2`
  6. `[rast2.val]` - Pixel value of the pixel of interest from `rast2`
  7. `[rast2.x]` - 1-based pixel column of the pixel of interest from `rast2`
  8. `[rast2.y]` - 1-based pixel row of the pixel of interest from `rast2`

Examples: Variants 1 and 2

```
WITH foo AS (
  SELECT ST_AddBand(ST_MakeEmptyRaster(10, 10, 0, 0, 1, 1, 0, 0, 0), '32BF', 1, -1) AS rast
)
SELECT
  ST_MapAlgebra(rast, 1, NULL, 'ceil([rast]*[rast.x]/[rast.y]+[rast.val])')
FROM foo
```

Examples: Variant 3 and 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', 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,
    '([rast2] + [rast1.val]) / 2'
  ) AS rast
FROM foo t1
CROSS JOIN foo t2
WHERE t1.rid = 1
  AND t2.rid = 2
```

See Also

rastbandarg, ST_Union, ST_MapAlgebra

9.11.1.6 ST_MapAlgebraExpr

ST_MapAlgebraExpr — 1 raster band version: Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation on the input raster band and of pixeltype provided. Band 1 is assumed if no band is specified.

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);

Description

Warning
ST_MapAlgebraExpr is deprecated as of 2.1.0. Use ST_MapAlgebra instead.

Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation defined by the `expression` on the input raster (`rast`). If no `band` is specified band 1 is assumed. The new raster will have the same georeference, width, and height as the original raster but will only have one band.

If `pixeltype` is passed in, then the new raster will have a band of that pixeltype. If pixeltype is passed NULL, then the new raster band will have the same pixeltype as the input `rast` band.

In the expression you can use the term `[rast]` to refer to the pixel value of the original band, `[rast.x]` to refer to the 1-based pixel column index, `[rast.y]` to refer to the 1-based pixel row index.

Availability: 2.0.0

Examples

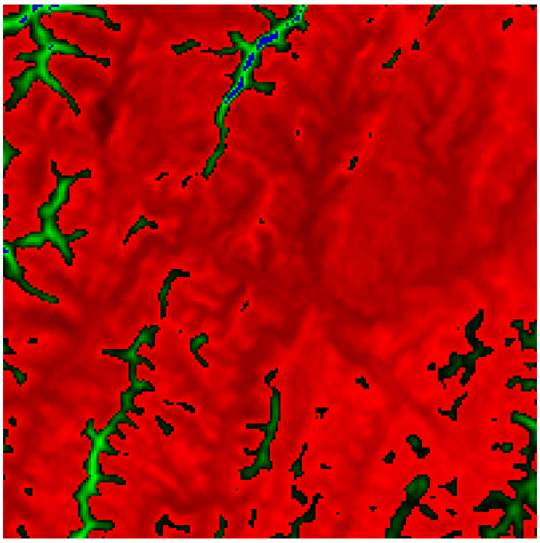
Create a new 1 band raster from our original that is a function of modulo 2 of the original raster band.

```
ALTER TABLE dummy_rast ADD COLUMN map_rast raster;
UPDATE dummy_rast SET map_rast = ST_MapAlgebraExpr(rast,NULL,'mod([rast],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
```

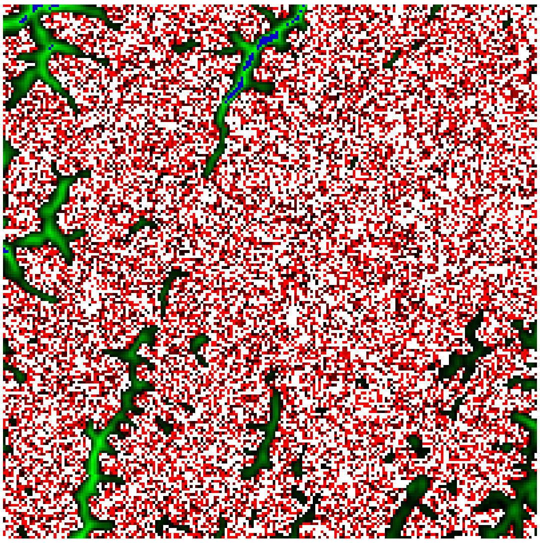
Create a new 1 band raster of pixel-type 2BUI from our original that is reclassified and set the nodata value to be 0.

```
ALTER TABLE dummy_rast ADD COLUMN map_rast2 raster;
UPDATE dummy_rast SET
  map_rast2 = ST_MapAlgebraExpr(rast,'2BUI','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', '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

Create a new 3 band raster same pixel type from our original 3 band raster with first band altered by map algebra and remaining 2 bands unaltered.

```
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;
```

See Also

ST_MapAlgebraExpr, ST_MapAlgebraFct, ST_BandPixelType, ST_GeoReference, ST_Value

9.11.1.7 ST_MapAlgebraExpr

ST_MapAlgebraExpr — 2 raster band version: Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation on the two input raster bands and of pixeltype provided. band 1 of each raster is assumed if no band numbers are specified. The resulting raster will be aligned (scale, skew and pixel corners) on the grid defined by the first raster and have its extent defined by the "extenttype" parameter. Values for "extenttype" can be: INTERSECTION, UNION, FIRST, SECOND.

Synopsis

raster **ST_MapAlgebraExpr**(raster rast1, raster rast2, text expression, text pixeltype=same_as_rast1_band, text extenttype=INTERSECT
text nodata1expr=NULL, text nodata2expr=NULL, double precision 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);

Description

Warning
ST_MapAlgebraExpr is deprecated as of 2.1.0. Use ST_MapAlgebra instead.

Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation to the two bands defined by the `expression` on the two input raster bands `rast1`, (`rast2`). If no `band1`, `band2` is specified band 1 is assumed. The resulting raster will be aligned (scale, skew and pixel corners) on the grid defined by the first raster. The resulting raster will have the extent defined by the `extenttype` parameter.

expression A PostgreSQL algebraic expression involving the two rasters and PostgreSQL defined functions/operators that will define the pixel value when pixels intersect. e.g. (([rast1] + [rast2])/2.0)::integer

pixeltype The resulting pixel type of the output raster. Must be one listed in ST_BandPixelType, left out or set to NULL. If not passed in or set to NULL, will default to the pixeltype of the first raster.

extenttype Controls the extent of resulting raster

1. `INTERSECTION` - The extent of the new raster is the intersection of the two rasters. This is the default.
2. `UNION` - The extent of the new raster is the union of the two rasters.
3. `FIRST` - The extent of the new raster is the same as the one of the first raster.
4. `SECOND` - The extent of the new raster is the same as the one of the second raster.

nodata1expr An algebraic expression involving only `rast2` or a constant that defines what to return when pixels of `rast1` are nodata values and spatially corresponding rast2 pixels have values.

nodata2expr An algebraic expression involving only `rast1` or a constant that defines what to return when pixels of `rast2` are nodata values and spatially corresponding rast1 pixels have values.

nodatanodataval A numeric constant to return when spatially corresponding rast1 and rast2 pixels are both nodata values.

If `pixeltype` is passed in, then the new raster will have a band of that pixeltype. If pixeltype is passed NULL or no pixel type specified, then the new raster band will have the same pixeltype as the input `rast1` band.

Use the term `[rast1.val]` `[rast2.val]` to refer to the pixel value of the original raster bands and `[rast1.x]`, `[rast1.y]` etc. to refer to the column / row positions of the pixels.

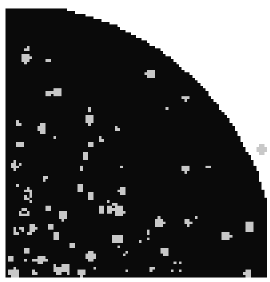
Availability: 2.0.0

Example: 2 Band Intersection and Union

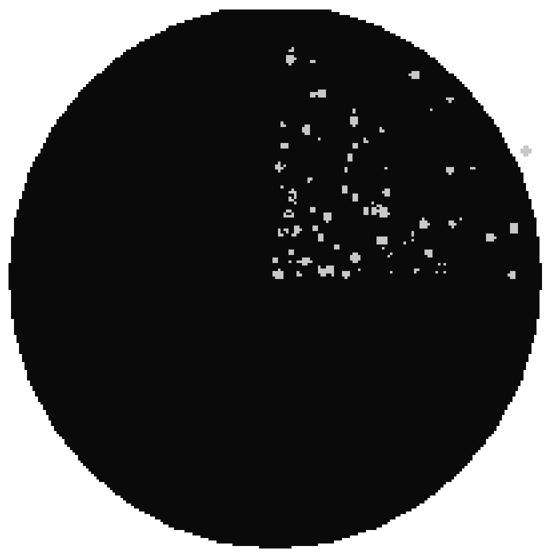
Create a new 1 band raster from our original that is a function of modulo 2 of the original raster band.

```
--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
```



mapalgebra intersection

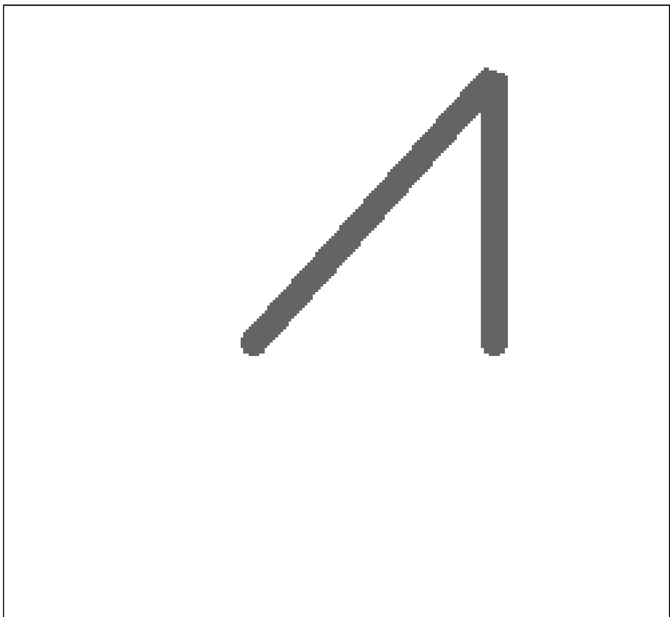


map algebra union

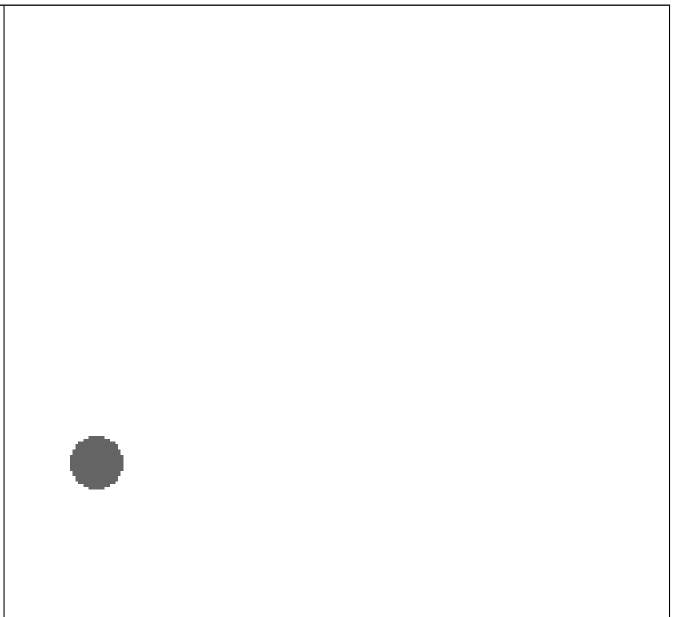
Example: Overlaying rasters on a canvas as separate bands

```
-- we use ST_AsPNG to render the image so all single band ones look grey --
```

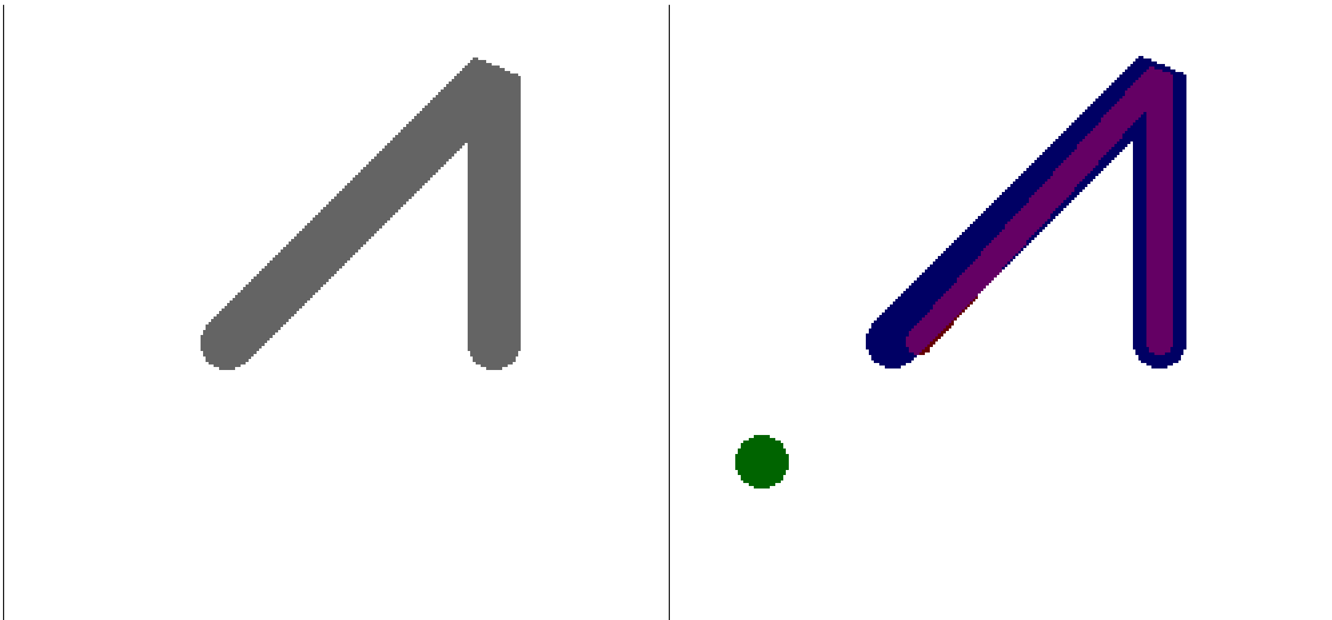
```
WITH mygeoms
    AS ( SELECT 2 As bnum, ST_Buffer(ST_Point(1,5),10) As geom
            UNION ALL
            SELECT 3 AS bnum,
                ST_Buffer(ST_GeomFromText('LINESTRING(50 50,150 150,150 50)'), 10,'join= ↩
                    bevel') As geom
            UNION ALL
            SELECT 1 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



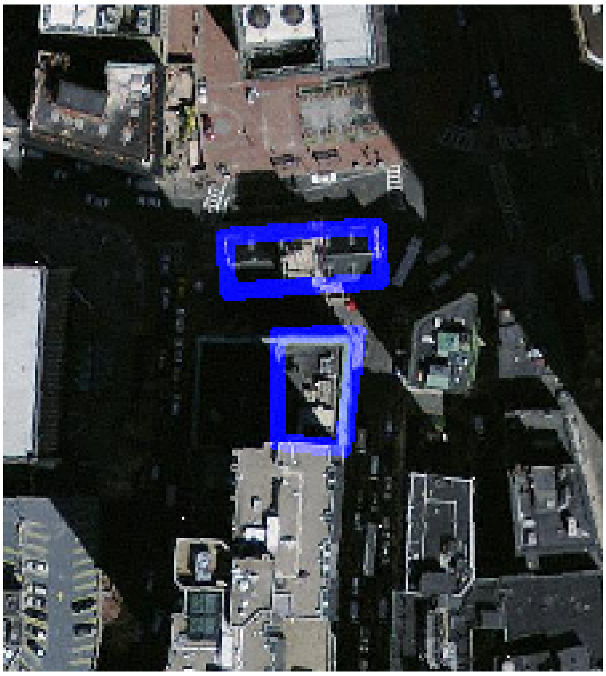
rast2



rast3 *final_rast*

Example: Overlay 2 meter boundary of select parcels over an aerial imagery

```
-- 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(the_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;
```



The blue lines are the boundaries of select parcels

See Also

ST_MapAlgebraExpr, ST_AddBand, ST_AsPNG, ST_AsRaster, ST_MapAlgebraFct, ST_BandPixelType, ST_GeoReference, ST_Value, ST_Union, ST_Union

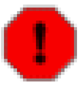
9.11.1.8 ST_MapAlgebraFct

ST_MapAlgebraFct — 1 band version - Creates a new one band raster formed by applying a valid PostgreSQL function on the input raster band and of pixeltype prodived. Band 1 is assumed if no band is specified.

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);

Description



Warning
ST_MapAlgebraFct is deprecated as of 2.1.0. Use ST_MapAlgebra instead.

Creates a new one band raster formed by applying a valid PostgreSQL function specified by the onerasteruserfunc on the input raster (rast). If no band is specified, band 1 is assumed. The new raster will have the same georeference, width, and height as the original raster but will only have one band.

If pixeltype is passed in, then the new raster will have a band of that pixeltype. If pixeltype is passed NULL, then the new raster band will have the same pixeltype as the input rast band.

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.

The third argument to the userfunction is a variadic text array. All trailing text arguments to any ST_MapAlgebraFct call are passed through to the specified userfunction, and are contained in the args argument.

> **Note**
> For more information about the VARIADIC keyword, please refer to the PostgreSQL documentation and the "SQL Functions with Variable Numbers of Arguments" section of Query Language (SQL) Functions.

> **Note**
> The text[] argument to the userfunction is required, regardless of whether you choose to pass any arguments to your user function for processing or not.

Availability: 2.0.0

Examples

Create a new 1 band raster from our original that is a function of modulo 2 of the original raster band.

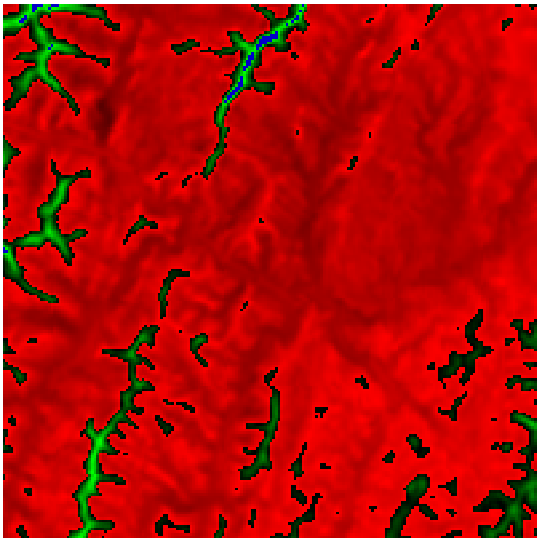
```
ALTER TABLE dummy_rast ADD COLUMN map_rast raster;
CREATE FUNCTION mod_fct(pixel float, pos integer[], variadic args text[])
RETURNS float
AS $$
BEGIN
    RETURN pixel::integer % 2;
END;
$$
```

```
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
```

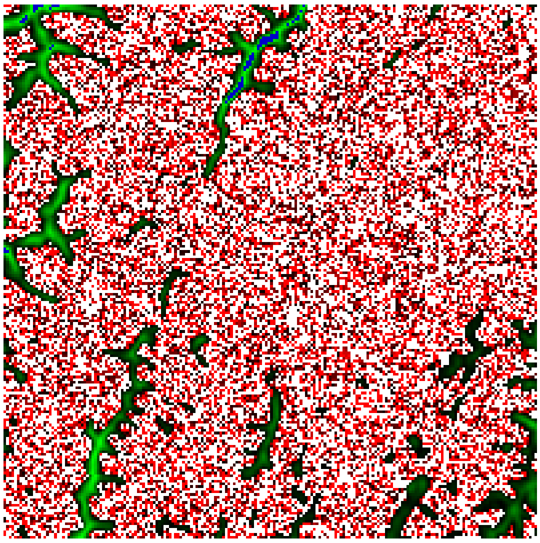
Create a new 1 band raster of pixel-type 2BUI from our original that is reclassified and set the nodata value to a passed parameter to the user function (0).

```
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
```



original (column rast-view)



rast_view_ma

Create a new 3 band raster same pixel type from our original 3 band raster with first band altered by map algebra and remaining 2 bands unaltered.

```
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;
```

See Also

ST_MapAlgebraExpr, ST_BandPixelType, ST_GeoReference, ST_SetValue

9.11.1.9 ST_MapAlgebraFct

ST_MapAlgebraFct — 2 band version - Creates a new one band raster formed by applying a valid PostgreSQL function on the 2 input raster bands and of pixeltype prodived. Band 1 is assumed if no band is specified. Extent type defaults to INTERSECTION if not specified.

Synopsis

raster **ST_MapAlgebraFct**(raster rast1, raster rast2, regprocedure tworastuserfunc, text pixeltype=same_as_rast1, 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);

Description

Warning
ST_MapAlgebraFct is deprecated as of 2.1.0. Use ST_MapAlgebra instead.

Creates a new one band raster formed by applying a valid PostgreSQL function specified by the `tworastuserfunc` on the input raster `rast1`, `rast2`. If no `band1` or `band2` is specified, band 1 is assumed. The new raster will have the same georeference, width, and height as the original rasters but will only have one band.

If `pixeltype` is passed in, then the new raster will have a band of that pixeltype. If pixeltype is passed NULL or left out, then the new raster band will have the same pixeltype as the input `rast1` band.

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 third 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
For more information about the VARIADIC keyword, please refer to the PostgreSQL documentation and the "SQL Functions with Variable Numbers of Arguments" section of Query Language (SQL) Functions.

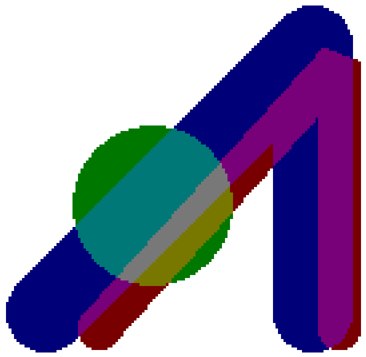
Note
The text[] argument to the `tworastuserfunc` is required, regardless of whether you choose to pass any arguments to your user function for processing or not.

Availability: 2.0.0

Example: Overlaying rasters on a canvas as separate bands

```
-- 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;
```

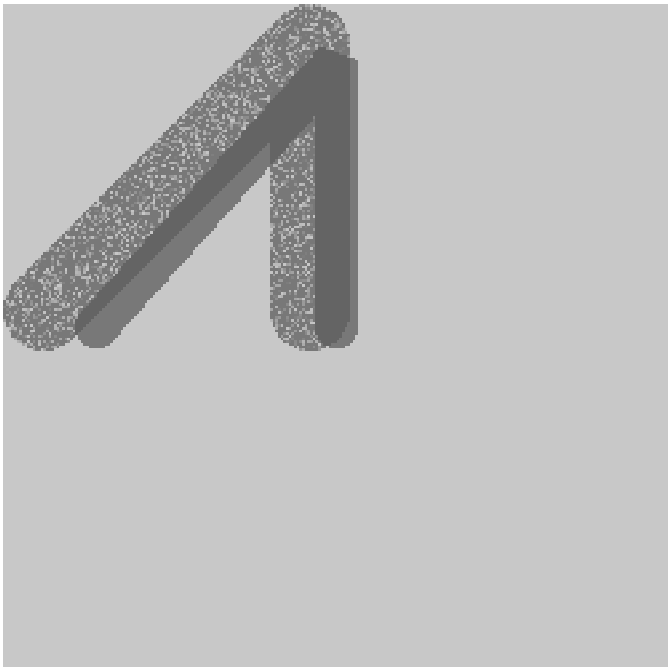


map bands overlay (canvas) (R: small road, G: circle, B: big road)

User Defined function that takes extra args

```
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)';
```



user defined with extra args and different bands from same raster

See Also

ST_MapAlgebraExpr, ST_BandPixelType, ST_GeoReference, ST_SetValue

9.11.1.10 ST_MapAlgebraFctNgb

ST_MapAlgebraFctNgb — 1-band version: Map Algebra Nearest Neighbor using user-defined PostgreSQL function. Return a raster which values are the result of a PLPGSQL user function involving a neighborhood of values from the input raster band.

Synopsis

raster **ST_MapAlgebraFctNgb**(raster rast, integer band, text pixeltype, integer ngbwidth, integer ngbheight, regprocedure onerastngbuserfunc, text nodatamode, text[] VARIADIC args);

Description

> **Warning**
> ST_MapAlgebraFctNgb is deprecated as of 2.1.0. Use ST_MapAlgebra instead.

(one raster version) Return a raster which values are the result of a PLPGSQL user function involving a neighborhood of values from the input raster band. The user function takes the neighborhood of pixel values as an array of numbers, for each pixel, returns the result from the user function, replacing pixel value of currently inspected pixel with the function result.

rast Raster on which the user function is evaluated.

band Band number of the raster to be evaluated. Default to 1.

pixeltype The resulting pixel type of the output raster. Must be one listed in ST_BandPixelType or left out or set to NULL. If not passed in or set to NULL, will default to the pixeltype of the `rast`. Results are truncated if they are larger than what is allowed for the pixeltype.

ngbwidth The width of the neighborhood, in cells.

ngbheight The height of the neighborhood, in cells.

onerastngbuserfunc PLPGSQL/psql user function to apply to neighborhood pixels of a single band of a raster. The first element is a 2-dimensional array of numbers representing the rectangular pixel neighborhood

nodatamode Defines what value to pass to the function for a neighborhood pixel that is nodata or NULL

'ignore': any NODATA values encountered in the neighborhood are ignored by the computation -- this flag must be sent to the user callback function, and the user function decides how to ignore it.

'NULL': any NODATA values encountered in the neighborhood will cause the resulting pixel to be NULL -- the user callback function is skipped in this case.

'value': any NODATA values encountered in the neighborhood are replaced by the reference pixel (the one in the center of the neighborhood). Note that if this value is NODATA, the behavior is the same as 'NULL' (for the affected neighborhood)

args Arguments to pass into the user function.

Availability: 2.0.0

Examples

Examples utilize the katrina raster loaded as a single tile described in http://trac.osgeo.org/gdal/wiki/frmts_wtkraster.html and then prepared in the ST_Rescale examples

```
--
-- 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;
```

First band of our raster

new raster after averaging pixels withing 4x4 pixels of each other

See Also

ST_MapAlgebraFct, ST_MapAlgebraExpr, ST_Rescale

9.11.1.11 ST_Reclass

ST_Reclass — Creates a new raster composed of band types reclassified from original. The nband is the band to be changed. If nband is not specified assumed to be 1. All other bands are returned unchanged. Use case: convert a 16BUI band to a 8BUI and so forth for simpler rendering as viewable formats.

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);

Description

Creates a new raster formed by applying a valid PostgreSQL algebraic operation defined by the `reclassexpr` on the input raster (`rast`). If no `band` is specified band 1 is assumed. The new raster will have the same georeference, width, and height as the original raster. Bands not designated will come back unchanged. Refer to reclassarg for description of valid reclassification expressions.

The bands of the new raster will have pixel type of `pixeltype`. If `reclassargset` is passed in then each reclassarg defines behavior of each band generated.

Availability: 2.0.0

Examples Basic

Create a new raster from the original where band 2 is converted from 8BUI to 4BUI and all values from 101-254 are set to nodata value.

```
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
```

Example: Advanced using multiple reclassargs

Create a new raster from the original where band 1,2,3 is converted to 1BB,4BUI, 4BUI respectively and reclassified. Note this uses the variadic `reclassarg` argument which can take as input an indefinite number of reclassargs (theoretically as many bands as you have)

```
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
```

Example: Advanced Map a single band 32BF raster to multiple viewable bands

Create a new 3 band (8BUI,8BUI,8BUI viewable raster) from a raster that has only one 32bf band

```
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)
          ]
          );
```

See Also

ST_AddBand, ST_Band, ST_BandPixelType, ST_MakeEmptyRaster, reclassarg, ST_Value

9.11.1.12 ST_Union

ST_Union — Returns the union of a set of raster tiles into a single raster composed of 1 or more bands.

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);

Description

Returns the union of a set of raster tiles into a single raster composed of at least one band. The resulting raster's extent is the extent of the whole set. In the case of intersection, the resulting value is defined by `uniontype` which is one of the following: LAST (default), FIRST, MIN, MAX, COUNT, SUM, MEAN, RANGE.

> **Note**
> In order for rasters to be unioned, they most 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.

Availability: 2.0.0

Enhanced: 2.1.0 Improved Speed (fully C-Based).

Availability: 2.1.0 ST_Union(rast, unionarg) variant was introduced.

Enhanced: 2.1.0 ST_Union(rast) (variant 1) unions all bands of all input rasters. Prior versions of PostGIS assumed the first band.

Enhanced: 2.1.0 ST_Union(rast, uniontype) (variant 4) unions all bands of all input rasters.

Examples: Reconstitute a single band chunked raster tile

```
-- 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;
```

Examples: Return a multi-band raster that is the union of tiles intersecting geometry

```
-- 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) ↩
     );
```

Examples: Return a multi-band raster that is the union of tiles intersecting geometry

Here we use the longer syntax if we only wanted a subset of bands or we want to change order of bands

```
-- 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) ↩
     );
```

See Also

unionarg, ST_Envelope, ST_ConvexHull, ST_Clip, ST_Union

9.11.2 Built-in Map Algebra Callback Functions

9.11.2.1 ST_Distinct4ma

ST_Distinct4ma — Raster processing function that calculates the number of unique pixel values in a neighborhood.

Synopsis

float8 **ST_Distinct4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Distinct4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

Description

Calculate the number of unique pixel values in a neighborhood of pixels.

Note
Variant 1 is a specialized callback function for use as a callback parameter to ST_MapAlgebraFctNgb.

Note
Variant 2 is a specialized callback function for use as a callback parameter to ST_MapAlgebra.

Warning
Use of Variant 1 is discouraged since ST_MapAlgebraFctNgb has been deprecated as of 2.1.0.

Availability: 2.0.0

Enhanced: 2.1.0 Addition of Variant 2

Examples

```
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)
```

See Also

ST_MapAlgebraFctNgb, ST_MapAlgebra, ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Distinct4ma, ST_StdDev4ma

9.11.2.2 ST_InvDistWeight4ma

ST_InvDistWeight4ma — Raster processing function that interpolates a pixel's value from the pixel's neighborhood.

Synopsis

double precision **ST_InvDistWeight4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

Description

Calculate an interpolated value for a pixel using the Inverse Distance Weighted method.

There are two optional parameters that can be passed through `userargs`. The first parameter is the power factor (variable k in the equation below) between 0 and 1 used in the Inverse Distance Weighted equation. If not specified, default value is 1. The second parameter is the weight percentage applied only when the value of the pixel of interest is included with the interpolated value from the neighborhood. If not specified and the pixel of interest has a value, that value is returned.

The basic inverse distance weight equation is:

$$\hat{z}(x_o) = \frac{\sum_{j=1}^{m} z(x_j) d_{ij}^{-k}}{\sum_{j=1}^{m} d_{ij}^{-k}}$$

k = power factor, a real number between 0 and 1

> **Note**
> This function is a specialized callback function for use as a callback parameter to ST_MapAlgebra.

Availability: 2.1.0

Examples

```
-- NEEDS EXAMPLE
```

See Also

ST_MapAlgebra, ST_MinDist4ma

9.11.2.3 ST_Max4ma

ST_Max4ma — Raster processing function that calculates the maximum pixel value in a neighborhood.

Synopsis

float8 **ST_Max4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Max4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

Description

Calculate the maximum pixel value in a neighborhood of pixels.

For Variant 2, a substitution value for NODATA pixels can be specified by passing that value to userargs.

Note
Variant 1 is a specialized callback function for use as a callback parameter to ST_MapAlgebraFctNgb.

Note
Variant 2 is a specialized callback function for use as a callback parameter to ST_MapAlgebra.

Warning
Use of Variant 1 is discouraged since ST_MapAlgebraFctNgb has been deprecated as of 2.1.0.

Availability: 2.0.0

Enhanced: 2.1.0 Addition of Variant 2

Examples

```
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)
```

See Also

ST_MapAlgebraFctNgb, ST_MapAlgebra, ST_Min4ma, ST_Sum4ma, ST_Mean4ma, ST_Range4ma, ST_Distinct4ma, ST_StdDev4ma

9.11.2.4 ST_Mean4ma

ST_Mean4ma — Raster processing function that calculates the mean pixel value in a neighborhood.

Synopsis

float8 **ST_Mean4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Mean4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

Description

Calculate the mean pixel value in a neighborhood of pixels.

For Variant 2, a substitution value for NODATA pixels can be specified by passing that value to userargs.

Note
Variant 1 is a specialized callback function for use as a callback parameter to ST_MapAlgebraFctNgb.

Note
Variant 2 is a specialized callback function for use as a callback parameter to ST_MapAlgebra.

Warning
Use of Variant 1 is discouraged since ST_MapAlgebraFctNgb has been deprecated as of 2.1.0.

Availability: 2.0.0

Enhanced: 2.1.0 Addition of Variant 2

Examples

```
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)
```

See Also

ST_MapAlgebraFctNgb, ST_MapAlgebra, ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Range4ma, ST_StdDev4ma

9.11.2.5 ST_Min4ma

ST_Min4ma — Raster processing function that calculates the minimum pixel value in a neighborhood.

Synopsis

float8 **ST_Min4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Min4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

Description

Calculate the minimum pixel value in a neighborhood of pixels.

For Variant 2, a substitution value for NODATA pixels can be specified by passing that value to userargs.

> **Note**
> Variant 1 is a specialized callback function for use as a callback parameter to ST_MapAlgebraFctNgb.

> **Note**
> Variant 2 is a specialized callback function for use as a callback parameter to ST_MapAlgebra.

> **Warning**
> Use of Variant 1 is discouraged since ST_MapAlgebraFctNgb has been deprecated as of 2.1.0.

Availability: 2.0.0

Enhanced: 2.1.0 Addition of Variant 2

Examples

```
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)
```

See Also

ST_MapAlgebraFctNgb, ST_MapAlgebra, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Range4ma, ST_Distinct4ma, ST_StdDev4m

9.11.2.6 ST_MinDist4ma

ST_MinDist4ma — Raster processing function that returns the minimum distance (in number of pixels) between the pixel of interest and a neighboring pixel with value.

Synopsis

double precision **ST_MinDist4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

Description

Return the shortest distance (in number of pixels) between the pixel of interest and the closest pixel with value in the neighborhood.

> **Note**
> The intent of this function is to provide an informative data point that helps infer the usefulness of the pixel of interest's interpolated value from ST_InvDistWeight4ma. This function is particularly useful when the neighborhood is sparsely populated.

> **Note**
> This function is a specialized callback function for use as a callback parameter to ST_MapAlgebra.

Availability: 2.1.0

Examples

```
-- NEEDS EXAMPLE
```

See Also

ST_MapAlgebra, ST_InvDistWeight4ma

9.11.2.7 ST_Range4ma

ST_Range4ma — Raster processing function that calculates the range of pixel values in a neighborhood.

Synopsis

float8 **ST_Range4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Range4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

Description

Calculate the range of pixel values in a neighborhood of pixels.

For Variant 2, a substitution value for NODATA pixels can be specified by passing that value to userargs.

> **Note**
> Variant 1 is a specialized callback function for use as a callback parameter to ST_MapAlgebraFctNgb.

> **Note**
> Variant 2 is a specialized callback function for use as a callback parameter to ST_MapAlgebra.

> **Warning**
> Use of Variant 1 is discouraged since ST_MapAlgebraFctNgb has been deprecated as of 2.1.0.

Availability: 2.0.0

Enhanced: 2.1.0 Addition of Variant 2

Examples

```
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)
```

See Also

ST_MapAlgebraFctNgb, ST_MapAlgebra, ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Distinct4ma, ST_StdDev4ma

9.11.2.8 ST_StdDev4ma

ST_StdDev4ma — Raster processing function that calculates the standard deviation of pixel values in a neighborhood.

Synopsis

float8 **ST_StdDev4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_StdDev4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

Description

Calculate the standard deviation of pixel values in a neighborhood of pixels.

> **Note**
> Variant 1 is a specialized callback function for use as a callback parameter to ST_MapAlgebraFctNgb.

> **Note**
> Variant 2 is a specialized callback function for use as a callback parameter to ST_MapAlgebra.

> **Warning**
> Use of Variant 1 is discouraged since ST_MapAlgebraFctNgb has been deprecated as of 2.1.0.

Availability: 2.0.0

Enhanced: 2.1.0 Addition of Variant 2

Examples

```
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)
```

See Also

ST_MapAlgebraFctNgb, ST_MapAlgebra, ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Distinct4ma, ST_StdDev4ma

9.11.2.9 ST_Sum4ma

ST_Sum4ma — Raster processing function that calculates the sum of all pixel values in a neighborhood.

Synopsis

float8 **ST_Sum4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Sum4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

Description

Calculate the sum of all pixel values in a neighborhood of pixels.

For Variant 2, a substitution value for NODATA pixels can be specified by passing that value to userargs.

> **Note**
> Variant 1 is a specialized callback function for use as a callback parameter to ST_MapAlgebraFctNgb.

> **Note**
> Variant 2 is a specialized callback function for use as a callback parameter to ST_MapAlgebra.

> **Warning**
> Use of Variant 1 is discouraged since ST_MapAlgebraFctNgb has been deprecated as of 2.1.0.

Availability: 2.0.0

Enhanced: 2.1.0 Addition of Variant 2

Examples

```
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)
```

See Also

ST_MapAlgebraFctNgb, ST_MapAlgebra, ST_Min4ma, ST_Max4ma, ST_Mean4ma, ST_Range4ma, ST_Distinct4ma, ST_StdDev4ma

9.11.3 DEM (Elevation)

9.11.3.1 ST_Aspect

ST_Aspect — Returns the aspect (in degrees by default) of an elevation raster band. Useful for analyzing terrain.

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);

Description

Returns the aspect (in degrees by default) of an elevation raster band. Utilizes map algebra and applies the aspect equation to neighboring pixels.

`units` indicates the units of the aspect. Possible values are: RADIANS, DEGREES (default).

When `units` = RADIANS, values are between 0 and 2 * pi radians measured clockwise from North.

When `units` = DEGREES, values are between 0 and 360 degrees measured clockwise from North.

If slope of pixel is zero, aspect of pixel is -1.

Note
For more information about Slope, Aspect and Hillshade, please refer to ESRI - How hillshade works and ERDAS Field Guide - Aspect Images.

Availability: 2.0.0

Enhanced: 2.1.0 Uses ST_MapAlgebra() and added optional `interpolate_nodata` function parameter

Changed: 2.1.0 In prior versions, return values were in radians. Now, return values default to degrees

Examples: Variant 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)
```

Examples: Variant 2

Complete example of tiles of a coverage. This query only works with PostgreSQL 9.1 or higher.

```
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;
```

See Also

ST_MapAlgebra, ST_TRI, ST_TPI, ST_Roughness, ST_HillShade, ST_Slope

9.11.3.2 ST_HillShade

ST_HillShade — Returns the hypothetical illumination of an elevation raster band using provided azimuth, altitude, brightness and scale inputs.

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);

Description

Returns the hypothetical illumination of an elevation raster band using the azimuth, altitude, brightness, and scale inputs. Utilizes map algebra and applies the hill shade equation to neighboring pixels. Return pixel values are between 0 and 255.

`azimuth` is a value between 0 and 360 degrees measured clockwise from North.

`altitude` is a value between 0 and 90 degrees where 0 degrees is at the horizon and 90 degrees is directly overhead.

`max_bright` is a value between 0 and 255 with 0 as no brightness and 255 as max brightness.

`scale` is the ratio of vertical units to horizontal. For Feet:LatLon use scale=370400, for Meters:LatLon use scale=111120.

If `interpolate_nodata` is TRUE, values for NODATA pixels from the input raster will be interpolated using ST_InvDistWeight4ma before computing the hillshade illumination.

> **Note**
> For more information about Hillshade, please refer to How hillshade works.

Availability: 2.0.0

Enhanced: 2.1.0 Uses ST_MapAlgebra() and added optional `interpolate_nodata` function parameter

Changed: 2.1.0 In prior versions, azimuth and altitude were expressed in radians. Now, azimuth and altitude are expressed in degrees

Examples: Variant 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)
```

Examples: Variant 2

Complete example of tiles of a coverage. This query only works with PostgreSQL 9.1 or higher.

```
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;
```

See Also

ST_MapAlgebra, ST_TRI, ST_TPI, ST_Roughness, ST_Aspect, ST_Slope

9.11.3.3 ST_Roughness

ST_Roughness — Returns a raster with the calculated "roughness" of a DEM.

Synopsis

raster **ST_Roughness**(raster rast, integer nband, raster customextent, text pixeltype="32BF" , boolean interpolate_nodata=FALSE);

Description

Calculates the "roughness" of a DEM, by subtracting the maximum from the minimum for a given area.

Availability: 2.1.0

Examples

```
-- needs examples
```

See Also

ST_MapAlgebra, ST_TRI, ST_TPI, ST_Slope, ST_HillShade, ST_Aspect

9.11.3.4 ST_Slope

ST_Slope — Returns the slope (in degrees by default) of an elevation raster band. Useful for analyzing terrain.

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);

Description

Returns the slope (in degrees by default) of an elevation raster band. Utilizes map algebra and applies the slope equation to neighboring pixels.

`units` indicates the units of the slope. Possible values are: RADIANS, DEGREES (default), PERCENT.

`scale` is the ratio of vertical units to horizontal. For Feet:LatLon use scale=370400, for Meters:LatLon use scale=111120.

If `interpolate_nodata` is TRUE, values for NODATA pixels from the input raster will be interpolated using ST_InvDistWeight4ma before computing the surface slope.

> **Note**
> For more information about Slope, Aspect and Hillshade, please refer to ESRI - How hillshade works and ERDAS Field Guide - Slope Images.

Availability: 2.0.0

Enhanced: 2.1.0 Uses ST_MapAlgebra() and added optional `units`, `scale`, `interpolate_nodata` function parameters

Changed: 2.1.0 In prior versions, return values were in radians. Now, return values default to degrees

Examples: Variant 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)
```

Examples: Variant 2

Complete example of tiles of a coverage. This query only works with PostgreSQL 9.1 or higher.

```
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;
```

See Also

ST_MapAlgebra, ST_TRI, ST_TPI, ST_Roughness, ST_HillShade, ST_Aspect

9.11.3.5 ST_TPI

ST_TPI — Returns a raster with the calculated Topographic Position Index.

Synopsis

raster **ST_TPI**(raster rast, integer nband, raster customextent, text pixeltype="32BF" , boolean interpolate_nodata=FALSE);

Description

Calculates the Topographic Position Index, which is defined as the folcal mean with radius of one minus the center cell.

Note
This function only supports a focalmean radius of one.

Availability: 2.1.0

Examples

```
-- needs examples
```

See Also

ST_MapAlgebra, ST_TRI, ST_Roughness, ST_Slope, ST_HillShade, ST_Aspect

9.11.3.6 ST_TRI

ST_TRI — Returns a raster with the calculated Terrain Ruggedness Index.

Synopsis

raster **ST_TRI**(raster rast, integer nband, raster customextent, text pixeltype="32BF" , boolean interpolate_nodata=FALSE);

Description

Terrain Ruggedness Index is calculated by comparing a central pixel with its neighbors, taking the absolute values of the differences, and averaging the result.

> **Note**
> This function only supports a focalmean radius of one.

Availability: 2.1.0

Examples

```
-- needs examples
```

See Also

ST_MapAlgebra, ST_Roughness, ST_TPI, ST_Slope, ST_HillShade, ST_Aspect

9.11.4 Raster to Geometry

9.11.4.1 Box3D

Box3D — Returns the box 3d representation of the enclosing box of the raster.

Synopsis

box3d **Box3D**(raster rast);

Description

Returns the box representing the extent of the raster.

The polygon is defined by the corner points of the bounding box ((MINX, MINY), (MAXX, MAXY))

Changed: 2.0.0 In pre-2.0 versions, there used to be a box2d instead of box3d. Since box2d is a deprecated type, this was changed to box3d.

Examples

```
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)
```

See Also

ST_Envelope

9.11.4.2 ST_ConvexHull

ST_ConvexHull — Return the convex hull geometry of the raster including pixel values equal to BandNoDataValue. For regular shaped and non-skewed rasters, this gives the same result as ST_Envelope so only useful for irregularly shaped or skewed rasters.

Synopsis

geometry **ST_ConvexHull**(raster rast);

Description

Return the convex hull geometry of the raster including the NoDataBandValue band pixels. For regular shaped and non-skewed rasters, this gives more or less the same result as ST_Envelope so only useful for irregularly shaped or skewed rasters.

> **Note**
> ST_Envelope floors the coordinates and hence add a little buffer around the raster so the answer is subtly different from ST_ConvexHull which does not floor.

Examples

Refer to PostGIS Raster Specification for a diagram of this.

```
-- 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) ↩
     )
```

See Also

ST_Envelope, ST_MinConvexHull, ST_ConvexHull, ST_AsText

9.11.4.3 ST_DumpAsPolygons

ST_DumpAsPolygons — Returns a set of geomval (geom,val) rows, from a given raster band. If no band number is specified, band num defaults to 1.

Synopsis

setof geomval **ST_DumpAsPolygons**(raster rast, integer band_num=1, boolean exclude_nodata_value=TRUE);

Description

This is a set-returning function (SRF). It returns a set of geomval rows, formed by a geometry (geom) and a pixel band value (val). Each polygon is the union of all pixels for that band that have the same pixel value denoted by val.

ST_DumpAsPolygon is useful for polygonizing rasters. It is the reverse of a GROUP BY in that it creates new rows. For example it can be used to expand a single raster into multiple POLYGONS/MULTIPOLYGONS.

Availability: Requires GDAL 1.7 or higher.

> **Note**
> If there is a no data value set for a band, pixels with that value will not be returned.

> **Note**
> If you only care about count of pixels with a given value in a raster, it is faster to use ST_ValueCount.

> **Note**
> This is different than ST_PixelAsPolygons where one geometry is returned for each pixel regardless of pixel value.

Examples

```
SELECT val, ST_AsText(geom) As geomwkt
FROM (
SELECT (ST_DumpAsPolygons(rast)).*
FROM dummy_rast
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))
```

See Also

geomval, ST_Value, ST_Polygon, ST_ValueCount

9.11.4.4 ST_Envelope

ST_Envelope — Returns the polygon representation of the extent of the raster.

Synopsis

geometry **ST_Envelope**(raster rast);

Description

Returns the polygon representation of the extent of the raster in spatial coordinate units defined by srid. It is a float8 minimum bounding box represented as a polygon.

The polygon is defined by the corner points of the bounding box ((`MINX`, `MINY`), (`MINX`, `MAXY`), (`MAXX`, `MAXY`), (`MAXX`, `MINY`), (`MINX`, `MINY`))

Examples

```
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))
```

See Also

ST_Envelope, ST_AsText, ST_SRID

9.11.4.5 ST_MinConvexHull

ST_MinConvexHull — Return the convex hull geometry of the raster excluding NODATA pixels.

Synopsis

geometry **ST_MinConvexHull**(raster rast, integer nband=NULL);

Description

Return the convex hull geometry of the raster excluding NODATA pixels. If `nband` is NULL, all bands of the raster are considered.

Availability: 2.1.0

Examples

```
WITH foo AS (
  SELECT
    ST_SetValues(
      ST_SetValues(
        ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(9, 9, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', 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))
```

See Also

ST_Envelope, ST_ConvexHull, ST_ConvexHull, ST_AsText

9.11.4.6 ST_Polygon

ST_Polygon — Returns a multipolygon geometry formed by the union of pixels that have a pixel value that is not no data value. If no band number is specified, band num defaults to 1.

Synopsis

geometry **ST_Polygon**(raster rast, integer band_num=1);

Description

Availability: 0.1.6 Requires GDAL 1.7 or higher.

Enhanced: 2.1.0 Improved Speed (fully C-Based) and the returning multipolygon is ensured to be valid.

Changed: 2.1.0 In prior versions would sometimes return a polygon, changed to always return multipolygon.

Examples

```
-- 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)))
```

See Also

ST_Value, ST_DumpAsPolygons

9.12 Raster Operators

9.12.1 &&

&& — Returns `TRUE` if A's bounding box intersects B's bounding box.

Synopsis

boolean **&&**(raster A , raster B);
boolean **&&**(raster A , geometry B);
boolean **&&**(geometry B , raster A);

Description

The `&&` operator returns `TRUE` if the bounding box of raster/geometr A intersects the bounding box of raster/geometr B.

> **Note**
> This operand will make use of any indexes that may be available on the rasters.

Availability: 2.0.0

Examples

```
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
```

9.12.2 &<

&< — Returns `TRUE` if A's bounding box is to the left of B's.

Synopsis

boolean **&<**(raster A , raster B);

Description

The `&<` operator returns `TRUE` if the bounding box of raster A overlaps or is to the left of the bounding box of raster B, or more accurately, overlaps or is NOT to the right of the bounding box of raster B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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
```

9.12.3 &>

&> — Returns `TRUE` if A's bounding box is to the right of B's.

Synopsis

boolean **&>**(raster A , raster B);

Description

The `&>` operator returns `TRUE` if the bounding box of raster A overlaps or is to the right of the bounding box of raster B, or more accurately, overlaps or is NOT to the left of the bounding box of raster B.

> **Note**
> This operand will make use of any indexes that may be available on the geometries.

Examples

```
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
```

9.12.4 @

@ — Returns `TRUE` if A's bounding box is contained by B's. Uses double precision bounding box.

Synopsis

boolean @(raster A , raster B);
boolean @(geometry A , raster B);
boolean @(raster B , geometry A);

Description

The `@` operator returns `TRUE` if the bounding box of raster/geometry A is contained by bounding box of raster/geometr B.

Note
This operand will use spatial indexes on the rasters.

Availability: 2.0.0 raster @ raster, raster @ geometry introduced

Availability: 2.0.5 geometry @ raster introduced

See Also

~

9.12.5 =

= — Returns `TRUE` if A's bounding box is the same as B's. Uses double precision bounding box.

Synopsis

boolean =(raster A , raster B);

Description

The = operator returns `TRUE` if the bounding box of raster A is the same as the bounding box of raster B. PostgreSQL uses the =, <, and > operators defined for rasters to perform internal orderings and comparison of rasters (ie. in a GROUP BY or ORDER BY clause).

> **Caution**
> This operand will NOT make use of any indexes that may be available on the rasters. Use ~= instead. This operator exists mostly so one can group by the raster column.

Availability: 2.1.0

See Also

~=

9.12.6 ~=

~= — Returns `TRUE` if A's bounding box is the same as B's.

Synopsis

boolean **~=**(raster A , raster B);

Description

The `~=` operator returns `TRUE` if the bounding box of raster A is the same as the bounding box of raster B.

> **Note**
> This operand will make use of any indexes that may be available on the rasters.

Availability: 2.0.0

Examples

Very useful usecase is for taking two sets of single band rasters that are of the same chunk but represent different themes and creating a multi-band raster

```
SELECT ST_AddBand(prec.rast, alt.rast) As new_rast
    FROM prec INNER JOIN alt ON (prec.rast ~= alt.rast);
```

See Also

ST_AddBand, =

9.12.7 ~

~ — Returns `TRUE` if A's bounding box is contains B's. Uses double precision bounding box.

Synopsis

boolean ~(raster A , raster B);
boolean ~(geometry A , raster B);
boolean ~(raster B , geometry A);

Description

The ~ operator returns `TRUE` if the bounding box of raster/geometry A is contains bounding box of raster/geometr B.

> **Note**
> This operand will use spatial indexes on the rasters.

Availability: 2.0.0

See Also

@

9.13 Raster and Raster Band Spatial Relationships

9.13.1 ST_Contains

ST_Contains — Return true if no points of raster rastB lie in the exterior of raster rastA and at least one point of the interior of rastB lies in the interior of rastA.

Synopsis

boolean **ST_Contains**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Contains**(raster rastA , raster rastB);

Description

Raster rastA contains rastB if and only if no points of rastB lie in the exterior of rastA and at least one point of the interior of rastB lies in the interior of rastA. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

> **Note**
> This function will make use of any indexes that may be available on the rasters.

> **Note**
> To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_Contains(ST_Polygon(raster), geometry) or ST_Contains(geometry, ST_Polygon(raster)).

> **Note**
> ST_Contains() is the inverse of ST_Within(). So, ST_Contains(rastA, rastB) implies ST_Within(rastB, rastA).

Availability: 2.1.0

Examples

```
-- 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
```

See Also

ST_Intersects, ST_Within

9.13.2 ST_ContainsProperly

ST_ContainsProperly — Return true if rastB intersects the interior of rastA but not the boundary or exterior of rastA.

Synopsis

boolean **ST_ContainsProperly**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_ContainsProperly**(raster rastA , raster rastB);

Description

Raster rastA contains properly rastB if rastB intersects the interior of rastA but not the boundary or exterior of rastA. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

Raster rastA does not contain properly itself but does contain itself.

> **Note**
> This function will make use of any indexes that may be available on the rasters.

Note
To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_ContainsProperly(ST_Polygon(raster), geometry) or ST_ContainsProperly(geometry, ST_Polygon(raster)).

Availability: 2.1.0

Examples

```
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
```

See Also

ST_Intersects, ST_Contains

9.13.3 ST_Covers

ST_Covers — Return true if no points of raster rastB lie outside raster rastA.

Synopsis

boolean **ST_Covers**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Covers**(raster rastA , raster rastB);

Description

Raster rastA covers rastB if and only if no points of rastB lie in the exterior of rastA. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

Note
This function will make use of any indexes that may be available on the rasters.

Note
To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_Covers(ST_Polygon(raster), geometry) or ST_Covers(geometry, ST_Polygon(raster)).

Availability: 2.1.0

Examples

```
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
```

See Also

ST_Intersects, ST_CoveredBy

9.13.4 ST_CoveredBy

ST_CoveredBy — Return true if no points of raster rastA lie outside raster rastB.

Synopsis

boolean **ST_CoveredBy**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_CoveredBy**(raster rastA , raster rastB);

Description

Raster rastA is covered by rastB if and only if no points of rastA lie in the exterior of rastB. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

> **Note**
> This function will make use of any indexes that may be available on the rasters.

> **Note**
> To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_CoveredBy(ST_Polygon(raster), geometry) or ST_CoveredBy(geometry, ST_Polygon(raster)).

Availability: 2.1.0

Examples

```
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
```

See Also

ST_Intersects, ST_Covers

9.13.5 ST_Disjoint

ST_Disjoint — Return true if raster rastA does not spatially intersect rastB.

Synopsis

boolean **ST_Disjoint**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Disjoint**(raster rastA , raster rastB);

Description

Raster rastA and rastB are disjointed if they do not share any space together. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

> **Note**
> This function does NOT use any indexes.

> **Note**
> To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_Disjoint(ST_Polygon(raster), geometry).

Availability: 2.1.0

Examples

```
-- 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
```

See Also

ST_Intersects

9.13.6 ST_Intersects

ST_Intersects — Return true if raster rastA spatially intersects raster 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);

Description

Return true if raster rastA spatially intersects raster rastB. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

Note
This function will make use of any indexes that may be available on the rasters.

Enhanced: 2.0.0 support raster/raster intersects was introduced.

Warning
Changed: 2.1.0 The behavior of the ST_Intersects(raster, geometry) variants changed to match that of ST_Intersects(geometry, raster).

Examples

```
-- different bands of same raster
SELECT ST_Intersects(rast, 2, rast, 3) FROM dummy_rast WHERE rid = 2;

 st_intersects
---------------
 t
```

See Also

ST_Intersection, ST_Disjoint

9.13.7 ST_Overlaps

ST_Overlaps — Return true if raster rastA and rastB intersect but one does not completely contain the other.

Synopsis

boolean **ST_Overlaps**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Overlaps**(raster rastA , raster rastB);

Description

Return true if raster rastA spatially overlaps raster rastB. This means that rastA and rastB intersect but one does not completely contain the other. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

> **Note**
> This function will make use of any indexes that may be available on the rasters.

> **Note**
> To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_Overlaps(ST_Polygon(raster), geometry).

Availability: 2.1.0

Examples

```
-- comparing different bands of same raster
SELECT ST_Overlaps(rast, 1, rast, 2) FROM dummy_rast WHERE rid = 2;

 st_overlaps
-------------
 f
```

See Also

ST_Intersects

9.13.8 ST_Touches

ST_Touches — Return true if raster rastA and rastB have at least one point in common but their interiors do not intersect.

Synopsis

boolean **ST_Touches**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Touches**(raster rastA , raster rastB);

Description

Return true if raster rastA spatially touches raster rastB. This means that rastA and rastB have at least one point in common but their interiors do not intersect. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

> **Note**
> This function will make use of any indexes that may be available on the rasters.

> **Note**
> To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_Touches(ST_Polygon(raster), geometry).

Availability: 2.1.0

Examples

```
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
```

See Also

ST_Intersects

9.13.9 ST_SameAlignment

ST_SameAlignment — Returns true if rasters have same skew, scale, spatial ref, and offset (pixels can be put on same grid without cutting into pixels) and false if they don't with notice detailing issue.

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);

Description

Non-Aggregate version (Variants 1 and 2): Returns true if the two rasters (either provided directly or made using the values for upperleft, scale, skew and srid) have the same scale, skew, srid and at least one of any of the four corners of any pixel of one raster falls on any corner of the grid of the other raster. Returns false if they don't and a NOTICE detailing the alignment issue.

Aggregate version (Variant 3): From a set of rasters, returns true if all rasters in the set are aligned. The ST_SameAlignment() 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.

Availability: 2.0.0

Enhanced: 2.1.0 addition of Aggegrate variant

Examples: Rasters

```
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
```

See Also

Section 5.1, ST_NotSameAlignmentReason, ST_MakeEmptyRaster

9.13.10 ST_NotSameAlignmentReason

ST_NotSameAlignmentReason — Returns text stating if rasters are aligned and if not aligned, a reason why.

Synopsis

text **ST_NotSameAlignmentReason**(raster rastA, raster rastB);

Description

Returns text stating if rasters are aligned and if not aligned, a reason why.

Note
If there are several reasons why the rasters are not aligned, only one reason (the first test to fail) will be returned.

Availability: 2.1.0

Examples

```
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)
```

See Also

Section 5.1, ST_SameAlignment

9.13.11 ST_Within

ST_Within — Return true if no points of raster rastA lie in the exterior of raster rastB and at least one point of the interior of rastA lies in the interior of rastB.

Synopsis

boolean **ST_Within**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Within**(raster rastA , raster rastB);

Description

Raster rastA is within rastB if and only if no points of rastA lie in the exterior of rastB and at least one point of the interior of rastA lies in the interior of rastB. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

> **Note**
> This operand will make use of any indexes that may be available on the rasters.

> **Note**
> To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_Within(ST_Polygon(raster), geometry) or ST_Within(geometry, ST_Polygon(raster)).

> **Note**
> ST_Within() is the inverse of ST_Contains(). So, ST_Within(rastA, rastB) implies ST_Contains(rastB, rastA).

Availability: 2.1.0

Examples

```
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
```

See Also

ST_Intersects, ST_Contains, ST_DWithin, ST_DFullyWithin

9.13.12 ST_DWithin

ST_DWithin — Return true if rasters rastA and rastB are within the specified distance of each other.

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);

Description

Return true if rasters rastA and rastB are within the specified distance of each other. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

The distance is specified in units defined by the spatial reference system of the rasters. For this function to make sense, the source rasters must both be of the same coordinate projection, having the same SRID.

Note
This operand will make use of any indexes that may be available on the rasters.

Note
To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_DWithin(ST_Polygon(raster), geometry).

Availability: 2.1.0

Examples

```
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
```

See Also

ST_Within, ST_DFullyWithin

9.13.13 ST_DFullyWithin

ST_DFullyWithin — Return true if rasters rastA and rastB are fully within the specified distance of each other.

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);

Description

Return true if rasters rastA and rastB are fully within the specified distance of each other. If the band number is not provided (or set to NULL), only the convex hull of the raster is considered in the test. If the band number is provided, only those pixels with value (not NODATA) are considered in the test.

The distance is specified in units defined by the spatial reference system of the rasters. For this function to make sense, the source rasters must both be of the same coordinate projection, having the same SRID.

> **Note**
> This operand will make use of any indexes that may be available on the rasters.

> **Note**
> To test the spatial relationship of a raster and a geometry, use ST_Polygon on the raster, e.g. ST_DFullyWithin(ST_Polygon(raster), geometry).

Availability: 2.1.0

Examples

```
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
```

See Also

ST_Within, ST_DWithin

Chapter 10

PostGIS Raster Frequently Asked Questions

1. *I'm getting error* `ERROR: RASTER_fromGDALRaster: Could not open bytea with GDAL. Check that the bytea is of a GDAL supported format.` *when using ST_FromGDALRaster or* `ERROR: rt_raster_to_gdal: Could not load the output GDAL driver` *when trying to use ST_AsPNG or other raster input functions.*

   As of PostGIS 2.1.3 and 2.0.5, a security change was made to by default disable all GDAL drivers and out of db rasters. The release notes are at PostGIS 2.0.6, 2.1.3 security release. In order to reenable specific drivers or all drivers and reenable out of database support, refer to Section 2.1.

2. *Where can I find out more about the PostGIS Raster Project?*

   Refer to the PostGIS Raster home page.

3. *Are there any books or tutorials to get me started with this wonderful invention?*

   There is a full length beginner tutorial Intersecting vector buffers with large raster coverage using PostGIS Raster. Jorge has a series of blog articles on PostGIS Raster that demonstrate how to load raster data as well as cross compare to same tasks in Oracle GeoRaster. Check out Jorge's PostGIS Raster / Oracle GeoRaster Series. There is a whole chapter (more than 35 pages of content) dedicated to PostGIS Raster with free code and data downloads at PostGIS in Action - Raster chapter. You can buy PostGIS in Action now from Manning in hard-copy (significant discounts for bulk purchases) or just the E-book format. You can also buy from Amazon and various other book distributors. All hard-copy books come with a free coupon to download the E-book version. Here is a review from a PostGIS Raster user PostGIS raster applied to land classification urban forestry

4. *How do I install Raster support in my PostGIS database?*

   The easiest is to download binaries for PostGIS and Raster which are currently available for windows and latest versions of Mac OSX. First you need a working PostGIS 2.0.0 or above and be running PostgreSQL 8.4, 9.0, or 9.1. Note in PostGIS 2.0 PostGIS Raster is fully integrated, so it will be compiled when you compile PostGIS.Instructions for installing and running under windows are available at How to Install and Configure PostGIS raster on windows If you are on windows, you can compile yourself, or use the pre-compiled PostGIS Raster windows binaries. If you are on Mac OSX Leopard or Snow Leopard, there are binaries available at Kyng Chaos Mac OSX PostgreSQL/GIS binaries. Then to enable raster support in your database, run the rtpostgis.sql file in your database. To upgrade an existing install use rtpostgis_upgrade_minor..sql instead of rtpostgis.sqlFor other platforms, you generally need to compile yourself. Dependencies are PostGIS and GDAL. For more details about compiling from source, please refer to Installing PostGIS Raster from source (in prior versions of PostGIS)

5. *I get error could not load library "C:/Program Files/PostgreSQL/8.4/lib/rtpostgis.dll": The specified module could not be found. or could not load library on Linux when trying to run rtpostgis.sql*

   rtpostgis.so/dll is built with dependency on libgdal.dll/so. Make sure for Windows you have libgdal-1.dll in the bin folder of your PostgreSQL install. For Linux libgdal has to be in your path or bin folder. You may also run into different errors if you don't have PostGIS installed in your database. Make sure to install PostGIS first in your database before trying to install the raster support.

6. *How do I load Raster data into PostGIS?*

   The latest version of PostGIS comes packaged with a `raster2pgsql` raster loader executable capable of loading many kinds of rasters and also generating lower resolution overviews without any additional software. Please refer to Section 5.1.1 for more details. Pre-2.0 versions came with a `raster2pgsql.py` that required python with numpy and GDAL. This is no longer needed.

7. *What kind of raster file formats can I load into my database?*

   Any that your GDAL library supports. GDAL supported formats are documented GDAL File Formats.Your particular GDAL install may not support all formats. To verify the ones supported by your particular GDAL install, you can use

```
raster2pgsql -G
```

8. *Can I export my PostGIS raster data to other raster formats?*

   YesGDAL 1.7+ has a PostGIS raster driver, but is only compiled in if you choose to compile with PostgreSQL support. The driver currently doesn't support irregularly blocked rasters, although you can store irregularly blocked rasters in PostGIS raster data type.If you are compiling from source, you need to include in your configure

```
--with-pg=path/to/pg_config
```

   to enable the driver. Refer to GDAL Build Hints for tips on building GDAL against in various OS platforms. If your version of GDAL is compiled with the PostGIS Raster driver you should see PostGIS Raster in list when you do

```
gdalinfo --formats
```

   To get a summary about your raster via GDAL use gdalinfo:

```
gdalinfo  "PG:host=localhost port=5432 dbname='mygisdb' user='postgres' password=' ↩
    whatever' schema='someschema' table=sometable"
```

   To export data to other raster formats, use gdal_translate the below will export all data from a table to a PNG file at 10% size.Depending on your pixel band types, some translations may not work if the export format does not support that Pixel type. For example floating point band types and 32 bit unsigned ints will not translate easily to JPG or some others.Here is an example simple translation

```
gdal_translate -of PNG -outsize 10% 10% "PG:host=localhost port=5432 dbname='mygisdb'  ↩
    user='postgres' password='whatever' schema='someschema' table=sometable" C:\ ↩
    somefile.png
```

   You can also use SQL where clauses in your export using the where=... in your driver connection string. Below are some using a where clause

```
gdal_translate -of PNG -outsize 10% 10% "PG:host=localhost port=5432 dbname='mygisdb'  ↩
    user='postgres' password='whatever' schema='someschema' table=sometable where=' ↩
    filename=\'abcd.sid\''" " C:\somefile.png
```

```
gdal_translate -of PNG -outsize 10% 10% "PG:host=localhost port=5432 dbname='mygisdb'  ↩
    user='postgres' password='whatever' schema='someschema' table=sometable where=' ↩
    ST_Intersects(rast, ST_SetSRID(ST_Point(-71.032,42.3793),4326) )' " C:\ ↩
    intersectregion.png
```

   To see more examples and syntax refer to Reading Raster Data of PostGIS Raster section

9. *Are their binaries of GDAL available already compiled with PostGIS Raster suppport?*

   Yes. Check out the page GDAL Binaries page. Any compiled with PostgreSQL support should have PostGIS Raster in them. PostGIS Raster is undergoing many changes. If you want to get the latest nightly build for Windows -- then check out the Tamas Szekeres nightly builds built with Visual Studio which contain GDAL trunk, Python Bindings and MapServer executables and PostGIS Raster driver built-in. Just click the SDK bat and run your commands from there. http://vbkto.dyndns.org/sdk/. Also available are VS project files.FWTools latest stable version for Windows is compiled with Raster support.

10. *What tools can I use to view PostGIS raster data?*

    You can use MapServer compiled with GDAL 1.7+ and PostGIS Raster driver support to view Raster data. QuantumGIS (QGIS) now supports viewing of PostGIS Raster if you have PostGIS raster driver installed.In theory any tool that renders data using GDAL can support PostGIS raster data or support it with fairly minimal effort. Again for Windows, Tamas' binaries http://vbkto.dyndns.org/sdk/ are a good choice if you don't want the hassle of having to setup to compile your own.

11. *How can I add a PostGIS raster layer to my MapServer map?*

    First you need GDAL 1.7 or higher compiled with PostGIS raster support. GDAL 1.8 or above is preferred since many issues have been fixed in 1.8 and more PostGIS raster issues fixed in trunk version.You can much like you can with any other raster. Refer to MapServer Raster processing options for list of various processing functions you can use with MapServer raster layers.What makes PostGIS raster data particularly interesting, is that since each tile can have various standard database columns, you can segment it in your data sourceBelow is an example of how you would define a PostGIS raster layer in MapServer.

> **Note**
> The mode=2 is required for tiled rasters and was added in PostGIS 2.0 and GDAL 1.8 drivers. This does not exist in GDAL 1.7 drivers.

```
-- displaying raster with standard raster options
LAYER
  NAME coolwktraster
  TYPE raster
  STATUS ON
  DATA "PG:host=localhost port=5432 dbname='somedb' user='someuser' password='whatever'
    schema='someschema' table='cooltable' mode='2'"
  PROCESSING "NODATA=0"
  PROCESSING "SCALE=AUTO"
  #... other standard raster processing functions here
  #... classes are optional but useful for 1 band data
  CLASS
    NAME "boring"
    EXPRESSION ([pixel] < 20)
    COLOR 250 250 250
  END
  CLASS
    NAME "mildly interesting"
    EXPRESSION ([pixel] > 20 AND [pixel] < 1000)
    COLOR 255 0 0
  END
  CLASS
    NAME "very interesting"
    EXPRESSION ([pixel] >= 1000)
    COLOR 0 255 0
  END
END
```

```
-- displaying raster with standard raster options and a where clause
LAYER
  NAME soil_survey2009
  TYPE raster
  STATUS ON
  DATA "PG:host=localhost port=5432 dbname='somedb' user='someuser' password='whatever'
    schema='someschema' table='cooltable' where='survey_year=2009' mode='2'"
  PROCESSING "NODATA=0"
  #... other standard raster processing functions here
  #... classes are optional but useful for 1 band data
END
```

12. *What functions can I currently use with my raster data?*

    Refer to the list of Chapter 9. There are more, but this is still a work in progress.Refer to the PostGIS Raster roadmap page for details of what you can expect in the future.

13. *I am getting error ERROR: function st_intersects(raster, unknown) is not unique or st_union(geometry,text) is not unique. How do I fix?*

    The function is not unique error happens if one of your arguments is a textual representation of a geometry instead of a geometry. In these cases, PostgreSQL marks the textual representation as an unknown type, which means it can fall into the st_intersects(raster, geometry) or st_intersects(raster,raster) thus resulting in a non-unique case since both functions can in theory support your request. To prevent this, you need to cast the geometry to a geometry.For example if your code looks like this:

```
SELECT rast
 FROM my_raster
   WHERE ST_Intersects(rast, 'SRID=4326;POINT(-10 10)');
```

    Cast the textual geometry representation to a geometry by changing your code to this:

```
SELECT rast
 FROM my_raster
   WHERE ST_Intersects(rast, 'SRID=4326;POINT(-10 10)'::geometry);
```

14. *How is PostGIS Raster different from Oracle GeoRaster (SDO_GEORASTER) and SDO_RASTER types?*

    For a more extensive discussion on this topic, check out Jorge Arévalo Oracle GeoRaster and PostGIS Raster: First impressions The major advantage of one-georeference-by-raster over one-georeference-by-layer is to allow:* coverages to be not necessarily rectangular (which is often the case of raster coverage covering large extents. See the possible raster arrangements in the documentation)* rasters to overlaps (which is necessary to implement lossless vector to raster conversion) These arrangements are possible in Oracle as well, but they imply the storage of multiple SDO_GEORASTER objects linked to as many SDO_RASTER tables. A complex coverage can lead to hundreds of tables in the database. With PostGIS Raster you can store a similar raster arrangement into a unique table.It's a bit like if PostGIS would force you to store only full rectangular vector coverage without gaps or overlaps (a perfect rectangular topological layer). This is very practical in some applications but practice has shown that it is not realistic or desirable for most geographical coverages. Vector structures needs the flexibility to store discontinuous and non-rectangular coverages. We think it is a big advantage that raster structure should benefit as well.

15. *raster2pgsql load of large file fails with String of N bytes is too long for encoding conversion?*

    raster2pgsql doesn't make any connections to your database when generating the file to load. If your database has set an explicit client encoding different from your database encoding, then when loading large raster files (above 30 MB in size), you may run into a `bytes is too long for encoding conversion`.This generally happens if for example you have your database in UTF8, but to support windows apps, you have the client encoding set to `WIN1252`.To work around this make sure the client encoding is the same as your database encoding during load. You can do this by explicitly setting the encoding in your load script. Example, if you are on windows:

```
set PGCLIENTENCODING=UTF8
```

    If you are on Unix/Linux

```
export PGCLIENTENCODING=UTF8
```

    Gory details of this issue are detailed in http://trac.osgeo.org/postgis/ticket/2209

Chapter 11

Topology

The PostGIS Topology types and functions are used to manage topological objects such as faces, edges and nodes.

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.

An example of a topologically based GIS database is the US Census Topologically Integrated Geographic Encoding and Reference System (TIGER) database. If you want to experiment with PostGIS topology and need some data, check out Topology_Load_Tiger.

The PostGIS topology module has existed in prior versions of PostGIS but was never part of the Official PostGIS documentation. In PostGIS 2.0.0 major cleanup is going on to remove use of all deprecated functions in it, fix known usability issues, better document the features and functions, add new functions, and enhance to closer conform to SQL-MM standards.

Details of this project can be found at PostGIS Topology Wiki

All functions and tables associated with this module are installed in a schema called `topology`.

Functions that are defined in SQL/MM standard are prefixed with ST_ and functions specific to PostGIS are not prefixed.

To build PostGIS 2.0 with topology support, compile with the --with-topology option as described in Chapter 2. Some functions depend on GEOS 3.3+ so you should compile with GEOS 3.3+ to fully utilize the topology support.

11.1 Topology Types

11.1.1 getfaceedges_returntype

getfaceedges_returntype — A composite type that consists of a sequence number and edge number. This is the return type for `ST_GetFaceEdges`

Description

A composite type that consists of a sequence number and edge number. This is the return type for `ST_GetFaceEdges` function.

1. `sequence` is an integer: Refers to a topology defined in the topology.topology table which defines the topology schema and srid.
2. `edge` is an integer: The identifier of an edge.

11.1.2 TopoGeometry

TopoGeometry — A composite type representing a topologically defined geometry

Description

A composite type that refers to a topology geometry in a specific topology layer, having a specific type and a specific id. The elements of a TopoGeometry are the properties: topology_id, layer_id, id integer, type integer.

1. `topology_id` is an integer: Refers to a topology defined in the topology.topology table which defines the topology schema and srid.
2. `layer_id` is an integer: The layer_id in the layers table that the TopoGeometry belongs to. The combination of topology_id, layer_id provides a unique reference in the topology.layers table.
3. `id` is an integer: The id is the autogenerated sequence number that uniquely defines the topogeometry in the respective topology layer.
4. `type` integer between 1 - 4 that defines the geometry type: 1:[multi]point, 2:[multi]line, 3:[multi]poly, 4:collection

Casting Behavior

This section lists the automatic as well as explicit casts allowed for this data type

Cast To	Behavior
geometry	automatic

See Also

CreateTopoGeom

11.1.3 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`

Description

A composite type that consists of an error message and two integers. The ValidateTopology function returns a set of these to denote validation errors and the id1 and id2 to denote the ids of the topology objects involved in the error.

1. `error` is varchar: Denotes type of error.

   Current error descriptors are: coincident nodes, edge crosses node, edge not simple, edge end node geometry mis-match, edge start node geometry mismatch, face overlaps face,face within face,
2. `id1` is an integer: Denotes identifier of edge / face / nodes in error.
3. `id2` is an integer: For errors that involve 2 objects denotes the secondary edge / or node

See Also

ValidateTopology

11.2 Topology Domains

11.2.1 TopoElement

TopoElement — An array of 2 integers generally used to identify a TopoGeometry component.

Description

An array of 2 integers used to represent the id (first element) and type (second element) of a topology primitive or the id (first element) and layer (second element) of a TopoGeometry. Sets of such pairs are used to define TopoGeometry objects (either simple or hierarchical).

Examples

```
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"
```

See Also

GetTopoGeomElements, TopoElementArray

11.2.2 TopoElementArray

TopoElementArray — An array of TopoElement objects

Description

An array of 1 or more TopoElement objects, generally used to pass around components of TopoGeometry objects.

Examples

```
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"
```

See Also

TopoElement, GetTopoGeomElementArray, TopoElementArray_Agg

11.3 Topology and TopoGeometry Management

11.3.1 AddTopoGeometryColumn

AddTopoGeometryColumn — Adds a topogeometry column to an existing table, registers this new column as a layer in topology.layer and returns the new 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);

Description

Each TopoGeometry object belongs to a specific Layer of a specific Topology. Before creating a TopoGeometry object you need to create its TopologyLayer. A Topology Layer is an association of a feature-table with the topology. It also contain type and hierarchy information. We create a layer using the AddTopoGeometryColumn() function:

This function will both add the requested column to the table and add a record to the topology.layer table with all the given info.

If you don't specify [child_layer] (or set it to NULL) this layer would contain Basic TopoGeometries (composed by primitive topology elements). Otherwise this layer will contain hierarchical TopoGeometries (composed by TopoGeometries from the child_layer).

Once the layer is created (its id is returned by the AddTopoGeometryColumn function) you're ready to construct TopoGeometry objects in it

Valid `feature_types` are: POINT, LINE, POLYGON, COLLECTION

Availability: 1.?

Examples

```
-- 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');
```

See Also

CreateTopology, CreateTopoGeom

11.3.2 DropTopology

DropTopology — Use with caution: Drops a topology schema and deletes its reference from topology.topology table and references to tables in that schema from the geometry_columns table.

Synopsis

integer **DropTopology**(varchar topology_schema_name);

Description

Drops a topology schema and deletes its reference from topology.topology table and references to tables in that schema from the geometry_columns table. This function should be USED WITH CAUTION, as it could destroy data you care about. If the schema does not exist, it just removes reference entries the named schema.

Availability: 1.?

Examples

Cascade drops the ma_topo schema and removes all references to it in topology.topology and geometry_columns.

```
SELECT topology.DropTopology('ma_topo');
```

See Also

11.3.3 DropTopoGeometryColumn

DropTopoGeometryColumn — Drops the topogeometry column from the table named `table_name` in schema `schema_name` and unregisters the columns from topology.layer table.

Synopsis

text **DropTopoGeometryColumn**(varchar schema_name, varchar table_name, varchar column_name);

Description

Drops the topogeometry column from the table named `table_name` in schema `schema_name` and unregisters the columns from topology.layer table. Returns summary of drop status. NOTE: it first sets all values to NULL before dropping to bypass referential integrity checks.

Availability: 1.?

Examples

```
SELECT topology.DropTopoGeometryColumn('ma_topo', 'parcel_topo', 'topo');
```

See Also

AddTopoGeometryColumn

11.3.4 TopologySummary

TopologySummary — Takes a topology name and provides summary totals of types of objects in topology

Synopsis

text **TopologySummary**(varchar topology_schema_name);

Description

Takes a topology name and provides summary totals of types of objects in topology.

Availability: 2.0.0

Examples

```
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
```

See Also

Topology_Load_Tiger

11.3.5 ValidateTopology

ValidateTopology — Returns a set of validatetopology_returntype objects detailing issues with topology

Synopsis

setof validatetopology_returntype **ValidateTopology**(varchar topology_schema_name);

Description

Returns a set of validatetopology_returntype objects detailing issues with topology. Table below lists possible errors and what the id1 and id2 mean in each case

Error	id1	id2
edge crosses node	node_id	edge_id # NOTE: should this be swapped?
invalid edge	edge_id	null
edge not simple	edge_id	null
edge crosses edge	edge_id	edge_id
edge start node geometry mis-match	edge_id	node_id
edge end node geometry mis-match	edge_id	node_id
face without edges	face_id	null
face has no rings	face_id	null
face overlaps face	face_id	face_id
face within face	inner face_id	outer face_id

Availability: 1.0.0

Enhanced: 2.0.0 more efficient edge crossing detection and fixes for false positives that were existent in prior versions.

Examples

```
SELECT * FROM  topology.ValidateTopology('ma_topo');
      error        | id1 | id2
-------------------+-----+-----
face without edges |   0 |
```

See Also

validatetopology_returntype, Topology_Load_Tiger

11.4 Topology Constructors

11.4.1 CreateTopology

CreateTopology — Creates a new topology schema and registers this new schema 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 tolerance);
integer **CreateTopology**(varchar topology_schema_name, integer srid, double precision tolerance, boolean hasz);

Description

Creates a new schema with name `topology_name` consisting of tables (`edge_data`,`face`,`node`, `relation` and registers this new topology in the topology.topology table. It returns the id of the topology in the topology table. The srid is the spatial reference identified as defined in spatial_ref_sys table for that topology. Topologies must be uniquely named. The tolerance is measured in the units of the spatial reference system. If the tolerance is not specified defaults to 0.

This is similar to the SQL/MM ST_InitTopoGeo but a bit more functional. `hasz` defaults to false if not specified.

Availability: 1.?

Examples

This example creates a new schema called ma_topo that will store edges, faces, and relations in Massachusetts State Plane meters. The tolerance represents 1/2 meter since the spatial reference system is a meter based spatial reference system

```
SELECT topology.CreateTopology('ma_topo',26986, 0.5);
```

Create Rhode Island topology in State Plane ft

```
SELECT topology.CreateTopology('ri_topo',3438) As topoid;
topoid
------
2
```

See Also

Section 4.3.1, ST_InitTopoGeo, Topology_Load_Tiger

11.4.2 CopyTopology

CopyTopology — Makes a copy of a topology structure (nodes, edges, faces, layers and TopoGeometries).

Synopsis

integer **CopyTopology**(varchar existing_topology_name, varchar new_name);

Description

Creates a new topology with name `new_topology_name` and SRID and precision taken from `existing_topology_name`, copies all nodes, edges and faces in there, copies layers and their TopoGeometries too.

> **Note**
> The new rows in topology.layer will contain synthesized values for schema_name, table_name and feature_column. This is because the TopoGeometry will only exist as a definition but won't be available in any user-level table yet.

Availability: 2.0.0

Examples

This example makes a backup of a topology called ma_topo

```
SELECT topology.CopyTopology('ma_topo', 'ma_topo_bakup');
```

See Also

Section 4.3.1, CreateTopology

11.4.3 ST_InitTopoGeo

ST_InitTopoGeo — Creates a new topology schema and registers this new schema in the topology.topology table and details summary of process.

Synopsis

text **ST_InitTopoGeo**(varchar topology_schema_name);

Description

This is an SQL-MM equivalent of CreateTopology but lacks the spatial reference and tolerance options of CreateTopology and outputs a text description of creation instead of topology id.

Availability: 1.?

This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.17

Examples

```
SELECT topology.ST_InitTopoGeo('topo_schema_to_create') AS topocreation;
                      astopocreation
------------------------------------------------------------
 Topology-Geometry 'topo_schema_to_create' (id:7) created.
```

See Also

CreateTopology

11.4.4 ST_CreateTopoGeo

ST_CreateTopoGeo — Adds a collection of geometries to a given empty topology and returns a message detailing success.

Synopsis

text **ST_CreateTopoGeo**(varchar atopology, geometry acollection);

Description

Adds a collection of geometries to a given empty topology and returns a message detailing success.

Useful for populating an empty topology.

Availability: 2.0

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details -- X.3.18

Examples

```
-- 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');
```

See Also

AddTopoGeometryColumn, CreateTopology, DropTopology

11.4.5 TopoGeo_AddPoint

TopoGeo_AddPoint — Adds a point to an existing topology using a tolerance and possibly splitting an existing edge.

Synopsis

integer **TopoGeo_AddPoint**(varchar toponame, geometry apoint, float8 tolerance);

Description

Adds a point to an existing topology and return 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.

Availability: 2.0.0

See Also

TopoGeo_AddLineString, TopoGeo_AddPolygon, AddNode, CreateTopology

11.4.6 TopoGeo_AddLineString

TopoGeo_AddLineString — Adds a linestring to an existing topology using a tolerance and possibly splitting existing edges/-faces. Returns edge identifiers

Synopsis

SETOF integer **TopoGeo_AddLineString**(varchar toponame, geometry aline, float8 tolerance);

Description

Adds a linestring to an existing topology and return a set of edge identifiers forming it up. The given line will snap to existing nodes or edges within given tolerance. Existing edges and faces may be split by the line.

Availability: 2.0.0

See Also

TopoGeo_AddPoint, TopoGeo_AddPolygon, AddEdge, CreateTopology

11.4.7 TopoGeo_AddPolygon

TopoGeo_AddPolygon — Adds a polygon to an existing topology using a tolerance and possibly splitting existing edges/faces.

Synopsis

integer **TopoGeo_AddPolygon**(varchar atopology, geometry apoly, float8 atolerance);

Description

Adds a polygon to an existing topology and return 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.

Availability: 2.0.0

See Also

TopoGeo_AddPoint, TopoGeo_AddLineString, AddFace, CreateTopology

11.5 Topology Editors

11.5.1 ST_AddIsoNode

ST_AddIsoNode — Adds an isolated node to a face in a topology and returns the nodeid of the new node. If face is null, the node is still created.

Synopsis

integer **ST_AddIsoNode**(varchar atopology, integer aface, geometry apoint);

Description

Adds an isolated node with point location `apoint` to an existing face with faceid `aface` to a topology `atopology` and returns the nodeid of the new node.

If the spatial reference system (srid) of the point geometry is not the same as the topology, the `apoint` is not a point geometry, the point is null, or the point intersects an existing edge (even at the boundaries) then an exception is thrown. If the point already exists as a node, an exception is thrown.

If `aface` is not null and the `apoint` is not within the face, then an exception is thrown.

Availability: 1.?

This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X+1.3.1

Examples

See Also

AddNode, CreateTopology, DropTopology, ST_Intersects

11.5.2 ST_AddIsoEdge

ST_AddIsoEdge — Adds an isolated edge defined by geometry `alinestring` to a topology connecting two existing isolated nodes `anode` and `anothernode` and returns the edge id of the new edge.

Synopsis

integer **ST_AddIsoEdge**(varchar atopology, integer anode, integer anothernode, geometry alinestring);

Description

Adds an isolated edge defined by geometry `alinestring` to a topology connecting two existing isolated nodes `anode` and `anothernode` and returns the edge id of the new edge.

If the spatial reference system (srid) of the `alinestring` geometry is not the same as the topology, any of the input arguments are null, or the nodes are contained in more than one face, or the nodes are start or end nodes of an existing edge, then an exception is thrown.

If the `alinestring` is not within the face of the face the `anode` and `anothernode` belong to, then an exception is thrown.

If the `anode` and `anothernode` are not the start and end points of the `alinestring` then an exception is thrown.

Availability: 1.?

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.4

Examples

See Also

ST_AddIsoNode, ST_IsSimple, ST_Within

11.5.3 ST_AddEdgeNewFaces

ST_AddEdgeNewFaces — Add a new edge and, if in doing so it splits a face, delete the original face and replace it with two new faces.

Synopsis

integer **ST_AddEdgeNewFaces**(varchar atopology, integer anode, integer anothernode, geometry acurve);

Description

Add a new edge and, if in doing so it splits a face, delete the original face and replace it with two new faces. Returns the id of the newly added edge.

Updates all existing joined edges and relationships accordingly.

If any arguments are null, the given nodes are unknown (must already exist in the `node` table of the topology schema) , the `acurve` is not a `LINESTRING`, the `anode` and `anothernode` are not the start and endpoints of `acurve` then an error is thrown.

If the spatial reference system (srid) of the `acurve` geometry is not the same as the topology an exception is thrown.

Availability: 2.0

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.12

Examples

See Also

ST_RemEdgeNewFace

ST_AddEdgeModFace

11.5.4 ST_AddEdgeModFace

ST_AddEdgeModFace — Add a new edge and, if in doing so it splits a face, modify the original face and add a new face.

Synopsis

integer **ST_AddEdgeModFace**(varchar atopology, integer anode, integer anothernode, geometry acurve);

Description

Add a new edge and, if doing so splits a face, modify the original face and add a new one.

> **Note**
> If possible, the new face will be created on left side of the new edge. This will not be possible if the face on the left side will need to be the Universe face (unbounded).

Returns the id of the newly added edge.

Updates all existing joined edges and relationships accordingly.

If any arguments are null, the given nodes are unknown (must already exist in the `node` table of the topology schema) , the `acurve` is not a `LINESTRING`, the `anode` and `anothernode` are not the start and endpoints of `acurve` then an error is thrown.

If the spatial reference system (srid) of the `acurve` geometry is not the same as the topology an exception is thrown.

Availability: 2.0

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.13

Examples

See Also

ST_RemEdgeModFace

ST_AddEdgeNewFaces

11.5.5 ST_RemEdgeNewFace

ST_RemEdgeNewFace — Removes an edge and, if the removed edge separated two faces, delete the original faces and replace them with a new face.

Synopsis

integer **ST_RemEdgeNewFace**(varchar atopology, integer anedge);

Description

Removes an edge and, if the removed edge separated two faces, delete the original faces and replace them with a new face.

Returns the id of a newly created face or NULL, if no new face is created. No new face is created when the removed edge is dangling or isolated or confined with the universe face (possibly making the universe flood into the face on the other side).

Updates all existing joined edges and relationships accordingly.

Refuses to remove an edge partecipating 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).

If any arguments are null, the given edge is unknown (must already exist in the `edge` table of the topology schema), the topology name is invalid then an error is thrown.

Availability: 2.0

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.14

Examples

See Also

ST_RemEdgeModFace

ST_AddEdgeNewFaces

11.5.6 ST_RemEdgeModFace

ST_RemEdgeModFace — Removes an edge and, if the removed edge separated two faces, delete one of the them and modify the other to take the space of both.

Synopsis

integer **ST_RemEdgeModFace**(varchar atopology, integer anedge);

Description

Removes an edge and, if the removed edge separated two faces, delete one of the them and modify the other to take the space of both. Preferentially keeps the face on the right, to be symmetric with ST_AddEdgeModFace also keeping it. Returns the id of the face remaining in place of the removed edge.

Updates all existing joined edges and relationships accordingly.

Refuses to remove an edge partecipating 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).

If any arguments are null, the given edge is unknown (must already exist in the `edge` table of the topology schema), the topology name is invalid then an error is thrown.

Availability: 2.0

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.15

Examples

See Also

ST_AddEdgeModFace

ST_RemEdgeNewFace

11.5.7 ST_ChangeEdgeGeom

ST_ChangeEdgeGeom — Changes the shape of an edge without affecting the topology structure.

Synopsis

integer **ST_ChangeEdgeGeom**(varchar atopology, integer anedge, geometry acurve);

Description

Changes the shape of an edge without affecting the topology structure.

If any arguments are null, the given edge does not exist in the `node` table of the topology schema, the `acurve` is not a `LINESTRING`, the `anode` and `anothernode` are not the start and endpoints of `acurve` or the modification would change the underlying topology then an error is thrown.

If the spatial reference system (srid) of the `acurve` geometry is not the same as the topology an exception is thrown.

If the new `acurve` is not simple, then an error is thrown.

If moving the edge from old to new position would hit an obstacle then an error is thrown.

Availability: 1.1.0

Enhanced: 2.0.0 adds topological consistency enforcement

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details X.3.6

Examples

```
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
```

See Also

ST_AddEdgeModFace

ST_RemEdgeModFace

ST_ModEdgeSplit

11.5.8 ST_ModEdgeSplit

ST_ModEdgeSplit — Split an edge by creating a new node along an existing edge, modifying the original edge and adding a new edge.

Synopsis

integer **ST_ModEdgeSplit**(varchar atopology, integer anedge, geometry apoint);

Description

Split an edge by creating a new node along an existing edge, modifying the original edge and adding a new edge. Updates all existing joined edges and relationships accordingly. Returns the identifier of the newly added node.

Availability: 1.?

Changed: 2.0 - In prior versions, this was misnamed ST_ModEdgesSplit

✓ This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9

Examples

```
-- 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
```

See Also

ST_NewEdgesSplit, ST_ModEdgeHeal, ST_NewEdgeHeal, AddEdge

11.5.9 ST_ModEdgeHeal

ST_ModEdgeHeal — Heal 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);

Description

Heal 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.

Availability: 2.0

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9

See Also

ST_ModEdgeSplit ST_NewEdgesSplit

11.5.10 ST_NewEdgeHeal

ST_NewEdgeHeal — Heal 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);

Description

Heal 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.

Availability: 2.0

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9

See Also

ST_ModEdgeHeal ST_ModEdgeSplit ST_NewEdgesSplit

11.5.11 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 anedge, geometry apoint);

Description

Moves an isolated node in a topology from one point to another. If new `apoint` geometry exists as a node an error is thrown.

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) then an exception is thrown.

If the spatial reference system (srid) of the point geometry is not the same as the topology an exception is thrown.

Availability: 1.?

This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X.3.2

Examples

```
-- 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
```

See Also

ST_AddIsoNode

11.5.12 ST_NewEdgesSplit

ST_NewEdgesSplit — Split an edge by creating a new node along an existing edge, deleting the original edge and replacing it with two new edges. Returns the id of the new node created that joins the new edges.

Synopsis

integer **ST_NewEdgesSplit**(varchar atopology, integer anedge, geometry apoint);

Description

Split an edge with edge id `anedge` by creating a new node with point location `apoint` along current edge, deleting the original edge and replacing it with two new edges. Returns the id of the new node created that joins the new edges. Updates all existing joined edges and relationships accordingly.

If the spatial reference system (srid) of the point geometry is not the same as the topology, the `apoint` is not a point geometry, the point is null, the point already exists as a node, the edge does not correspond to an existing edge or the point is not within the edge then an exception is thrown.

Availability: 1.?

This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X.3.8

Examples

```
-- 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
```

See Also

ST_ModEdgeSplit ST_ModEdgeHeal ST_NewEdgeHeal AddEdge

11.5.13 ST_RemoveIsoNode

ST_RemoveIsoNode — Removes an isolated node and returns description of action. If the node is not isolated (is start or end of an edge), then an exception is thrown.

Synopsis

text **ST_RemoveIsoNode**(varchar atopology, integer anode);

Description

Removes an isolated node and returns description of action. If the node is not isolated (is start or end of an edge), then an exception is thrown.

Availability: 1.?

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X+1.3.3

Examples

```
-- Add an isolated node with no face  --
SELECT topology.ST_RemoveIsoNode('ma_topo',  7 ) As result;
         result
-------------------------
 Isolated node 7 removed
```

See Also

ST_AddIsoNode

11.5.14 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);

Description

Removes an isolated edge and returns description of action. If the edge is not isolated, then an exception is thrown.

Availability: 1.?

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X+1.3.3

Examples

```
-- Remove an isolated node with no face  --
SELECT topology.ST_RemoveIsoNode('ma_topo',  7 ) As result;
         result
-------------------------
 Isolated node 7 removed
```

See Also

ST_AddIsoNode

11.6 Topology Accessors

11.6.1 GetEdgeByPoint

GetEdgeByPoint — Find the edge-id of an edge that intersects a given point

Synopsis

integer **GetEdgeByPoint**(varchar atopology, geometry apoint, float8 tol);

Retrieve the id of an edge that intersects a Point

The function returns an integer (id-edge) given a topology, a POINT and a tolerance. If tolerance = 0 then the point has to intersect the edge.

If the point 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
If tolerance = 0, the function use ST_Intersects otherwise uses ST_DWithin.

Availability: 2.0.0 - requires GEOS >= 3.3.0.

Examples

These examples use edges we created in 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
```

See Also

AddEdge, GetNodeByPoint, GetFaceByPoint

11.6.2 GetFaceByPoint

GetFaceByPoint — Find the face-id of a face that intersects a given point

Synopsis

integer **GetFaceByPoint**(varchar atopology, geometry apoint, float8 tol);

Description

Retrieve the id of a face that intersects a Point.

The function returns an integer (id-face) given a topology, a POINT and a tolerance. If tolerance = 0 then the point has to intersect the face.

If the point doesn't intersect a face, returns 0 (zero).

If use tolerance > 0 and there is more than one face near the point then an exception is thrown.

Note
If tolerance = 0, the function uses ST_Intersects otherwise uses ST_DWithin.

Availability: 2.0.0 - requires GEOS >= 3.3.0.

Examples

These examples use edges faces created in AddFace

```
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
```

See Also

AddFace, GetNodeByPoint, GetEdgeByPoint

11.6.3 GetNodeByPoint

GetNodeByPoint — Find the id of a node at a point location

Synopsis

integer **GetNodeByPoint**(varchar atopology, geometry point, float8 tol);

Retrieve the id of a node at a point location

The function return an integer (id-node) given a topology, a POINT and a tolerance. If tolerance = 0 mean exactly intersection otherwise retrieve the node from an interval.

If there isn't a node at the point, it return 0 (zero).

If use tolerance > 0 and near the point there are more than one node it throw an exception.

> **Note**
> If tolerance = 0, the function use ST_Intersects otherwise will use ST_DWithin.

Availability: 2.0.0 - requires GEOS >= 3.3.0.

Examples

These examples use edges we created in 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
```

See Also

AddEdge, GetEdgeByPoint, GetFaceByPoint

11.6.4 GetTopologyID

GetTopologyID — Returns the id of a topology in the topology.topology table given the name of the topology.

Synopsis

integer **GetTopologyID**(varchar toponame);

Description

Returns the id of a topology in the topology.topology table given the name of the topology.

Availability: 1.?

Examples

```
SELECT topology.GetTopologyID('ma_topo') As topo_id;
 topo_id
---------
       1
```

See Also

CreateTopology, DropTopology, GetTopologyName, GetTopologySRID

11.6.5 GetTopologySRID

GetTopologySRID — Returns the SRID of a topology in the topology.topology table given the name of the topology.

Synopsis

integer **GetTopologyID**(varchar toponame);

Description

Returns the spatial reference id of a topology in the topology.topology table given the name of the topology.

Availability: 2.0.0

Examples

```
SELECT topology.GetTopologySRID('ma_topo') As SRID;
 SRID
-------
  4326
```

See Also

CreateTopology, DropTopology, GetTopologyName, GetTopologyID

11.6.6 GetTopologyName

GetTopologyName — Returns the name of a topology (schema) given the id of the topology.

Synopsis

varchar **GetTopologyName**(integer topology_id);

Description

Returns the topology name (schema) of a topology from the topology.topology table given the topology id of the topology.

Availability: 1.?

Examples

```
SELECT topology.GetTopologyName(1) As topo_name;
 topo_name
-----------
 ma_topo
```

See Also

CreateTopology, DropTopology, GetTopologyID, GetTopologySRID

11.6.7 ST_GetFaceEdges

ST_GetFaceEdges — Returns a set of ordered edges that bound `aface`.

Synopsis

getfaceedges_returntype **ST_GetFaceEdges**(varchar atopology, integer aface);

Description

Returns a set of ordered edges that bound `aface`. Each output consists of a sequence and edgeid. Sequence numbers start with value 1.

Enumeration of each ring edges start from the edge with smallest identifier. Order of edges follows a left-hand-rule (bound face is on the left of each directed edge).

Availability: 2.0

This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.5

Examples

```
-- 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 sequenc, 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;
```

See Also

GetRingEdges, AddFace, ST_GetFaceGeometry

11.6.8 ST_GetFaceGeometry

ST_GetFaceGeometry — Returns the polygon in the given topology with the specified face id.

Synopsis

geometry **ST_GetFaceGeometry**(varchar atopology, integer aface);

Description

Returns the polygon in the given topology with the specified face id. Builds the polygon from the edges making up the face.

Availability: 1.?

This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.16

Examples

```
-- 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))
```

See Also

AddFace

11.6.9 GetRingEdges

GetRingEdges — Returns the ordered set of signed edge identifiers met by walking on an a given edge side.

Synopsis

getfaceedges_returntype **GetRingEdges**(varchar atopology, integer aring, integer max_edges=null);

Description

Returns the ordered set of signed edge identifiers met by walking on an a given edge side. Each output consists of a sequence and a signed edge id. Sequence numbers start with value 1.

If you pass a positive edge id, the walk starts on the left side of the corresponding edge and follows the edge direction. If you pass a negative edge id, the walk starts on the right side of it and goes backward.

If `max_edges` is not null no more than those records are returned by that function. This is meant to be a safety parameter when dealing with possibly invalid topologies.

> **Note**
> This function uses edge ring linking metadata.

Availability: 2.0.0

See Also

ST_GetFaceEdges, GetNodeEdges

11.6.10 GetNodeEdges

GetNodeEdges — Returns an ordered set of edges incident to the given node.

Synopsis

getfaceedges_returntype **GetNodeEdges**(varchar atopology, integer anode);

Description

Returns an ordered set of edges incident to the given node. Each output consists of a sequence and a signed edge id. Sequence numbers start with value 1. A positive edge starts at the given node. A negative edge ends into the given node. Closed edges will appear twice (with both signs). Order is clockwise starting from northbound.

> **Note**
> This function computes ordering rather than deriving from metadata and is thus usable to build edge ring linking.

Availability: 2.0

See Also

GetRingEdges, ST_Azimuth

11.7 Topology Processing

11.7.1 Polygonize

Polygonize — Find and register all faces defined by topology edges

Synopsis

text **Polygonize**(varchar toponame);

Description

Register all faces that can be built out a topology edge primitives.

The target topology is assumed to contain no self-intersecting edges.

Note
Already known faces are recognized, so it is safe to call Polygonize multiple times on the same topology.

Note
This function does not use nor set the next_left_edge and next_right_edge fields of the edge table.

Availability: 2.0.0

See Also

AddFace, ST_Polygonize

11.7.2 AddNode

AddNode — Adds a point node to the node table in the specified topology schema and returns the nodeid of new node. If point already exists as node, the existing nodeid is returned.

Synopsis

integer **AddNode**(varchar toponame, geometry apoint, boolean allowEdgeSplitting=false, boolean computeContainingFace=false);

Description

Adds a point node to the node table in the specified topology schema. The AddEdge function automatically adds start and end points of an edge when called so not necessary to explicitly add nodes of an edge.

If any edge crossing the node is found either an exception is raised or the edge is splitted, depending on the `allowEdgeSplitting` parameter value.

If `computeContainingFace` is true a newly added node would get the correct containing face computed.

> **Note**
> If the `apoint` geometry already exists as a node, the node is not added but the existing nodeid is returned.

Availability: 2.0.0

Examples

```
SELECT topology.AddNode('ma_topo', ST_GeomFromText('POINT(227641.6 893816.5)', 26986) ) As ↩
    nodeid;
-- result --
nodeid
--------
 4
```

See Also

AddEdge, CreateTopology

11.7.3 AddEdge

AddEdge — Adds a linestring edge to the edge table and associated start and end points to the point nodes table of the specified topology schema using the specified linestring geometry and returns the edgeid of the new (or existing) edge.

Synopsis

integer **AddEdge**(varchar toponame, geometry aline);

Description

Adds an edge to the edge table and associated nodes to the nodes table of the specified `toponame` schema using the specified linestring geometry and returns the edgeid of the new or existing record. The newly added edge has "universe" face on both sides and links to itself.

> **Note**
> If the `aline` geometry crosses, overlaps, contains or is contained by an existing linestring edge, then an error is thrown and the edge is not added.

> **Note**
> The geometry of `aline` must have the same `srid` as defined for the topology otherwise an invalid spatial reference sys error will be thrown.

Availability: 2.0.0 requires GEOS >= 3.3.0.

Examples

```
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
```

See Also

CreateTopology, Section 4.3.1

11.7.4 AddFace

AddFace — Registers a face primitive to a topology and gets its identifier.

Synopsis

integer **AddFace**(varchar toponame, geometry apolygon, boolean force_new=false);

Description

Registers a face primitive to a topology and gets its identifier.

For a newly added face, the edges forming its boundaries and the ones contained in the face will be updated to have correct values in the left_face and right_face fields. Isolated nodes contained in the face will also be updated to have a correct containing_face field value.

> **Note**
> This function does not use nor set the next_left_edge and next_right_edge fields of the edge table.

The target topology is assumed to be valid (containing no self-intersecting edges). An exception is raised if: The polygon boundary is not fully defined by existing edges or the polygon overlaps an existing face.

If the `apolygon` geometry already exists as a face, then: if `force_new` is false (the default) the face id of the existing face is returned; if `force_new` is true a new id will be assigned to the newly registered face.

> **Note**
> When a new registration of an existing face is performed (force_new=true), no action will be taken to resolve dangling references to the existing face in the edge, node an relation tables, nor will the MBR field of the existing face record be updated. It is up to the caller to deal with that.

> **Note**
> The `apolygon` geometry must have the same `srid` as defined for the topology otherwise an invalid spatial reference sys error will be thrown.

Availability: 2.0.0

Examples

```
-- 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
```

See Also

AddEdge, CreateTopology, Section 4.3.1

11.7.5 ST_Simplify

ST_Simplify — Returns a "simplified" geometry version of the given TopoGeometry using the Douglas-Peucker algorithm.

Synopsis

geometry **ST_Simplify**(TopoGeometry geomA, float tolerance);

Description

Returns a "simplified" geometry version of the given TopoGeometry using the Douglas-Peucker algorithm on each component edge.

> **Note**
> The returned geometry may be non-simple or non-valid.
> Splitting component edges may help retaining simplicity/validity.

Performed by the GEOS module.

Availability: 2.1.0

See Also

Geometry ST_Simplify, ST_IsSimple, ST_IsValid, ST_ModEdgeSplit

11.8 TopoGeometry Constructors

11.8.1 CreateTopoGeom

CreateTopoGeom — Creates a new topo geometry object from topo element array - tg_type: 1:[multi]point, 2:[multi]line, 3:[multi]poly, 4:collection

Synopsis

topogeometry **CreateTopoGeom**(varchar toponame, integer tg_type, integer layer_id, topoelementarray tg_objs);
topogeometry **CreateTopoGeom**(varchar toponame, integer tg_type, integer layer_id);

Description

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.

punctal layers are formed from set of nodes, lineal layers are formed from a set of edges, areal layers are formed from a set of faces, and collections can be formed from a mixture of nodes, edges, and faces.

Omitting the array of components generates an empty TopoGeometry object.

Availability: 1.?

Examples: Form from existing edges

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);
```

Examples: Convert an areal geometry to best guess topogeometry

Lets say we have geometries that should be formed from a collection of faces. We have for example blockgroups table and want to know the topo geometry of each block group. If our data was perfectly aligned, we could do this:

```
-- 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 denomalized 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;
```

See Also

AddTopoGeometryColumn, toTopoGeom ST_CreateTopoGeo, ST_GetFaceGeometry, TopoElementArray, TopoElementArray_Agg

11.8.2 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);

Description

Converts a simple Geometry into a TopoGeometry.

Topological primitives required to represent the input geometry will be added to the underlying topology, possibly splitting existing ones, and they will be associated with the output TopoGeometry in the `relation` table.

Existing TopoGeometry objects (with the possible exception of `topogeom`, if given) will retain their shapes.

When `tolerance` is given it will be used to snap the input geometry to existing primitives.

In the first form a new TopoGeometry will be created for the given layer (`layer_id`) of the given topology (`toponame`).

In the second form the primitives resulting from the conversion will be added to the pre-existing TopoGeometry (`topogeom`), possibly adding space to its final shape. To have the new shape completely replace the old one see clearTopoGeom.

Availability: 2.0

Enhanced: 2.1.0 adds the version taking an existing TopoGeometry.

Examples

This is a full self-contained 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
  );
```

See Also

CreateTopology, AddTopoGeometryColumn, CreateTopoGeom, TopologySummary, clearTopoGeom

11.8.3 TopoElementArray_Agg

TopoElementArray_Agg — Returns a `topoelementarray` for a set of element_id, type arrays (topoelements)

Synopsis

topoelementarray **TopoElementArray_Agg**(topoelement set tefield);

Description

Used to create a TopoElementArray from a set of TopoElement.

Availability: 2.0.0

Examples

```
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}}
```

See Also

TopoElement, TopoElementArray

11.9 TopoGeometry Editors

11.9.1 clearTopoGeom

clearTopoGeom — Clears the content of a topo geometry

Synopsis

topogeometry **clearTopoGeom**(topogeometry topogeom);

Description

Clears the content a TopoGeometry turning it into an empty one. Mostly useful in conjunction with toTopoGeom to replace the shape of existing objects and any dependent object in higher hierarchical levels.

Availability: 2.1

Examples

```
-- Shrink all TopoGeometry polygons by 10 meters
UPDATE nei_topo SET topo = ST_Buffer(clearTopoGeom(topo), -10);
```

See Also

toTopoGeom

11.9.2 toTopoGeom

toTopoGeom — Adds a geometry shape to an existing topo geometry

Description

Refer to toTopoGeom

11.10 TopoGeometry Accessors

11.10.1 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 topoelement **GetTopoGeomElementArray**(topogeometry tg);

Description

Returns a TopoElementArray containing the topological elements and type of the given TopoGeometry (primitive elements). This is similar to GetTopoGeomElements except it returns the elements as an array rather than as a dataset.

tg_id is the topogeometry id of the topogeometry object in the topology in the layer denoted by `layer_id` in the topology.layer table.

Availability: 1.?

Examples

See Also

GetTopoGeomElements, TopoElementArray

11.10.2 GetTopoGeomElements

GetTopoGeomElements — Returns a set of `topoelement` objects containing the topological element_id,element_type of the given TopoGeometry (primitive elements)

Synopsis

setof topoelement **GetTopoGeomElements**(varchar toponame, integer layer_id, integer tg_id);

setof topoelement **GetTopoGeomElements**(topogeometry tg);

Description

Returns a set of element_id,element_type (topoelements) for a given topogeometry object in `toponame` schema.

tg_id is the topogeometry id of the topogeometry object in the topology in the layer denoted by `layer_id` in the topology.layer table.

Availability: 1.?

Examples

See Also

GetTopoGeomElementArray, TopoElement

11.11 TopoGeometry Outputs

11.11.1 AsGML

AsGML — Returns the GML representation of a topogeometry.

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);

Description

Returns the GML representation of a topogeometry in version GML3 format. If no `nsprefix_in` is specified then `gml` is used. Pass in an empty string for nsprefix to get a non-qualified name space. The precision (default: 15) and options (default 1) parameters, if given, are passed untouched to the underlying call to ST_AsGML.

The `visitedTable` parameter, if given, is used for keeping track of the visited Node and Edge elements so to use cross-references (xlink:xref) rather than duplicating definitions. The table is expected to have (at least) two integer fields: 'element_type' and 'element_id'. The calling user must have both read and write privileges on the given table. For best performance, an index should be defined on `element_type` and `element_id`, in that order. Such index would be created automatically by adding a unique constraint to the fields. Example:

```
CREATE TABLE visited (
  element_type integer, element_id integer,
  unique(element_type, element_id)
);
```

The `idprefix` parameter, if given, will be prepended to Edge and Node tag identifiers.

The `gmlver` parameter, if given, will be passed to the underlying ST_AsGML. Defaults to 3.

Availability: 2.0.0

Examples

This uses the topo geometry we created in 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>
```

Same exercise as previous without namespace

```
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>
```

See Also

CreateTopoGeom, ST_CreateTopoGeo

11.11.2 AsTopoJSON

AsTopoJSON — Returns the TopoJSON representation of a topogeometry.

Synopsis

text **AsTopoJSON**(topogeometry tg, regclass edgeMapTable);

Description

Returns the TopoJSON representation of a topogeometry. If `edgeMapTable` is not null, it will be used as a lookup/storage mapping of edge identifiers to arc indices. This is to be able to allow for a compact "arcs" array in the final document.

The table, if given, is expected to have an "arc_id" field of type "serial" and an "edge_id" of type integer; the code will query the table for "edge_id" so it is recommended to add an index on that field.

Note
Arc indices in the TopoJSONjoutput are 0-based but they are 1-based in the "edgeMapTable" table.

A full TopoJSON document will be need to contain, in addition to the snippets returned by this function, the actual arcs plus some headers. See the TopoJSON specification.

Availability: 2.1.0

See Also

ST_AsGeoJSON

Examples

```
CREATE TEMP TABLE edgemap(arc_id serial, edge_id int unique);

-- header
SELECT '{ "type": "Topology", "transform": { "scale": [1,1], "translate": [0,0] }, "objects ↩
    ": {';

-- objects
SELECT '"' || feature_name || '": ' || AsTopoJSON(feature, 'edgemap')
FROM features.big_parcels WHERE feature_name = 'P3P4';

-- arcs
SELECT '}, "arcs": ['
  UNION ALL
SELECT (regexp_matches(ST_AsGEOJSON(ST_SnapToGrid(e.geom,1)), '\[.*\]'))[1] as t
FROM edgemap m, city_data.edge e WHERE e.edge_id = m.edge_id;

-- footer
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],[31,30],[31,40],[17,40],[17,30],[25,30]]
[[35,6],[35,14]]
[[35,6],[47,6]]
[[47,6],[47,14]]
[[47,14],[47,22]]
[[35,22],[47,22]]
[[35,14],[35,22]]
]}
```

11.12 Topology Spatial Relationships

11.12.1 Equals

Equals — Returns true if two topogeometries are composed of the same topology primitives.

Synopsis

boolean **Equals**(topogeometry tg1, topogeometry tg2);

Description

Returns true if two topogeometries are composed of the same topology primitives: faces, edges, nodes.

> **Note**
> This function not supported for topogeometries that are geometry collections. It also can not compare topogeometries from different topologies.

Availability: 1.1.0

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

Examples

See Also

GetTopoGeomElements, ST_Equals

11.12.2 Intersects

Intersects — Returns true if any pair of primitives from the two topogeometries intersect.

Synopsis

boolean **Intersects**(topogeometry tg1, topogeometry tg2);

Description

Returns true if any pair of primitives from the two topogeometries intersect.

> **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 hierarchichal topogeometries (topogeometries composed of other topogeometries).

Availability: 1.1.0

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

Examples

```
```

See Also

ST_Intersects

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 plpgsql based or standard shell scripts that can be run as is.

12.1 Tiger Geocoder

There are a couple other open source geocoders for PostGIS, that unlike tiger geocoder have the advantage of multi-country geocoding support

- Nominatim and uses OpenStreetMap gazeteer formatted data. It requires osm2pgsql for loading the data, PostgreSQL 8.4+ and PostGIS 1.5+ to function. It is packaged as a webservice interface and seems designed to be called as a webservice. Just like the tiger geocoder, it has both a geocoder and a reverse geocoder component. From the documentation, it is unclear if it has a pure SQL interface like the tiger geocoder, or if a good deal of the logic is implemented in the web interface.
- GIS Graphy also utilizes PostGIS and like Nominatim works with OpenStreetMap (OSM) data. It comes with a loader to load OSM data and similar to Nominatim is capable of geocoding not just US. Much like Nominatim, it runs as a webservice and relies on Java 1.5, Servlet apps, Solr. GisGraphy is cross-platform and also has a reverse geocoder among some other neat features.

12.1.1 Drop_Indexes_Generate_Script

Drop_Indexes_Generate_Script — Generates a script that drops all non-primary key and non-unique indexes on tiger schema and user specified schema. Defaults schema to `tiger_data` if no schema is specified.

Synopsis

text **Drop_Indexes_Generate_Script**(text param_schema=tiger_data);

Description

Generates a script that drops all non-primary key and non-unique indexes on tiger schema and user specified schema. Defaults schema to `tiger_data` if no schema is specified.

This is useful for minimizing index bloat that may confuse the query planner or take up unnecessary space. Use in combination with Install_Missing_Indexes to add just the indexes used by the geocoder.

Availability: 2.0.0

Examples

```
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;
:
:
```

See Also

Install_Missing_Indexes, Missing_Indexes_Generate_Script

12.1.2 Drop_Nation_Tables_Generate_Script

Drop_Nation_Tables_Generate_Script — Generates a script that drops all tables in the specified schema that start with `county_all`, `state_all` or stae code followed by `county` or `state`.

Synopsis

text **Drop_Nation_Tables_Generate_Script**(text param_schema=tiger_data);

Description

Generates a script that drops all tables in the specified schema that start with `county_all`, `state_all` or stae code followed by `county` or `state`. This is needed if you are upgrading from `tiger_2010` to `tiger_2011` data.

Availability: 2.1.0

Examples

```
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;
```

See Also

Loader_Generate_Nation_Script

12.1.3 Drop_State_Tables_Generate_Script

Drop_State_Tables_Generate_Script — Generates a script that drops all tables in the specified schema that are prefixed with the state abbreviation. Defaults schema to `tiger_data` if no schema is specified.

Synopsis

text **Drop_State_Tables_Generate_Script**(text param_state, text param_schema=tiger_data);

Description

Generates a script that drops all tables in the specified schema that are prefixed with the state abbreviation. Defaults schema to `tiger_data` if no schema is specified. This function is useful for dropping tables of a state just before you reload a state in case something went wrong during your previous load.

Availability: 2.0.0

Examples

```
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;
```

See Also

Loader_Generate_Script

12.1.4 Geocode

Geocode — Takes in an address as a string (or other normalized address) and outputs a set of possible locations which include a point geometry in NAD 83 long lat, a normalized address for each, and the rating. The lower the rating the more likely the match. Results are sorted by lowest rating first. Can optionally pass in maximum results, defaults to 10, and restrict_region (defaults to 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);

Description

Takes in an address as a string (or already normalized address) and outputs a set of possible locations which include a point geometry in NAD 83 long lat, a `normalized_address` (addy) for each, and the rating. The lower the rating the more likely the match. Results are sorted by lowest rating first. Uses Tiger data (edges,faces,addr), PostgreSQL fuzzy string matching (soundex,levenshtein) and PostGIS line interpolation functions to interpolate address along the Tiger edges. The higher the rating the less likely the geocode is right. The geocoded point is defaulted to offset 10 meters from center-line off to side (L/R) of street address is located on.

Enhanced: 2.0.0 to support Tiger 2010 structured data and revised some logic to improve speed, accuracy of geocoding, and to offset point from centerline to side of street address is located on. New parameter max_results useful for specifying ot just return the best result.

Examples: Basic

The below examples timings are on a 3.0 GHZ single processor Windows 7 machine with 2GB ram running PostgreSQL 9.1rc1/PostGIS 2.0 loaded with all of MA,MN,CA, RI state Tiger data loaded.

Exact matches are faster to compute (61ms)

```
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') As g;
 rating |        lon        |       lat        | stno | street | styp |  city  | st |  zip
--------+-------------------+------------------+------+--------+------+--------+----+------- ↩

      0 | -71.0556722990239 | 42.3589914927049 |   75 | State  | St   | Boston | MA | 02109
```

Even if zip is not passed in the geocoder can guess (took about 122-150 ms)

```
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
```

Can handle misspellings and provides more than one possible solution with ratings and takes longer (500ms).

```
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') As g;
 rating |         wktlonlat         | stno | street | styp |  city  | st |  zip
--------+---------------------------+------+--------+------+--------+----+-------
     70 | POINT(-71.06459 42.35113) |   31 | Stuart | St   | Boston | MA | 02116
```

Using to do a batch geocode of addresses. Easiest is to set `max_results=1`. Only process those not yet geocoded (have no rating).

```
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.geo).rating,-1), pprint_addy((g.geo).addy),
     ST_X((g.geo).geomout)::numeric(8,5), ST_Y((g.geo).geomout)::numeric(8,5) )
FROM (SELECT addid
  FROM addresses_to_geocode
  WHERE rating IS NULL ORDER BY addid LIMIT 3) As a
  LEFT JOIN (SELECT addid, (geocode(address,1)) As geo
    FROM addresses_to_geocode As ag
  WHERE ag.rating IS NULL ORDER BY addid LIMIT 3) As g ON a.addid = g.addid
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            | -71.07181 | 42.38359 | 529 Main St, ←
          Boston, MA 02129             |      0
     2 | 77 Massachusetts Avenue, Cambridge, MA 02139 | -71.09428 | 42.35988 | 77  ←
         Massachusetts Ave, Cambridge, MA 02139 |      0
     3 | 25 Wizard of Oz, Walaford, KS 99912323       |           |          |  ←
                                                |     -1
```

Examples: Using Geometry filter

```
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
--------+--------------------------+------+---------+------+------+----+-------
      8 | POINT(-70.96796 42.4659) |  100 | Federal | St   | Lynn | MA | 01905
Total query runtime: 245 ms.
```

See Also

Normalize_Address, Pprint_Addy, ST_AsText, ST_SnapToGrid, ST_X, ST_Y

12.1.5 Geocode_Intersection

Geocode_Intersection — Takes in 2 streets that intersect and a state, city, zip, and outputs a set of possible locations on the first cross street that is at the intersection, also includes a point geometry in NAD 83 long lat, a normalized address for each location, and the rating. The lower the rating the more likely the match. Results are sorted by lowest rating first. Can optionally pass in maximum results, defaults to 10

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);

Description

Takes in 2 streets that intersect and a state, city, zip, and outputs a set of possible locations on the first cross street that is at the intersection, also includes a point geometry in NAD 83 long lat, a normalized address for each location, and the rating. The lower the rating the more likely the match. Results are sorted by lowest rating first. Can optionally pass in maximum results, defaults to 10. Returns `normalized_address` (addy) for each, geomout as the point location in nad 83 long lat, and the rating. The lower the rating the more likely the match. Results are sorted by lowest rating first. Uses Tiger data (edges,faces,addr), PostgreSQL fuzzy string matching (soundex,levenshtein)

Availability: 2.0.0

Examples: Basic

The below examples timings are on a 3.0 GHZ single processor Windows 7 machine with 2GB ram running PostgreSQL 9.0/PostGIS 1.5 loaded with all of MA state Tiger data loaded. Currently a bit slow (3000 ms)

Testing on Windows 2003 64-bit 8GB on PostGIS 2.0 PostgreSQL 64-bit Tiger 2011 data loaded -- (41ms)

```
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
```

Even if zip is not passed in the geocoder can guess (took about 3500 ms on the windows 7 box), on the windows 2003 64-bit 741 ms

```
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
```

See Also

Geocode, Pprint_Addy, ST_AsText

12.1.6 Get_Geocode_Setting

Get_Geocode_Setting — Returns value of specific setting stored in tiger.geocode_settings table.

Synopsis

text **Get_Geocode_Setting**(text setting_name);

Description

Returns value of specific setting stored in tiger.geocode_settings table. Settings allow you to toggle debugging of functions. Later plans will be to control rating with settings. Current list of settings are as follows:

```
              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 pagc_address normalizer instead of tiger built one
```

Availability: 2.1.0

Example return debugging setting

```
SELECT get_geocode_setting('debug_geocode_address) As result;
result
---------
false
```

See Also

Set_Geocode_Setting

12.1.7 Get_Tract

Get_Tract — Returns census tract or field from tract table of where the geometry is located. Default to returning short name of tract.

Synopsis

text **get_tract**(geometry loc_geom, text output_field=name);

Description

Given a geometry will return the census tract location of that geometry. NAD 83 long lat is assumed if no spatial ref sys is specified.

Availability: 2.0.0

Examples: Basic

```
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
```

See Also

Geocode>

12.1.8 Install_Missing_Indexes

Install_Missing_Indexes — Finds all tables with key columns used in geocoder joins and filter conditions that are missing used indexes on those columns and will add them.

Synopsis

boolean **Install_Missing_Indexes**();

Description

Finds all tables in `tiger` and `tiger_data` schemas with key columns used in geocoder joins and filters that are missing indexes on those columns and will output the SQL DDL to define the index for those tables and then execute the generated script. This is a helper function that adds new indexes needed to make queries faster that may have been missing during the load process. This function is a companion to Missing_Indexes_Generate_Script that in addition to generating the create index script, also executes it. It is called as part of the `update_geocode.sql` upgrade script.

Availability: 2.0.0

Examples

```
SELECT install_missing_indexes();
     install_missing_indexes
-------------------------
 t
```

See Also

Loader_Generate_Script, Missing_Indexes_Generate_Script

12.1.9 Loader_Generate_Census_Script

Loader_Generate_Census_Script — Generates a shell script for the specified platform for the specified states that will download Tiger census state tract, bg, and tabblocks data tables, stage and load into `tiger_data` schema. Each state script is returned as a separate record.

Synopsis

setof text **loader_generate_census_script**(text[] param_states, text os);

Description

Generates a shell script for the specified platform for the specified states that will download Tiger data census state `tract`, block groups `bg`, and `tabblocks` data tables, stage and load into `tiger_data` schema. Each state script is returned as a separate record.

It uses unzip on Linux (7-zip on Windows by default) and wget to do the downloading. It uses Section 4.4.2 to load in the data. Note the smallest unit it does is a whole state. It will only process the files in the staging and temp folders.

It uses the following control tables to control the process and different OS shell syntax variations.

1. `loader_variables` keeps track of various variables such as census site, year, data and staging schemas
2. `loader_platform` profiles of various platforms and where the various executables are located. Comes with windows and linux. More can be added.
3. `loader_lookuptables` each record defines a kind of table (state, county), whether to process records in it and how to load them in. Defines the steps to import data, stage data, add, removes columns, indexes, and constraints for each. Each table is prefixed with the state and inherits from a table in the tiger schema. e.g. creates `tiger_data.ma_faces` which inherits from `tiger.faces`

Availability: 2.0.0

Note

Loader_Generate_Script includes this logic, but if you installed tiger geocoder prior to PostGIS 2.0.0 alpha5, you'll need to run this on the states you have already done to get these additional tables.

Examples

Generate script to load up data for select states in Windows shell script format.

```
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');"
:
```

Generate sh script

```
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
:
:
```

See Also

Loader_Generate_Script

12.1.10 Loader_Generate_Script

Loader_Generate_Script — Generates a shell script for the specified platform for the specified states that will download Tiger data, stage and load into `tiger_data` schema. Each state script is returned as a separate record. Latest version supports Tiger 2010 structural changes and also loads census tract, block groups, and blocks tables.

Synopsis

setof text **loader_generate_script**(text[] param_states, text os);

Description

Generates a shell script for the specified platform for the specified states that will download Tiger data, stage and load into `tiger_data` schema. Each state script is returned as a separate record.

It uses unzip on Linux (7-zip on Windows by default) and wget to do the downloading. It uses Section 4.4.2 to load in the data. Note the smallest unit it does is a whole state, but you can overwrite this by downloading the files yourself. It will only process the files in the staging and temp folders.

It uses the following control tables to control the process and different OS shell syntax variations.

1. `loader_variables` keeps track of various variables such as census site, year, data and staging schemas
2. `loader_platform` profiles of various platforms and where the various executables are located. Comes with windows and linux. More can be added.
3. `loader_lookuptables` each record defines a kind of table (state, county), whether to process records in it and how to load them in. Defines the steps to import data, stage data, add, removes columns, indexes, and constraints for each. Each table is prefixed with the state and inherits from a table in the tiger schema. e.g. creates `tiger_data.ma_faces` which inherits from `tiger.faces`

Availability: 2.0.0 to support Tiger 2010 structured data and load census tract (tract), block groups (bg), and blocks (tabblocks) tables .

Examples

Generate script to load up data for 2 states in Windows shell script format.

```
SELECT loader_generate_script(ARRAY['MA','RI'], 'windows') AS result;
-- result --
set STATEDIR="\gisdata\www2.census.gov\geo\pvs\tiger2010st\44_Rhode_Island"
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\8.4\bin\
set PGPORT=5432
set PGHOST=localhost
```

```
set PGUSER=postgres
set PGPASSWORD=yourpasswordhere
set PGDATABASE=geocoder
set PSQL="%PGBIN%psql"
set SHP2PGSQL="%PGBIN%shp2pgsql"

%WGETTOOL% http://www2.census.gov/geo/pvs/tiger2010st/44_Rhode_Island/ --no-parent -- ↩
    relative --recursive --level=2 --accept=zip,txt --mirror --reject=html
:
:
```

Generate sh script

```
SELECT loader_generate_script(ARRAY['MA','RI'], 'sh') AS result;
-- result --
STATEDIR="/gisdata/www2.census.gov/geo/pvs/tiger2010st/44_Rhode_Island"
TMPDIR="/gisdata/temp/"
UNZIPTOOL=unzip
PGPORT=5432
PGHOST=localhost
PGUSER=postgres
PGPASSWORD=yourpasswordhere
PGDATABASE=geocoder
PSQL=psql
SHP2PGSQ=shp2pgsql

wget http://www2.census.gov/geo/pvs/tiger2010st/44_Rhode_Island/ --no-parent --relative -- ↩
    recursive --level=2 --accept=zip,txt --mirror --reject=html
:
:
```

See Also

12.1.11 Loader_Generate_Nation_Script

Loader_Generate_Nation_Script — Generates a shell script for the specified platform that loads in the county and state lookup tables.

Synopsis

text **loader_generate_nation_script**(text os);

Description

Generates a shell script for the specified platform that loads in the `county_all`, `county_all_lookup`, `state_all` tables into `tiger_data` schema. These inherit respectively from the `county`, `county_lookup`, `state` tables in `tiger` schema.

It uses unzip on Linux (7-zip on Windows by default) and wget to do the downloading. It uses Section 4.4.2 to load in the data.

It uses the following control tables `tiger.loader_platform`, `tiger.loader_variables`, and `tiger.loader_lookuptables` to control the process and different OS shell syntax variations.

1. `loader_variables` keeps track of various variables such as census site, year, data and staging schemas
2. `loader_platform` profiles of various platforms and where the various executables are located. Comes with windows and linux/unix. More can be added.

3. loader_lookuptables each record defines a kind of table (state, county), whether to process records in it and how to load them in. Defines the steps to import data, stage data, add, removes columns, indexes, and constraints for each. Each table is prefixed with the state and inherits from a table in the tiger schema. e.g. creates tiger_data.ma_faces which inherits from tiger.faces

Availability: 2.1.0

> **Note**
> If you were running tiger_2010 version and you want to reload as state with tiger_2011, you'll need to for the very first load generate and run drop statements Drop_Nation_Tables_Generate_Script before you run this script.

Examples

Generate script script to load nation data Windows.

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

Generate script to load up data for Linux/Unix systems.

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

See Also

Loader_Generate_Script

12.1.12 Missing_Indexes_Generate_Script

Missing_Indexes_Generate_Script — Finds all tables with key columns used in geocoder joins that are missing indexes on those columns and will output the SQL DDL to define the index for those tables.

Synopsis

text **Missing_Indexes_Generate_Script**();

Description

Finds all tables in tiger and tiger_data schemas with key columns used in geocoder joins that are missing indexes on those columns and will output the SQL DDL to define the index for those tables. This is a helper function that adds new indexes needed to make queries faster that may have been missing during the load process. As the geocoder is improved, this function will be updated to accommodate new indexes being used. If this function outputs nothing, it means all your tables have what we think are the key indexes already in place.

Availability: 2.0.0

Examples

```
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);
```

See Also

Loader_Generate_Script, Install_Missing_Indexes

12.1.13 Normalize_Address

Normalize_Address — Given a textual street address, returns a composite `norm_addy` type that has road suffix, prefix and type standardized, street, streetname etc. broken into separate fields. This function will work with just the lookup data packaged with the tiger_geocoder (no need for tiger census data).

Synopsis

norm_addy **normalize_address**(varchar in_address);

Description

Given a textual street address, returns a composite `norm_addy` type that has road suffix, prefix and type standardized, street, streetname etc. broken into separate fields. This is the first step in the geocoding process to get all addresses into normalized postal form. No other data is required aside from what is packaged with the geocoder.

This function just uses the various direction/state/suffix lookup tables preloaded with the tiger_geocoder and located in the `tiger` schema, so it doesn't need you to download tiger census data or any other additional data to make use of it. You may find the need to add more abbreviations or alternative namings to the various lookup tables in the `tiger` schema.

It uses various control lookup tables located in `tiger` schema to normalize the input address.

Fields in the `norm_addy` type object returned by this function in this order where () indicates a field required by the geocoder, [] indicates an optional field:

(address) [predirAbbrev] (streetName) [streetTypeAbbrev] [postdirAbbrev] [internal] [location] [stateAbbrev] [zip]

1. `address` is an integer: The street number
2. `predirAbbrev` is varchar: Directional prefix of road such as N, S, E, W etc. These are controlled using the `direction_lookup` table.
3. `streetName` varchar
4. `streetTypeAbbrev` varchar abbreviated version of street type: e.g. St, Ave, Cir. These are controlled using the `street_type_lookup` table.
5. `postdirAbbrev` varchar abbreviated directional suffice of road N, S, E, W etc. These are controlled using the `direction_lookup` table.
6. `internal` varchar internal address such as an apartment or suite number.
7. `location` varchar usually a city or governing province.
8. `stateAbbrev` varchar two character US State. e.g MA, NY, MI. These are controlled by the `state_lookup` table.
9. `zip` varchar 5-digit zipcode. e.g. 02109.
10. `parsed` boolean - denotes if addess was formed from normalize process. The normalize_address function sets this to true before returning the address.

Examples

Output select fields. Use Pprint_Addy if you want a pretty textual output.

```
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  |
```

See Also

Geocode, Pprint_Addy

12.1.14 Pagc_Normalize_Address

Pagc_Normalize_Address — Given a textual street address, returns a composite `norm_addy` type that has road suffix, prefix and type standardized, street, streetname etc. broken into separate fields. This function will work with just the lookup data packaged with the tiger_geocoder (no need for tiger census data). Requires address_standardizer extension.

Synopsis

norm_addy **pagc_normalize_address**(varchar in_address);

Description

Given a textual street address, returns a composite `norm_addy` type that has road suffix, prefix and type standardized, street, streetname etc. broken into separate fields. This is the first step in the geocoding process to get all addresses into normalized postal form. No other data is required aside from what is packaged with the geocoder.

This function just uses the various pagc_* lookup tables preloaded with the tiger_geocoder and located in the `tiger` schema, so it doesn't need you to download tiger census data or any other additional data to make use of it. You may find the need to add more abbreviations or alternative namings to the various lookup tables in the `tiger` schema.

It uses various control lookup tables located in `tiger` schema to normalize the input address.

Fields in the `norm_addy` type object returned by this function in this order where () indicates a field required by the geocoder, [] indicates an optional field:

This version uses the PAGC address standardizer C extension which you can download. There are slight variations in casing and formatting and also provides a richer breakout.

Availability: 2.1.0

(address) [predirAbbrev] (streetName) [streetTypeAbbrev] [postdirAbbrev] [internal] [location] [stateAbbrev] [zip]

The native standardaddr of address_standardizer extension is at this time a bit richer than norm_addy since its designed to support international addresses (including country). standardaddr equivalent fields are:

house_num,predir, name, suftype, sufdir, unit, city, state, postcode

1. `address` is an integer: The street number

2. `predirAbbrev` is varchar: Directional prefix of road such as N, S, E, W etc. These are controlled using the `direction_lookup` table.
3. `streetName` varchar
4. `streetTypeAbbrev` varchar abbreviated version of street type: e.g. St, Ave, Cir. These are controlled using the `street_type_lookup` table.
5. `postdirAbbrev` varchar abbreviated directional suffice of road N, S, E, W etc. These are controlled using the `direction_lookup` table.
6. `internal` varchar internal address such as an apartment or suite number.
7. `location` varchar usually a city or governing province.
8. `stateAbbrev` varchar two character US State. e.g MA, NY, MI. These are controlled by the `state_lookup` table.
9. `zip` varchar 5-digit zipcode. e.g. 02109.
10. `parsed` boolean - denotes if addess was formed from normalize process. The normalize_address function sets this to true before returning the address.

Examples

Single call example

```
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
```

Batch call. There are currently speed issues with the way postgis_tiger_geocoder wraps the address_standardizer. These will hopefully be resolved in later editions. To work around them, if you need speed for batch geocoding to call generate a normaddy in batch mode, you are encouraged to directly call the address_standardizer standardize_address function as shown below which is similar exercise to what we did in Normalize_Address that uses data created in Geocode.

```
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
```

See Also

Normalize_Address, Geocode

12.1.15 Pprint_Addy

Pprint_Addy — Given a `norm_addy` composite type object, returns a pretty print representation of it. Usually used in conjunction with normalize_address.

Synopsis

varchar **pprint_addy**(norm_addy in_addy);

Description

Given a `norm_addy` composite type object, returns a pretty print representation of it. No other data is required aside from what is packaged with the geocoder.

Usually used in conjunction with Normalize_Address.

Examples

Pretty print a single 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
```

Pretty print address a table of addresses

```
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
```

See Also

Normalize_Address

12.1.16 Reverse_Geocode

Reverse_Geocode — Takes a geometry point in a known spatial ref sys and returns a record containing an array of theoretically possible addresses and an array of cross streets. If include_strnum_range = true, includes the street range in the cross streets.

Synopsis

record **Reverse_Geocode**(geometry pt, boolean include_strnum_range=false, geometry[] OUT intpt, norm_addy[] OUT addy, varchar[] OUT street);

Description

Takes a geometry point in a known spatial ref and returns a record containing an array of theoretically possible addresses and an array of cross streets. If include_strnum_range = true, includes the street range in the cross streets. include_strnum_range defaults to false if not passed in. Addresses are sorted according to which road a point is closest to so first address is most likely the right one.

Why do we say theoretical instead of actual addresses. The Tiger data doesn't have real addresses, but just street ranges. As such the theoretical address is an interpolated address based on the street ranges. Like for example interpolating one of my addresses returns a 26 Court St. and 26 Court Sq., though there is no such place as 26 Court Sq. This is because a point may be at a corner of 2 streets and thus the logic interpolates along both streets. The logic also assumes addresses are equally spaced along a street, which of course is wrong since you can have a municipal building taking up a good chunk of the street range and the rest of the buildings are clustered at the end.

Note: Hmm this function relies on Tiger data. If you have not loaded data covering the region of this point, then hmm you will get a record filled with NULLS.

Returned elements of the record are as follows:

1. `intpt` is an array of points: These are the center line points on the street closest to the input point. There are as many points as there are addresses.
2. `addy` is an array of norm_addy (normalized addresses): These are an array of possible addresses that fit the input point. The first one in the array is most likely. Generally there should be only one, except in the case when a point is at the corner of 2 or 3 streets, or the point is somewhere on the road and not off to the side.
3. `street` an array of varchar: These are cross streets (or the street) (streets that intersect or are the street the point is projected to be on).

Availability: 2.0.0

Examples

Example of a point at the corner of two streets, but closest to one. This is approximate location of MIT: 77 Massachusetts Ave, Cambridge, MA 02139 Note that although we don't have 3 streets, PostgreSQL will just return null for entries above our upper bound so safe to use. This includes street ranges

```
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
```

Here we choose not to include the address ranges for the cross streets and picked a location really really close to a corner of 2 streets thus could be known by two different addresses.

```
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
```

For this one we reuse our geocoded example from Geocode and we only want the primary address and at most 2 cross streets.

```
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
```

See Also

Pprint_Addy, Geocode

12.1.17 Topology_Load_Tiger

Topology_Load_Tiger — Loads a defined region of tiger data into a PostGIS Topology and transforming the tiger data to spatial reference of the topology and snapping to the precision tolerance of the topology.

Synopsis

text **Topology_Load_Tiger**(varchar topo_name, varchar region_type, varchar region_id);

Description

Loads a defined region of tiger data into a PostGIS Topology. The faces, nodes and edges are transformed to the spatial reference system of the target topology and points are snapped to the tolerance of the target topology. The created faces, nodes, edges maintain the same ids as the original Tiger data faces, nodes, edges so that datasets can be in the future be more easily reconciled with tiger data. Returns summary details about the process.

This would be useful for example for redistricting data where you require the newly formed polygons to follow the center lines of streets and for the resulting polygons not to overlap.

> **Note**
> This function relies on Tiger data as well as the installation of the PostGIS topology module. For more information, refer to Chapter 11 and Section 2.4.1. If you have not loaded data covering the region of interest, then no topology records will be created. This function will also fail if you have not created a topology using the topology functions.

> **Note**
> Most topology validation errors are a result of tolerance issues where after transformation the edges points don't quite line up or overlap. To remedy the situation you may want to increase or lower the precision if you get topology validation failures.

Required arguments:

1. `topo_name` The name of an existing PostGIS topology to load data into.
2. `region_type` The type of bounding region. Currently only `place` and `county` are supported. Plan is to have several more. This is the table to look into to define the region bounds. e.g `tiger.place`, `tiger.county`
3. `region_id` This is what TIGER calls the geoid. It is the unique identifier of the region in the table. For place it is the `plcidfp` column in `tiger.place`. For county it is the `cntyidfp` column in `tiger.county`

Availability: 2.0.0

Example: Boston, Massachusetts Topology

Create a topology for Boston, Massachusetts in Mass State Plane Feet (2249) with tolerance 0.25 feet and then load in Boston city tiger faces, edges, nodes.

```
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
-------------------+-----------+-----------
```

Example: Suffolk, Massachusetts Topology

Create a topology for Suffolk, Massachusetts in Mass State Plane Meters (26986) with tolerance 0.25 meters and then load in Suffolk county tiger faces, edges, nodes.

```
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
```

See Also

CreateTopology, CreateTopoGeom, TopologySummary, ValidateTopology

12.1.18 Set_Geocode_Setting

Set_Geocode_Setting — Sets a setting that affects behavior of geocoder functions.

Synopsis

text **Set_Geocode_Setting**(text setting_name, text setting_value);

Description

Sets value of specific setting stored in `tiger.geocode_settings` table. Settings allow you to toggle debugging of functions. Later plans will be to control rating with settings. Current list of settings are listed in Get_Geocode_Setting.

Availability: 2.1.0

Example return debugging setting

If you run Geocode when this function is true, the NOTICE log will output timing and queries.

```
SELECT set_geocode_setting('debug_geocode_address', 'true') As result;
result
---------
true
```

See Also

Get_Geocode_Setting

Chapter 13

PostGIS Special Functions Index

13.1 PostGIS Aggregate Functions

The functions given below are spatial aggregate functions provided with PostGIS that can be used just like any other sql aggregate function such as sum, average.

- ST_3DExtent - an aggregate function that returns the box3D bounding box that bounds rows of geometries.
- ST_Accum - Aggregate. Constructs an array of geometries.
- ST_Collect - Return a specified ST_Geometry value from a collection of other geometries.
- ST_Extent - an aggregate function that returns the bounding box that bounds rows of geometries.
- ST_MakeLine - Creates a Linestring from point or line geometries.
- ST_MemUnion - Same as ST_Union, only memory-friendly (uses less memory and more processor time).
- ST_Polygonize - Aggregate. Creates a GeometryCollection containing possible polygons formed from the constituent linework of a set of geometries.
- ST_SameAlignment - Returns true if rasters have same skew, scale, spatial ref, and offset (pixels can be put on same grid without cutting into pixels) and false if they don't with notice detailing issue.
- ST_Union - Returns a geometry that represents the point set union of the Geometries.
- TopoElementArray_Agg - Returns a topoelementarray for a set of element_id, type arrays (topoelements)

13.2 PostGIS SQL-MM Compliant Functions

The functions given below are PostGIS functions that conform to the SQL/MM 3 standard

Note
SQL-MM defines the default SRID of all geometry constructors as 0. PostGIS uses a default SRID of -1.

- ST_3DDWithin - For 3d (z) geometry type Returns true if two geometries 3d distance is within number of units. This method implements the SQL/MM specification. SQL-MM ?
- ST_3DDistance - For geometry type Returns the 3-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units. This method implements the SQL/MM specification. SQL-MM ?

- ST_3DIntersects - Returns TRUE if the Geometries "spatially intersect" in 3d - only for points and linestrings This method implements the SQL/MM specification. SQL-MM 3: ?
- ST_AddEdgeModFace - Add a new edge and, if in doing so it splits a face, modify the original face and add a new face. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.13
- ST_AddEdgeNewFaces - Add a new edge and, if in doing so it splits a face, delete the original face and replace it with two new faces. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.12
- ST_AddIsoEdge - Adds an isolated edge defined by geometry alinestring to a topology connecting two existing isolated nodes anode and anothernode and returns the edge id of the new edge. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.4
- ST_AddIsoNode - Adds an isolated node to a face in a topology and returns the nodeid of the new node. If face is null, the node is still created. This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X+1.3.1
- ST_Area - Returns the area of the surface if it is a polygon or multi-polygon. For "geometry" type area is in SRID units. For "geography" area is in square meters. This method implements the SQL/MM specification. SQL-MM 3: 8.1.2, 9.5.3
- ST_AsBinary - Return the Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data. This method implements the SQL/MM specification. SQL-MM 3: 5.1.37
- ST_AsText - Return the Well-Known Text (WKT) representation of the geometry/geography without SRID metadata. This method implements the SQL/MM specification. SQL-MM 3: 5.1.25
- ST_Boundary - Returns the closure of the combinatorial boundary of this Geometry. This method implements the SQL/MM specification. SQL-MM 3: 5.1.14
- ST_Buffer - (T) For geometry: Returns a geometry that represents all points whose distance from this Geometry is less than or equal to distance. Calculations are in the Spatial Reference System of this Geometry. For geography: Uses a planar transform wrapper. Introduced in 1.5 support for different end cap and mitre settings to control shape. buffer_style options: quad_segs=#,endcap=round|flat|square,join=round|mitre|bevel,mitre_limit=#.# This method implements the SQL/MM specification. SQL-MM 3: 5.1.17
- ST_Centroid - Returns the geometric center of a geometry. This method implements the SQL/MM specification. SQL-MM 3: 8.1.4, 9.5.5
- ST_ChangeEdgeGeom - Changes the shape of an edge without affecting the topology structure. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details X.3.6
- ST_Contains - Returns true if and only if no points of B lie in the exterior of A, and at least one point of the interior of B lies in the interior of A. This method implements the SQL/MM specification. SQL-MM 3: 5.1.31
- ST_ConvexHull - The convex hull of a geometry represents the minimum convex geometry that encloses all geometries within the set. This method implements the SQL/MM specification. SQL-MM 3: 5.1.16
- ST_CoordDim - Return the coordinate dimension of the ST_Geometry value. This method implements the SQL/MM specification. SQL-MM 3: 5.1.3
- ST_CreateTopoGeo - Adds a collection of geometries to a given empty topology and returns a message detailing success. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details -- X.3.18
- ST_Crosses - Returns TRUE if the supplied geometries have some, but not all, interior points in common. This method implements the SQL/MM specification. SQL-MM 3: 5.1.29
- ST_CurveToLine - Converts a CIRCULARSTRING/CURVEPOLYGON to a LINESTRING/POLYGON This method implements the SQL/MM specification. SQL-MM 3: 7.1.7
- ST_Difference - Returns a geometry that represents that part of geometry A that does not intersect with geometry B. This method implements the SQL/MM specification. SQL-MM 3: 5.1.20
- ST_Dimension - The inherent dimension of this Geometry object, which must be less than or equal to the coordinate dimension. This method implements the SQL/MM specification. SQL-MM 3: 5.1.2

- ST_Disjoint - Returns TRUE if the Geometries do not "spatially intersect" - if they do not share any space together. This method implements the SQL/MM specification. SQL-MM 3: 5.1.26
- ST_Distance - For geometry type Returns the 2-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units. For geography type defaults to return spheroidal minimum distance between two geographies in meters. This method implements the SQL/MM specification. SQL-MM 3: 5.1.23
- ST_EndPoint - Returns the last point of a LINESTRING geometry as a POINT. This method implements the SQL/MM specification. SQL-MM 3: 7.1.4
- ST_Envelope - Returns a geometry representing the double precision (float8) bounding box of the supplied geometry. This method implements the SQL/MM specification. SQL-MM 3: 5.1.15
- ST_Equals - Returns true if the given geometries represent the same geometry. Directionality is ignored. This method implements the SQL/MM specification. SQL-MM 3: 5.1.24
- ST_ExteriorRing - Returns a line string representing the exterior ring of the POLYGON geometry. Return NULL if the geometry is not a polygon. Will not work with MULTIPOLYGON This method implements the SQL/MM specification. SQL-MM 3: 8.2.3, 8.3.3
- ST_GMLToSQL - Return a specified ST_Geometry value from GML representation. This is an alias name for ST_GeomFromGML This method implements the SQL/MM specification. SQL-MM 3: 5.1.50 (except for curves support).
- ST_GeomCollFromText - Makes a collection Geometry from collection WKT with the given SRID. If SRID is not give, it defaults to 0. This method implements the SQL/MM specification.
- ST_GeomFromText - Return a specified ST_Geometry value from Well-Known Text representation (WKT). This method implements the SQL/MM specification. SQL-MM 3: 5.1.40
- ST_GeomFromWKB - Creates a geometry instance from a Well-Known Binary geometry representation (WKB) and optional SRID. This method implements the SQL/MM specification. SQL-MM 3: 5.1.41
- ST_GeometryFromText - Return a specified ST_Geometry value from Well-Known Text representation (WKT). This is an alias name for ST_GeomFromText This method implements the SQL/MM specification. SQL-MM 3: 5.1.40
- ST_GeometryN - Return the 1-based Nth geometry if the geometry is a GEOMETRYCOLLECTION, (MULTI)POINT, (MULTI)LINE MULTICURVE or (MULTI)POLYGON, POLYHEDRALSURFACE Otherwise, return NULL. This method implements the SQL/MM specification. SQL-MM 3: 9.1.5
- ST_GeometryType - Return the geometry type of the ST_Geometry value. This method implements the SQL/MM specification. SQL-MM 3: 5.1.4
- ST_GetFaceEdges - Returns a set of ordered edges that bound aface. This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.5
- ST_GetFaceGeometry - Returns the polygon in the given topology with the specified face id. This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.16
- ST_InitTopoGeo - Creates a new topology schema and registers this new schema in the topology.topology table and details summary of process. This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.17
- ST_InteriorRingN - Return the Nth interior linestring ring of the polygon geometry. Return NULL if the geometry is not a polygon or the given N is out of range. This method implements the SQL/MM specification. SQL-MM 3: 8.2.6, 8.3.5
- ST_Intersection - (T) Returns a geometry that represents the shared portion of geomA and geomB. The geography implementation does a transform to geometry to do the intersection and then transform back to WGS84. This method implements the SQL/MM specification. SQL-MM 3: 5.1.18
- ST_Intersects - Returns TRUE if the Geometries/Geography "spatially intersect in 2D" - (share any portion of space) and FALSE if they don't (they are Disjoint). For geography -- tolerance is 0.00001 meters (so any points that close are considered to intersect) This method implements the SQL/MM specification. SQL-MM 3: 5.1.27

- ST_IsClosed - Returns TRUE if the LINESTRING's start and end points are coincident. For Polyhedral surface is closed (volumetric). This method implements the SQL/MM specification. SQL-MM 3: 7.1.5, 9.3.3
- ST_IsEmpty - Returns true if this Geometry is an empty geometrycollection, polygon, point etc. This method implements the SQL/MM specification. SQL-MM 3: 5.1.7
- ST_IsRing - Returns TRUE if this LINESTRING is both closed and simple. This method implements the SQL/MM specification. SQL-MM 3: 7.1.6
- ST_IsSimple - Returns (TRUE) if this Geometry has no anomalous geometric points, such as self intersection or self tangency. This method implements the SQL/MM specification. SQL-MM 3: 5.1.8
- ST_IsValid - Returns true if the ST_Geometry is well formed. This method implements the SQL/MM specification. SQL-MM 3: 5.1.9
- ST_Length - Returns the 2d length of the geometry if it is a linestring or multilinestring. geometry are in units of spatial reference and geography are in meters (default spheroid) This method implements the SQL/MM specification. SQL-MM 3: 7.1.2, 9.3.4
- ST_LineFromText - Makes a Geometry from WKT representation with the given SRID. If SRID is not given, it defaults to 0. This method implements the SQL/MM specification. SQL-MM 3: 7.2.8
- ST_LineFromWKB - Makes a LINESTRING from WKB with the given SRID This method implements the SQL/MM specification. SQL-MM 3: 7.2.9
- ST_LinestringFromWKB - Makes a geometry from WKB with the given SRID. This method implements the SQL/MM specification. SQL-MM 3: 7.2.9
- ST_M - Return the M coordinate of the point, or NULL if not available. Input must be a point. This method implements the SQL/MM specification.
- ST_MLineFromText - Return a specified ST_MultiLineString value from WKT representation. This method implements the SQL/MM specification.SQL-MM 3: 9.4.4
- ST_MPointFromText - Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to 0. This method implements the SQL/MM specification. SQL-MM 3: 9.2.4
- ST_MPolyFromText - Makes a MultiPolygon Geometry from WKT with the given SRID. If SRID is not give, it defaults to 0. This method implements the SQL/MM specification. SQL-MM 3: 9.6.4
- ST_ModEdgeHeal - Heal two edges by deleting the node connecting them, modifying the first edgeand deleting the second edge. Returns the id of the deleted node. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9
- ST_ModEdgeSplit - Split an edge by creating a new node along an existing edge, modifying the original edge and adding a new edge. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9
- 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. This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X.3.2
- ST_NewEdgeHeal - Heal two edges by deleting the node connecting them, deleting both edges,and replacing them with an edge whose direction is the same as the firstedge provided. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9
- ST_NewEdgesSplit - Split an edge by creating a new node along an existing edge, deleting the original edge and replacing it with two new edges. Returns the id of the new node created that joins the new edges. This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X.3.8
- ST_NumGeometries - If geometry is a GEOMETRYCOLLECTION (or MULTI*) return the number of geometries, for single geometries will return 1, otherwise return NULL. This method implements the SQL/MM specification. SQL-MM 3: 9.1.4

- ST_NumInteriorRings - Return the number of interior rings of the a polygon in the geometry. This will work with POLYGON and return NULL for a MULTIPOLYGON type or any other type This method implements the SQL/MM specification. SQL-MM 3: 8.2.5
- ST_NumPatches - Return the number of faces on a Polyhedral Surface. Will return null for non-polyhedral geometries. This method implements the SQL/MM specification. SQL-MM 3: ?
- ST_NumPoints - Return the number of points in an ST_LineString or ST_CircularString value. This method implements the SQL/MM specification. SQL-MM 3: 7.2.4
- ST_OrderingEquals - Returns true if the given geometries represent the same geometry and points are in the same directional order. This method implements the SQL/MM specification. SQL-MM 3: 5.1.43
- ST_Overlaps - Returns TRUE if the Geometries share space, are of the same dimension, but are not completely contained by each other. This method implements the SQL/MM specification. SQL-MM 3: 5.1.32
- ST_PatchN - Return the 1-based Nth geometry (face) if the geometry is a POLYHEDRALSURFACE, POLYHEDRALSURFACEM. Otherwise, return NULL. This method implements the SQL/MM specification. SQL-MM 3: ?
- ST_Perimeter - Return the length measurement of the boundary of an ST_Surface or ST_MultiSurface geometry or geography. (Polygon, Multipolygon). geometry measurement is in units of spatial reference and geography is in meters. This method implements the SQL/MM specification. SQL-MM 3: 8.1.3, 9.5.4
- ST_Point - Returns an ST_Point with the given coordinate values. OGC alias for ST_MakePoint. This method implements the SQL/MM specification. SQL-MM 3: 6.1.2
- ST_PointFromText - Makes a point Geometry from WKT with the given SRID. If SRID is not given, it defaults to unknown. This method implements the SQL/MM specification. SQL-MM 3: 6.1.8
- ST_PointFromWKB - Makes a geometry from WKB with the given SRID This method implements the SQL/MM specification. SQL-MM 3: 6.1.9
- ST_PointN - Return the Nth point in the first linestring or circular linestring in the geometry. Return NULL if there is no linestring in the geometry. This method implements the SQL/MM specification. SQL-MM 3: 7.2.5, 7.3.5
- ST_PointOnSurface - Returns a POINT guaranteed to lie on the surface. This method implements the SQL/MM specification. SQL-MM 3: 8.1.5, 9.5.6. According to the specs, ST_PointOnSurface works for surface geometries (POLYGONs, MULTIPOLYGONS, CURVED POLYGONS). So PostGIS seems to be extending what the spec allows here. Most databases Oracle,DB II, ESRI SDE seem to only support this function for surfaces. SQL Server 2008 like PostGIS supports for all common geometries.
- ST_Polygon - Returns a polygon built from the specified linestring and SRID. This method implements the SQL/MM specification. SQL-MM 3: 8.3.2
- ST_PolygonFromText - Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to 0. This method implements the SQL/MM specification. SQL-MM 3: 8.3.6
- ST_Relate - Returns true if this Geometry is spatially related to anotherGeometry, by testing for intersections between the Interior, Boundary and Exterior of the two geometries as specified by the values in the intersectionMatrixPattern. If no intersectionMatrixPattern is passed in, then returns the maximum intersectionMatrixPattern that relates the 2 geometries. This method implements the SQL/MM specification. SQL-MM 3: 5.1.25
- ST_RemEdgeModFace - Removes an edge and, if the removed edge separated two faces,delete one of the them and modify the other to take the space of both. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.15
- ST_RemEdgeNewFace - Removes an edge and, if the removed edge separated two faces,delete the original faces and replace them with a new face. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.14
- ST_RemoveIsoEdge - Removes an isolated edge and returns description of action. If the edge is not isolated, then an exception is thrown. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X+1.3.3

- ST_RemoveIsoNode - Removes an isolated node and returns description of action. If the node is not isolated (is start or end of an edge), then an exception is thrown. This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X+1.3.3
- ST_SRID - Returns the spatial reference identifier for the ST_Geometry as defined in spatial_ref_sys table. This method implements the SQL/MM specification. SQL-MM 3: 5.1.5
- ST_StartPoint - Returns the first point of a LINESTRING geometry as a POINT. This method implements the SQL/MM specification. SQL-MM 3: 7.1.3
- ST_SymDifference - Returns a geometry that represents the portions of A and B that do not intersect. It is called a symmetric difference because ST_SymDifference(A,B) = ST_SymDifference(B,A). This method implements the SQL/MM specification. SQL-MM 3: 5.1.21
- ST_Touches - Returns TRUE if the geometries have at least one point in common, but their interiors do not intersect. This method implements the SQL/MM specification. SQL-MM 3: 5.1.28
- ST_Transform - Returns a new geometry with its coordinates transformed to the SRID referenced by the integer parameter. This method implements the SQL/MM specification. SQL-MM 3: 5.1.6
- ST_Union - Returns a geometry that represents the point set union of the Geometries. This method implements the SQL/MM specification. SQL-MM 3: 5.1.19 the z-index (elevation) when polygons are involved.
- ST_WKBToSQL - Return a specified ST_Geometry value from Well-Known Binary representation (WKB). This is an alias name for ST_GeomFromWKB that takes no srid This method implements the SQL/MM specification. SQL-MM 3: 5.1.36
- ST_WKTToSQL - Return a specified ST_Geometry value from Well-Known Text representation (WKT). This is an alias name for ST_GeomFromText This method implements the SQL/MM specification. SQL-MM 3: 5.1.34
- ST_Within - Returns true if the geometry A is completely inside geometry B This method implements the SQL/MM specification. SQL-MM 3: 5.1.30
- ST_X - Return the X coordinate of the point, or NULL if not available. Input must be a point. This method implements the SQL/MM specification. SQL-MM 3: 6.1.3
- ST_Y - Return the Y coordinate of the point, or NULL if not available. Input must be a point. This method implements the SQL/MM specification. SQL-MM 3: 6.1.4
- ST_Z - Return the Z coordinate of the point, or NULL if not available. Input must be a point. This method implements the SQL/MM specification.

13.3 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 tranform - (favoring UTM, Lambert Azimuthal (North/South), and falling back on mercator in worst case scenario)

- ST_Area - Returns the area of the surface if it is a polygon or multi-polygon. For "geometry" type area is in SRID units. For "geography" area is in square meters.
- ST_AsBinary - Return the Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKT - Return the Well-Known Text (WKT) representation of the geometry with SRID meta data.

- ST_AsGML - Return the geometry as a GML version 2 or 3 element.
- ST_AsGeoJSON - Return the geometry as a GeoJSON element.
- ST_AsKML - Return the geometry as a KML element. Several variants. Default version=2, default precision=15
- ST_AsSVG - Returns a Geometry in SVG path data given a geometry or geography object.
- ST_AsText - Return the Well-Known Text (WKT) representation of the geometry/geography without SRID metadata.
- ST_Azimuth - Returns the north-based azimuth as the angle in radians measured clockwise from the vertical on pointA to pointB.
- ST_Buffer - (T) For geometry: Returns a geometry that represents all points whose distance from this Geometry is less than or equal to distance. Calculations are in the Spatial Reference System of this Geometry. For geography: Uses a planar transform wrapper. Introduced in 1.5 support for different end cap and mitre settings to control shape. buffer_style options: quad_segs=#,endcap=round|flat|square,join=round|mitre|bevel,mitre_limit=#.#
- ST_CoveredBy - Returns 1 (TRUE) if no point in Geometry/Geography A is outside Geometry/Geography B
- ST_Covers - Returns 1 (TRUE) if no point in Geometry B is outside Geometry A
- ST_DWithin - Returns true if the geometries are within the specified distance of one another. For geometry units are in those of spatial reference and For geography units are in meters and measurement is defaulted to use_spheroid=true (measure around spheroid), for faster check, use_spheroid=false to measure along sphere.
- ST_Distance - For geometry type Returns the 2-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units. For geography type defaults to return spheroidal minimum distance between two geographies in meters.
- ST_GeogFromText - Return a specified geography value from Well-Known Text representation or extended (WKT).
- ST_GeogFromWKB - Creates a geography instance from a Well-Known Binary geometry representation (WKB) or extended Well Known Binary (EWKB).
- ST_GeographyFromText - Return a specified geography value from Well-Known Text representation or extended (WKT).
- = - Returns TRUE if A's bounding box is the same as B's. Uses double precision bounding box.
- ST_Intersection - (T) Returns a geometry that represents the shared portion of geomA and geomB. The geography implementation does a transform to geometry to do the intersection and then transform back to WGS84.
- ST_Intersects - Returns TRUE if the Geometries/Geography "spatially intersect in 2D" - (share any portion of space) and FALSE if they don't (they are Disjoint). For geography -- tolerance is 0.00001 meters (so any points that close are considered to intersect)
- ST_Length - Returns the 2d length of the geometry if it is a linestring or multilinestring. geometry are in units of spatial reference and geography are in meters (default spheroid)
- ST_Perimeter - Return the length measurement of the boundary of an ST_Surface or ST_MultiSurface geometry or geography. (Polygon, Multipolygon). geometry measurement is in units of spatial reference and geography is in meters.
- ST_Project - Returns a POINT projected from a start point using a distance in meters and bearing (azimuth) in radians.
- ST_Segmentize - Return a modified geometry/geography having no segment longer than the given distance. Distance computation is performed in 2d only. For geometry, length units are in units of spatial reference. For geography, units are in meters.
- ST_Summary - Returns a text summary of the contents of the geometry.
- && - Returns TRUE if A's 2D bounding box intersects B's 2D bounding box.

13.4 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 - Returns the box 3d representation of the enclosing box of the raster.
- @ - Returns TRUE if A's bounding box is contained by B's. Uses double precision bounding box.
- ~ - Returns TRUE if A's bounding box is contains B's. Uses double precision bounding box.
- = - Returns TRUE if A's bounding box is the same as B's. Uses double precision bounding box.
- && - Returns TRUE if A's bounding box intersects B's bounding box.
- &< - Returns TRUE if A's bounding box is to the left of B's.
- &> - Returns TRUE if A's bounding box is to the right of B's.
- ~= - Returns TRUE if A's bounding box is the same as B's.
- ST_AddBand - Returns a raster with the new band(s) of given type added with given initial value in the given index location. If no index is specified, the band is added to the end.
- ST_AsBinary - Return the Well-Known Binary (WKB) representation of the raster without SRID meta data.
- 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_GDALRasters() to get a list of formats supported by your library.
- ST_AsJPEG - Return the raster tile selected bands as a single Joint Photographic Exports Group (JPEG) image (byte array). If no band is specified and 1 or more than 3 bands, then only the first band is used. If only 3 bands then all 3 bands are used and mapped to RGB.
- ST_AsPNG - Return the raster tile selected bands as a single portable network graphics (PNG) image (byte array). If 1, 3, or 4 bands in raster and no bands are specified, then all bands are used. If more 2 or more than 4 bands and no bands specified, then only band 1 is used. Bands are mapped to RGB or RGBA space.
- ST_AsRaster - Converts a PostGIS geometry to a PostGIS raster.
- ST_AsTIFF - Return the raster selected bands as a single TIFF image (byte array). If no band is specified, then will try to use all bands.
- ST_Aspect - Returns the aspect (in degrees by default) of an elevation raster band. Useful for analyzing terrain.
- ST_Band - Returns one or more bands of an existing raster as a new raster. Useful for building new rasters from existing rasters.
- ST_BandIsNoData - Returns true if the band is filled with only nodata values.
- ST_BandMetaData - Returns basic meta data for a specific raster band. band num 1 is assumed if none-specified.
- ST_BandNoDataValue - Returns the value in a given band that represents no data. If no band num 1 is assumed.
- ST_BandPath - Returns system file path to a band stored in file system. If no bandnum specified, 1 is assumed.
- ST_BandPixelType - Returns the type of pixel for given band. If no bandnum specified, 1 is assumed.
- ST_Clip - Returns the raster clipped by the input geometry. If band number not is specified, all bands are processed. If crop is not specified or TRUE, the output raster is cropped.
- ST_ColorMap - Creates a new raster of up to four 8BUI bands (grayscale, RGB, RGBA) from the source raster and a specified band. Band 1 is assumed if not specified.
- ST_Contains - Return true if no points of raster rastB lie in the exterior of raster rastA and at least one point of the interior of rastB lies in the interior of rastA.

- ST_ContainsProperly - Return true if rastB intersects the interior of rastA but not the boundary or exterior of rastA.
- ST_ConvexHull - Return the convex hull geometry of the raster including pixel values equal to BandNoDataValue. For regular shaped and non-skewed rasters, this gives the same result as ST_Envelope so only useful for irregularly shaped or skewed rasters.
- ST_Count - Returns the number of pixels in a given band of a raster or raster coverage. If no band is specified defaults to band 1. If exclude_nodata_value is set to true, will only count pixels that are not equal to the nodata value.
- ST_CoveredBy - Return true if no points of raster rastA lie outside raster rastB.
- ST_Covers - Return true if no points of raster rastB lie outside raster rastA.
- ST_DFullyWithin - Return true if rasters rastA and rastB are fully within the specified distance of each other.
- ST_DWithin - Return true if rasters rastA and rastB are within the specified distance of each other.
- ST_Disjoint - Return true if raster rastA does not spatially intersect rastB.
- ST_DumpAsPolygons - Returns a set of geomval (geom,val) rows, from a given raster band. If no band number is specified, band num defaults to 1.
- ST_DumpValues - Get the values of the specified band as a 2-dimension array.
- ST_Envelope - Returns the polygon representation of the extent of the raster.
- ST_FromGDALRaster - Returns a raster from a supported GDAL raster file.
- ST_GeoReference - Returns the georeference meta data in GDAL or ESRI format as commonly seen in a world file. Default is GDAL.
- ST_HasNoBand - Returns true if there is no band with given band number. If no band number is specified, then band number 1 is assumed.
- ST_Height - Returns the height of the raster in pixels.
- ST_HillShade - Returns the hypothetical illumination of an elevation raster band using provided azimuth, altitude, brightness and scale inputs.
- ST_Histogram - Returns a set of record summarizing a raster or raster coverage data distribution separate bin ranges. Number of bins are autocomputed if not specified.
- ST_Intersection - Returns a raster or a set of geometry-pixelvalue pairs representing the shared portion of two rasters or the geometrical intersection of a vectorization of the raster and a geometry.
- ST_Intersects - Return true if raster rastA spatially intersects raster rastB.
- ST_IsEmpty - Returns true if the raster is empty (width = 0 and height = 0). Otherwise, returns false.
- ST_MakeEmptyRaster - Returns an empty raster (having no bands) of given dimensions (width & height), upperleft X and Y, pixel size and rotation (scalex, scaley, skewx & skewy) and reference system (srid). If a raster is passed in, returns a new raster with the same size, alignment and SRID. If srid is left out, the spatial ref is set to unknown (0).
- ST_MapAlgebra - Callback function version - Returns a one-band raster given one or more input rasters, band indexes and one user-specified callback function.
- ST_MapAlgebraExpr - 1 raster band version: Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation on the input raster band and of pixeltype provided. Band 1 is assumed if no band is specified.
- ST_MapAlgebraExpr - 2 raster band version: Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation on the two input raster bands and of pixeltype provided. band 1 of each raster is assumed if no band numbers are specified. The resulting raster will be aligned (scale, skew and pixel corners) on the grid defined by the first raster and have its extent defined by the "extenttype" parameter. Values for "extenttype" can be: INTERSECTION, UNION, FIRST, SECOND.
- ST_MapAlgebraFct - 1 band version - Creates a new one band raster formed by applying a valid PostgreSQL function on the input raster band and of pixeltype prodived. Band 1 is assumed if no band is specified.

- ST_MapAlgebraFct - 2 band version - Creates a new one band raster formed by applying a valid PostgreSQL function on the 2 input raster bands and of pixeltype prodived. Band 1 is assumed if no band is specified. Extent type defaults to INTERSECTION if not specified.
- ST_MapAlgebraFctNgb - 1-band version: Map Algebra Nearest Neighbor using user-defined PostgreSQL function. Return a raster which values are the result of a PLPGSQL user function involving a neighborhood of values from the input raster band.
- ST_MapAlgebra - Expression version - Returns a one-band raster given one or two input rasters, band indexes and one or more user-specified SQL expressions.
- ST_MetaData - Returns basic meta data about a raster object such as pixel size, rotation (skew), upper, lower left, etc.
- ST_MinConvexHull - Return the convex hull geometry of the raster excluding NODATA pixels.
- ST_NearestValue - Returns the nearest non-NODATA value of a given band's pixel specified by a columnx and rowy or a geometric point expressed in the same spatial reference coordinate system as the raster.
- ST_Neighborhood - Returns a 2-D double precision array of the non-NODATA values around a given band's pixel specified by either a columnX and rowY or a geometric point expressed in the same spatial reference coordinate system as the raster.
- ST_NotSameAlignmentReason - Returns text stating if rasters are aligned and if not aligned, a reason why.
- ST_NumBands - Returns the number of bands in the raster object.
- ST_Overlaps - Return true if raster rastA and rastB intersect but one does not completely contain the other.
- ST_PixelAsCentroid - Returns the centroid (point geometry) of the area represented by a pixel.
- ST_PixelAsCentroids - Returns the centroid (point geometry) for each pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel. The point geometry is the centroid of the area represented by a pixel.
- ST_PixelAsPoint - Returns a point geometry of the pixel's upper-left corner.
- ST_PixelAsPoints - Returns a point geometry for each pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel. The coordinates of the point geometry are of the pixel's upper-left corner.
- ST_PixelAsPolygon - Returns the polygon geometry that bounds the pixel for a particular row and column.
- ST_PixelAsPolygons - Returns the polygon geometry that bounds every pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel.
- ST_PixelHeight - Returns the pixel height in geometric units of the spatial reference system.
- ST_PixelOfValue - Get the columnx, rowy coordinates of the pixel whose value equals the search value.
- ST_PixelWidth - Returns the pixel width in geometric units of the spatial reference system.
- ST_Polygon - Returns a multipolygon geometry formed by the union of pixels that have a pixel value that is not no data value. If no band number is specified, band num defaults to 1.
- ST_Quantile - Compute quantiles for a raster or raster table coverage in the context of the sample or population. Thus, a value could be examined to be at the raster's 25%, 50%, 75% percentile.
- ST_RasterToWorldCoord - Returns the raster's upper left corner as geometric X and Y (longitude and latitude) given a column and row. Column and row starts at 1.
- ST_RasterToWorldCoordX - Returns the geometric X coordinate upper left of a raster, column and row. Numbering of columns and rows starts at 1.
- ST_RasterToWorldCoordY - Returns the geometric Y coordinate upper left corner of a raster, column and row. Numbering of columns and rows starts at 1.
- ST_Reclass - Creates a new raster composed of band types reclassified from original. The nband is the band to be changed. If nband is not specified assumed to be 1. All other bands are returned unchanged. Use case: convert a 16BUI band to a 8BUI and so forth for simpler rendering as viewable formats.

- ST_Resample - Resample a raster using a specified resampling algorithm, new dimensions, an arbitrary grid corner and a set of raster georeferencing attributes defined or borrowed from another raster.
- 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 or Lanczos resampling algorithm. Default is NearestNeighbor.
- ST_Resize - Resize a raster to a new width/height
- ST_Reskew - Resample a raster by adjusting only its skew (or rotation parameters). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. Default is NearestNeighbor.
- ST_Rotation - Returns the rotation of the raster in radian.
- ST_Roughness - Returns a raster with the calculated "roughness" of a DEM.
- ST_SRID - Returns the spatial reference identifier of the raster as defined in spatial_ref_sys table.
- ST_SameAlignment - Returns true if rasters have same skew, scale, spatial ref, and offset (pixels can be put on same grid without cutting into pixels) and false if they don't with notice detailing issue.
- ST_ScaleX - Returns the X component of the pixel width in units of coordinate reference system.
- ST_ScaleY - Returns the Y component of the pixel height in units of coordinate reference system.
- ST_SetBandIsNoData - Sets the isnodata flag of the band to TRUE.
- ST_SetBandNoDataValue - Sets the value for the given band that represents no data. Band 1 is assumed if no band is specified. To mark a band as having no nodata value, set the nodata value = NULL.
- ST_SetGeoReference - Set Georeference 6 georeference parameters in a single call. Numbers should be separated by white space. Accepts inputs in GDAL or ESRI format. Default is GDAL.
- ST_SetRotation - Set the rotation of the raster in radian.
- ST_SetSRID - Sets the SRID of a raster to a particular integer srid defined in the spatial_ref_sys table.
- ST_SetScale - Sets the X and Y size of pixels in units of coordinate reference system. Number units/pixel width/height.
- ST_SetSkew - Sets the georeference X and Y skew (or rotation parameter). If only one is passed in, sets X and Y to the same value.
- ST_SetUpperLeft - Sets the value of the upper left corner of the pixel to projected X and Y coordinates.
- ST_SetValue - Returns modified raster resulting from setting the value of a given band in a given columnx, rowy pixel or the pixels that intersect a particular geometry. Band numbers start at 1 and assumed to be 1 if not specified.
- ST_SetValues - Returns modified raster resulting from setting the values of a given band.
- ST_SkewX - Returns the georeference X skew (or rotation parameter).
- ST_SkewY - Returns the georeference Y skew (or rotation parameter).
- ST_Slope - Returns the slope (in degrees by default) of an elevation raster band. Useful for analyzing terrain.
- ST_SnapToGrid - Resample a raster by snapping it to a grid. New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. Default is NearestNeighbor.
- ST_Summary - Returns a text summary of the contents of the raster.
- ST_SummaryStats - Returns record consisting of count, sum, mean, stddev, min, max for a given raster band of a raster or raster coverage. Band 1 is assumed is no band is specified.
- ST_TPI - Returns a raster with the calculated Topographic Position Index.

- ST_TRI - Returns a raster with the calculated Terrain Ruggedness Index.
- ST_Tile - Returns a set of rasters resulting from the split of the input raster based upon the desired dimensions of the output rasters.
- ST_Touches - Return true if raster rastA and rastB have at least one point in common but their interiors do not intersect.
- ST_Transform - Reprojects a raster in a known spatial reference system to another known spatial reference system using specified resampling algorithm. Options are NearestNeighbor, Bilinear, Cubic, CubicSpline, Lanczos defaulting to NearestNeighbor.
- ST_Union - Returns the union of a set of raster tiles into a single raster composed of 1 or more bands.
- ST_UpperLeftX - Returns the upper left X coordinate of raster in projected spatial ref.
- ST_UpperLeftY - Returns the upper left Y coordinate of raster in projected spatial ref.
- ST_Value - Returns the value of a given band in a given columnx, rowy pixel or at a particular geometric point. Band numbers start at 1 and assumed to be 1 if not specified. If exclude_nodata_value is set to false, then all pixels include nodata pixels are considered to intersect and return value. If exclude_nodata_value is not passed in then reads it from metadata of raster.
- ST_ValueCount - Returns a set of records containing a pixel band value and count of the number of pixels in a given band of a raster (or a raster coverage) that have a given set of values. If no band is specified defaults to band 1. By default nodata value pixels are not counted. and all other values in the pixel are output and pixel band values are rounded to the nearest integer.
- ST_Width - Returns the width of the raster in pixels.
- ST_Within - Return true if no points of raster rastA lie in the exterior of raster rastB and at least one point of the interior of rastA lies in the interior of rastB.
- ST_WorldToRasterCoord - Returns the upper left corner as column and row given geometric X and Y (longitude and latitude) or a point geometry expressed in the spatial reference coordinate system of the raster.
- ST_WorldToRasterCoordX - Returns the column in the raster of the point geometry (pt) or a X and Y world coordinate (xw, yw) represented in world spatial reference system of raster.
- ST_WorldToRasterCoordY - Returns the row in the raster of the point geometry (pt) or a X and Y world coordinate (xw, yw) represented in world spatial reference system of raster.
- UpdateRasterSRID - Change the SRID of all rasters in the user-specified column and table.

13.5 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 - Returns a set of geomval (geom,val) rows, from a given raster band. If no band number is specified, band num defaults to 1.
- ST_Intersection - Returns a raster or a set of geometry-pixelvalue pairs representing the shared portion of two rasters or the geometrical intersection of a vectorization of the raster and a geometry.
- ST_Dump - Returns a set of geometry_dump (geom,path) rows, that make up a geometry g1.
- ST_DumpPoints - Returns a set of geometry_dump (geom,path) rows of all points that make up a geometry.
- ST_DumpRings - Returns a set of geometry_dump rows, representing the exterior and interior rings of a polygon.

13.6 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 maximum extents of the geometry.
- Box3D - Returns a BOX3D representing the maximum extents of the geometry.
- Box3D - Returns the box 3d representation of the enclosing box of the raster.
- ST_3DExtent - an aggregate function that returns the box3D bounding box that bounds rows of geometries.
- ST_3DMakeBox - Creates a BOX3D defined by the given 3d point geometries.
- ST_Box2dFromGeoHash - Return a BOX2D from a GeoHash string.
- ST_EstimatedExtent - Return the 'estimated' extent of the given spatial table. The estimated is taken from the geometry column's statistics. The current schema will be used if not specified.
- ST_Expand - Returns bounding box expanded in all directions from the bounding box of the input geometry. Uses double-precision
- ST_Extent - an aggregate function that returns the bounding box that bounds rows of geometries.
- ST_MakeBox2D - Creates a BOX2D defined by the given point geometries.
- ST_XMax - Returns X maxima of a bounding box 2d or 3d or a geometry.
- ST_XMin - Returns X minima of a bounding box 2d or 3d or a geometry.
- ST_YMax - Returns Y maxima of a bounding box 2d or 3d or a geometry.
- ST_YMin - Returns Y minima of a bounding box 2d or 3d or a geometry.
- ST_ZMax - Returns Z minima of a bounding box 2d or 3d or a geometry.
- ST_ZMin - Returns Z minima of a bounding box 2d or 3d or a geometry.

13.7 PostGIS Functions that support 3D

The functions given below are PostGIS functions that do not throw away the Z-Index.

- AddGeometryColumn - Adds a geometry column to an existing table of attributes. By default uses type modifier to define rather than constraints. Pass in false for use_typmod to get old check constraint based behavior
- Box3D - Returns a BOX3D representing the maximum extents of the geometry.
- DropGeometryColumn - Removes a geometry column from a spatial table.
- GeometryType - Returns the type of the geometry as a string. Eg: 'LINESTRING', 'POLYGON', 'MULTIPOINT', etc.
- ST_3DArea - Computes area of 3D geometries
- ST_3DClosestPoint - Returns the 3-dimensional point on g1 that is closest to g2. This is the first point of the 3D shortest line.
- ST_3DDFullyWithin - Returns true if all of the 3D geometries are within the specified distance of one another.
- ST_3DDWithin - For 3d (z) geometry type Returns true if two geometries 3d distance is within number of units.
- ST_3DDistance - For geometry type Returns the 3-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units.

- ST_3DExtent - an aggregate function that returns the box3D bounding box that bounds rows of geometries.
- ST_3DIntersection - Perform 3D intersection
- ST_3DIntersects - Returns TRUE if the Geometries "spatially intersect" in 3d - only for points and linestrings
- ST_3DLength - Returns the 3-dimensional or 2-dimensional length of the geometry if it is a linestring or multi-linestring.
- ST_3DLength_Spheroid - Calculates the length of a geometry on an ellipsoid, taking the elevation into account. This is just an alias for ST_Length_Spheroid.
- ST_3DLongestLine - Returns the 3-dimensional longest line between two geometries
- ST_3DMakeBox - Creates a BOX3D defined by the given 3d point geometries.
- ST_3DMaxDistance - For geometry type Returns the 3-dimensional cartesian maximum distance (based on spatial ref) between two geometries in projected units.
- ST_3DPerimeter - Returns the 3-dimensional perimeter of the geometry, if it is a polygon or multi-polygon.
- ST_3DShortestLine - Returns the 3-dimensional shortest line between two geometries
- ST_Accum - Aggregate. Constructs an array of geometries.
- ST_AddMeasure - Return a derived geometry with measure elements linearly interpolated between the start and end points. If the geometry has no measure dimension, one is added. If the geometry has a measure dimension, it is over-written with new values. Only LINESTRINGS and MULTILINESTRINGS are supported.
- ST_AddPoint - Adds a point to a LineString before point <position> (0-based index).
- ST_Affine - Applies a 3d affine transformation to the geometry to do things like translate, rotate, scale in one step.
- ST_AsBinary - Return the Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKB - Return the Well-Known Binary (WKB) representation of the geometry with SRID meta data.
- ST_AsEWKT - Return the Well-Known Text (WKT) representation of the geometry with SRID meta data.
- ST_AsGML - Return the geometry as a GML version 2 or 3 element.
- ST_AsGeoJSON - Return the geometry as a GeoJSON element.
- ST_AsHEXEWKB - Returns a Geometry in HEXEWKB format (as text) using either little-endian (NDR) or big-endian (XDR) encoding.
- ST_AsKML - Return the geometry as a KML element. Several variants. Default version=2, default precision=15
- ST_AsX3D - Returns a Geometry in X3D xml node element format: ISO-IEC-19776-1.2-X3DEncodings-XML
- ST_Boundary - Returns the closure of the combinatorial boundary of this Geometry.
- ST_Collect - Return a specified ST_Geometry value from a collection of other geometries.
- ST_ConvexHull - The convex hull of a geometry represents the minimum convex geometry that encloses all geometries within the set.
- ST_CoordDim - Return the coordinate dimension of the ST_Geometry value.
- ST_CurveToLine - Converts a CIRCULARSTRING/CURVEPOLYGON to a LINESTRING/POLYGON
- ST_DelaunayTriangles - Return a Delaunay triangulation around the given input points.
- ST_Difference - Returns a geometry that represents that part of geometry A that does not intersect with geometry B.
- ST_Dump - Returns a set of geometry_dump (geom,path) rows, that make up a geometry g1.
- ST_DumpPoints - Returns a set of geometry_dump (geom,path) rows of all points that make up a geometry.

- ST_DumpRings - Returns a set of geometry_dump rows, representing the exterior and interior rings of a polygon.
- ST_EndPoint - Returns the last point of a LINESTRING geometry as a POINT.
- ST_ExteriorRing - Returns a line string representing the exterior ring of the POLYGON geometry. Return NULL if the geometry is not a polygon. Will not work with MULTIPOLYGON
- ST_Extrude - Extrude a surface to a related volume
- ST_FlipCoordinates - Returns a version of the given geometry with X and Y axis flipped. Useful for people who have built latitude/longitude features and need to fix them.
- ST_ForceLHR - Force LHR orientation
- ST_ForceRHR - Forces the orientation of the vertices in a polygon to follow the Right-Hand-Rule.
- ST_ForceSFS - Forces the geometries to use SFS 1.1 geometry types only.
- ST_Force_2D - Forces the geometries into a "2-dimensional mode" so that all output representations will only have the X and Y coordinates.
- ST_Force_3D - Forces the geometries into XYZ mode. This is an alias for ST_Force3DZ.
- ST_Force_3DZ - Forces the geometries into XYZ mode. This is a synonym for ST_Force3D.
- ST_Force_4D - Forces the geometries into XYZM mode.
- ST_Force_Collection - Converts the geometry into a GEOMETRYCOLLECTION.
- ST_GeomFromEWKB - Return a specified ST_Geometry value from Extended Well-Known Binary representation (EWKB).
- ST_GeomFromEWKT - Return a specified ST_Geometry value from Extended Well-Known Text representation (EWKT).
- ST_GeomFromGML - Takes as input GML representation of geometry and outputs a PostGIS geometry object
- ST_GeomFromGeoJSON - Takes as input a geojson representation of a geometry and outputs a PostGIS geometry object
- ST_GeomFromKML - Takes as input KML representation of geometry and outputs a PostGIS geometry object
- ST_GeometryN - Return the 1-based Nth geometry if the geometry is a GEOMETRYCOLLECTION, (MULTI)POINT, (MULTI)LINE MULTICURVE or (MULTI)POLYGON, POLYHEDRALSURFACE Otherwise, return NULL.
- ST_GeometryType - Return the geometry type of the ST_Geometry value.
- ST_HasArc - Returns true if a geometry or geometry collection contains a circular string
- ST_InteriorRingN - Return the Nth interior linestring ring of the polygon geometry. Return NULL if the geometry is not a polygon or the given N is out of range.
- ST_InterpolatePoint - Return the value of the measure dimension of a geometry at the point closed to the provided point.
- ST_IsClosed - Returns TRUE if the LINESTRING's start and end points are coincident. For Polyhedral surface is closed (volumetric).
- ST_IsCollection - Returns TRUE if the argument is a collection (MULTI*, GEOMETRYCOLLECTION, ...)
- ST_IsSimple - Returns (TRUE) if this Geometry has no anomalous geometric points, such as self intersection or self tangency.
- ST_Length_Spheroid - Calculates the 2D or 3D length/perimeter of a geometry on an ellipsoid. This is useful if the coordinates of the geometry are in longitude/latitude and a length is desired without reprojection.
- ST_LineFromMultiPoint - Creates a LineString from a MultiPoint geometry.
- ST_LineInterpolatePoint - Returns a point interpolated along a line. Second argument is a float8 between 0 and 1 representing fraction of total length of linestring the point has to be located.

- ST_LineSubstring - Return a linestring being a substring of the input one starting and ending at the given fractions of total 2d length. Second and third arguments are float8 values between 0 and 1.
- ST_LineToCurve - Converts a LINESTRING/POLYGON to a CIRCULARSTRING, CURVEPOLYGON
- ST_LocateBetweenElevations - Return a derived geometry (collection) value with elements that intersect the specified range of elevations inclusively. Only 3D, 4D LINESTRINGS and MULTILINESTRINGS are supported.
- ST_M - Return the M coordinate of the point, or NULL if not available. Input must be a point.
- ST_MakeLine - Creates a Linestring from point or line geometries.
- ST_MakePoint - Creates a 2D,3DZ or 4D point geometry.
- ST_MakePolygon - Creates a Polygon formed by the given shell. Input geometries must be closed LINESTRINGS.
- ST_MakeValid - Attempts to make an invalid geometry valid without losing vertices.
- ST_MemUnion - Same as ST_Union, only memory-friendly (uses less memory and more processor time).
- ST_Mem_Size - Returns the amount of space (in bytes) the geometry takes.
- ST_MinkowskiSum - Performs Minkowski sum
- ST_NDims - Returns coordinate dimension of the geometry as a small int. Values are: 2,3 or 4.
- ST_NPoints - Return the number of points (vertexes) in a geometry.
- ST_NRings - If the geometry is a polygon or multi-polygon returns the number of rings.
- ST_Node - Node a set of linestrings.
- ST_NumGeometries - If geometry is a GEOMETRYCOLLECTION (or MULTI*) return the number of geometries, for single geometries will return 1, otherwise return NULL.
- ST_NumPatches - Return the number of faces on a Polyhedral Surface. Will return null for non-polyhedral geometries.
- ST_Orientation - Determine surface orientation
- ST_PatchN - Return the 1-based Nth geometry (face) if the geometry is a POLYHEDRALSURFACE, POLYHEDRALSURFACEM. Otherwise, return NULL.
- ST_PointFromWKB - Makes a geometry from WKB with the given SRID
- ST_PointN - Return the Nth point in the first linestring or circular linestring in the geometry. Return NULL if there is no linestring in the geometry.
- ST_PointOnSurface - Returns a POINT guaranteed to lie on the surface.
- ST_Polygon - Returns a polygon built from the specified linestring and SRID.
- ST_RemovePoint - Removes point from a linestring. Offset is 0-based.
- ST_RemoveRepeatedPoints - Returns a version of the given geometry with duplicated points removed.
- ST_Rotate - Rotate a geometry rotRadians counter-clockwise about an origin.
- ST_RotateX - Rotate a geometry rotRadians about the X axis.
- ST_RotateY - Rotate a geometry rotRadians about the Y axis.
- ST_RotateZ - Rotate a geometry rotRadians about the Z axis.
- ST_Scale - Scales the geometry to a new size by multiplying the ordinates with the parameters. Ie: ST_Scale(geom, Xfactor, Yfactor, Zfactor).
- ST_SetPoint - Replace point N of linestring with given point. Index is 0-based.

- ST_Shift_Longitude - Reads every point/vertex in every component of every feature in a geometry, and if the longitude coordinate is <0, adds 360 to it. The result would be a 0-360 version of the data to be plotted in a 180 centric map
- ST_SnapToGrid - Snap all points of the input geometry to a regular grid.
- ST_StartPoint - Returns the first point of a LINESTRING geometry as a POINT.
- ST_StraightSkeleton - Compute a straight skeleton from a geometry
- ST_SymDifference - Returns a geometry that represents the portions of A and B that do not intersect. It is called a symmetric difference because ST_SymDifference(A,B) = ST_SymDifference(B,A).
- ST_Tesselate - Perform surface Tesselation
- ST_TransScale - Translates the geometry using the deltaX and deltaY args, then scales it using the XFactor, YFactor args, working in 2D only.
- ST_Translate - Translates the geometry to a new location using the numeric parameters as offsets. Ie: ST_Translate(geom, X, Y) or ST_Translate(geom, X, Y,Z).
- ST_UnaryUnion - Like ST_Union, but working at the geometry component level.
- ST_X - Return the X coordinate of the point, or NULL if not available. Input must be a point.
- ST_XMax - Returns X maxima of a bounding box 2d or 3d or a geometry.
- ST_XMin - Returns X minima of a bounding box 2d or 3d or a geometry.
- ST_Y - Return the Y coordinate of the point, or NULL if not available. Input must be a point.
- ST_YMax - Returns Y maxima of a bounding box 2d or 3d or a geometry.
- ST_YMin - Returns Y minima of a bounding box 2d or 3d or a geometry.
- ST_Z - Return the Z coordinate of the point, or NULL if not available. Input must be a point.
- ST_ZMax - Returns Z minima of a bounding box 2d or 3d or a geometry.
- ST_ZMin - Returns Z minima of a bounding box 2d or 3d or a geometry.
- ST_Zmflag - Returns ZM (dimension semantic) flag of the geometries as a small int. Values are: 0=2d, 1=3dm, 2=3dz, 3=4d.
- TG_Equals - Returns true if two topogeometries are composed of the same topology primitives.
- TG_Intersects - Returns true if any pair of primitives from thetwo topogeometries intersect.
- UpdateGeometrySRID - Updates the SRID of all features in a geometry column, geometry_columns metadata and srid. If it was enforced with constraints, the constraints will be updated with new srid constraint. If the old was enforced by type definition, the type definition will be changed.
- geometry_overlaps_nd - Returns TRUE if A's n-D bounding box intersects B's n-D bounding box.
- postgis_sfcgal_version - Returns the version of SFCGAL in use

13.8 PostGIS Curved Geometry Support Functions

The functions given below are PostGIS functions that can use CIRCULARSTRING, CURVEPOLYGON, and other curved geometry types

- AddGeometryColumn - Adds a geometry column to an existing table of attributes. By default uses type modifier to define rather than constraints. Pass in false for use_typmod to get old check constraint based behavior
- Box2D - Returns a BOX2D representing the maximum extents of the geometry.

- Box3D - Returns a BOX3D representing the maximum extents of the geometry.
- DropGeometryColumn - Removes a geometry column from a spatial table.
- GeometryType - Returns the type of the geometry as a string. Eg: 'LINESTRING', 'POLYGON', 'MULTIPOINT', etc.
- PostGIS_AddBBox - Add bounding box to the geometry.
- PostGIS_DropBBox - Drop the bounding box cache from the geometry.
- PostGIS_HasBBox - Returns TRUE if the bbox of this geometry is cached, FALSE otherwise.
- ST_3DExtent - an aggregate function that returns the box3D bounding box that bounds rows of geometries.
- ST_Accum - Aggregate. Constructs an array of geometries.
- ST_Affine - Applies a 3d affine transformation to the geometry to do things like translate, rotate, scale in one step.
- ST_AsBinary - Return the Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKB - Return the Well-Known Binary (WKB) representation of the geometry with SRID meta data.
- ST_AsEWKT - Return the Well-Known Text (WKT) representation of the geometry with SRID meta data.
- ST_AsHEXEWKB - Returns a Geometry in HEXEWKB format (as text) using either little-endian (NDR) or big-endian (XDR) encoding.
- ST_AsText - Return the Well-Known Text (WKT) representation of the geometry/geography without SRID metadata.
- ST_Collect - Return a specified ST_Geometry value from a collection of other geometries.
- ST_CoordDim - Return the coordinate dimension of the ST_Geometry value.
- ST_CurveToLine - Converts a CIRCULARSTRING/CURVEPOLYGON to a LINESTRING/POLYGON
- ST_Distance - For geometry type Returns the 2-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units. For geography type defaults to return spheroidal minimum distance between two geographies in meters.
- ST_Dump - Returns a set of geometry_dump (geom,path) rows, that make up a geometry g1.
- ST_DumpPoints - Returns a set of geometry_dump (geom,path) rows of all points that make up a geometry.
- ST_EstimatedExtent - Return the 'estimated' extent of the given spatial table. The estimated is taken from the geometry column's statistics. The current schema will be used if not specified.
- ST_FlipCoordinates - Returns a version of the given geometry with X and Y axis flipped. Useful for people who have built latitude/longitude features and need to fix them.
- ST_ForceSFS - Forces the geometries to use SFS 1.1 geometry types only.
- ST_Force2D - Forces the geometries into a "2-dimensional mode" so that all output representations will only have the X and Y coordinates.
- ST_Force3D - Forces the geometries into XYZ mode. This is an alias for ST_Force3DZ.
- ST_Force3DM - Forces the geometries into XYM mode.
- ST_Force3DZ - Forces the geometries into XYZ mode. This is a synonym for ST_Force3D.
- ST_Force4D - Forces the geometries into XYZM mode.
- ST_ForceCollection - Converts the geometry into a GEOMETRYCOLLECTION.
- ST_GeoHash - Return a GeoHash representation of the geometry.
- ST_GeogFromWKB - Creates a geography instance from a Well-Known Binary geometry representation (WKB) or extended Well Known Binary (EWKB).

- ST_GeomFromEWKB - Return a specified ST_Geometry value from Extended Well-Known Binary representation (EWKB).
- ST_GeomFromEWKT - Return a specified ST_Geometry value from Extended Well-Known Text representation (EWKT).
- ST_GeomFromText - Return a specified ST_Geometry value from Well-Known Text representation (WKT).
- ST_GeomFromWKB - Creates a geometry instance from a Well-Known Binary geometry representation (WKB) and optional SRID.
- ST_GeometryN - Return the 1-based Nth geometry if the geometry is a GEOMETRYCOLLECTION, (MULTI)POINT, (MULTI)LINE MULTICURVE or (MULTI)POLYGON, POLYHEDRALSURFACE Otherwise, return NULL.
- = - Returns TRUE if A's bounding box is the same as B's. Uses double precision bounding box.
- &<| - Returns TRUE if A's bounding box overlaps or is below B's.
- ST_HasArc - Returns true if a geometry or geometry collection contains a circular string
- ST_IsClosed - Returns TRUE if the LINESTRING's start and end points are coincident. For Polyhedral surface is closed (volumetric).
- ST_IsCollection - Returns TRUE if the argument is a collection (MULTI*, GEOMETRYCOLLECTION, ...)
- ST_IsEmpty - Returns true if this Geometry is an empty geometrycollection, polygon, point etc.
- ST_LineToCurve - Converts a LINESTRING/POLYGON to a CIRCULARSTRING, CURVEPOLYGON
- ST_Mem_Size - Returns the amount of space (in bytes) the geometry takes.
- ST_NPoints - Return the number of points (vertexes) in a geometry.
- ST_NRings - If the geometry is a polygon or multi-polygon returns the number of rings.
- ST_PointFromWKB - Makes a geometry from WKB with the given SRID
- ST_PointN - Return the Nth point in the first linestring or circular linestring in the geometry. Return NULL if there is no linestring in the geometry.
- ST_Rotate - Rotate a geometry rotRadians counter-clockwise about an origin.
- ST_RotateZ - Rotate a geometry rotRadians about the Z axis.
- ST_SRID - Returns the spatial reference identifier for the ST_Geometry as defined in spatial_ref_sys table.
- ST_Scale - Scales the geometry to a new size by multiplying the ordinates with the parameters. Ie: ST_Scale(geom, Xfactor, Yfactor, Zfactor).
- ST_SetSRID - Sets the SRID on a geometry to a particular integer value.
- ST_TransScale - Translates the geometry using the deltaX and deltaY args, then scales it using the XFactor, YFactor args, working in 2D only.
- ST_Transform - Returns a new geometry with its coordinates transformed to the SRID referenced by the integer parameter.
- ST_Translate - Translates the geometry to a new location using the numeric parameters as offsets. Ie: ST_Translate(geom, X, Y) or ST_Translate(geom, X, Y,Z).
- ST_XMax - Returns X maxima of a bounding box 2d or 3d or a geometry.
- ST_XMin - Returns X minima of a bounding box 2d or 3d or a geometry.
- ST_YMax - Returns Y maxima of a bounding box 2d or 3d or a geometry.
- ST_YMin - Returns Y minima of a bounding box 2d or 3d or a geometry.
- ST_ZMax - Returns Z minima of a bounding box 2d or 3d or a geometry.

- ST_ZMin - Returns Z minima of a bounding box 2d or 3d or a geometry.
- ST_Zmflag - Returns ZM (dimension semantic) flag of the geometries as a small int. Values are: 0=2d, 1=3dm, 2=3dz, 3=4d.
- UpdateGeometrySRID - Updates the SRID of all features in a geometry column, geometry_columns metadata and srid. If it was enforced with constraints, the constraints will be updated with new srid constraint. If the old was enforced by type definition, the type definition will be changed.
- && - Returns TRUE if A's 2D bounding box intersects B's 2D bounding box.
- &&& - Returns TRUE if A's n-D bounding box intersects B's n-D bounding box.

13.9 PostGIS Polyhedral Surface Support Functions

The functions given below are PostGIS functions that can use POLYHEDRALSURFACE, POLYHEDRALSURFACEM geometries

- Box2D - Returns a BOX2D representing the maximum extents of the geometry.
- Box3D - Returns a BOX3D representing the maximum extents of the geometry.
- GeometryType - Returns the type of the geometry as a string. Eg: 'LINESTRING', 'POLYGON', 'MULTIPOINT', etc.
- ST_3DArea - Computes area of 3D geometries
- ST_3DClosestPoint - Returns the 3-dimensional point on g1 that is closest to g2. This is the first point of the 3D shortest line.
- ST_3DDFullyWithin - Returns true if all of the 3D geometries are within the specified distance of one another.
- ST_3DDWithin - For 3d (z) geometry type Returns true if two geometries 3d distance is within number of units.
- ST_3DDistance - For geometry type Returns the 3-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units.
- ST_3DExtent - an aggregate function that returns the box3D bounding box that bounds rows of geometries.
- ST_3DIntersection - Perform 3D intersection
- ST_3DIntersects - Returns TRUE if the Geometries "spatially intersect" in 3d - only for points and linestrings
- ST_3DLongestLine - Returns the 3-dimensional longest line between two geometries
- ST_3DMaxDistance - For geometry type Returns the 3-dimensional cartesian maximum distance (based on spatial ref) between two geometries in projected units.
- ST_3DShortestLine - Returns the 3-dimensional shortest line between two geometries
- ST_Accum - Aggregate. Constructs an array of geometries.
- ST_Affine - Applies a 3d affine transformation to the geometry to do things like translate, rotate, scale in one step.
- ST_Area - Returns the area of the surface if it is a polygon or multi-polygon. For "geometry" type area is in SRID units. For "geography" area is in square meters.
- ST_AsBinary - Return the Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsEWKB - Return the Well-Known Binary (WKB) representation of the geometry with SRID meta data.
- ST_AsEWKT - Return the Well-Known Text (WKT) representation of the geometry with SRID meta data.
- ST_AsGML - Return the geometry as a GML version 2 or 3 element.
- ST_AsX3D - Returns a Geometry in X3D xml node element format: ISO-IEC-19776-1.2-X3DEncodings-XML

- ST_CoordDim - Return the coordinate dimension of the ST_Geometry value.
- ST_Dimension - The inherent dimension of this Geometry object, which must be less than or equal to the coordinate dimension.
- ST_Dump - Returns a set of geometry_dump (geom,path) rows, that make up a geometry g1.
- ST_DumpPoints - Returns a set of geometry_dump (geom,path) rows of all points that make up a geometry.
- ST_Expand - Returns bounding box expanded in all directions from the bounding box of the input geometry. Uses double-precision
- ST_Extent - an aggregate function that returns the bounding box that bounds rows of geometries.
- ST_Extrude - Extrude a surface to a related volume
- ST_FlipCoordinates - Returns a version of the given geometry with X and Y axis flipped. Useful for people who have built latitude/longitude features and need to fix them.
- ST_ForceLHR - Force LHR orientation
- ST_ForceRHR - Forces the orientation of the vertices in a polygon to follow the Right-Hand-Rule.
- ST_ForceSFS - Forces the geometries to use SFS 1.1 geometry types only.
- ST_Force2D - Forces the geometries into a "2-dimensional mode" so that all output representations will only have the X and Y coordinates.
- ST_Force3D - Forces the geometries into XYZ mode. This is an alias for ST_Force3DZ.
- ST_Force3DZ - Forces the geometries into XYZ mode. This is a synonym for ST_Force3D.
- ST_ForceCollection - Converts the geometry into a GEOMETRYCOLLECTION.
- ST_GeomFromEWKB - Return a specified ST_Geometry value from Extended Well-Known Binary representation (EWKB).
- ST_GeomFromEWKT - Return a specified ST_Geometry value from Extended Well-Known Text representation (EWKT).
- ST_GeomFromGML - Takes as input GML representation of geometry and outputs a PostGIS geometry object
- ST_GeometryN - Return the 1-based Nth geometry if the geometry is a GEOMETRYCOLLECTION, (MULTI)POINT, (MULTI)LINE MULTICURVE or (MULTI)POLYGON, POLYHEDRALSURFACE Otherwise, return NULL.
- ST_GeometryType - Return the geometry type of the ST_Geometry value.
- = - Returns TRUE if A's bounding box is the same as B's. Uses double precision bounding box.
- &<| - Returns TRUE if A's bounding box overlaps or is below B's.
- ~= - Returns TRUE if A's bounding box is the same as B's.
- ST_IsClosed - Returns TRUE if the LINESTRING's start and end points are coincident. For Polyhedral surface is closed (volumetric).
- ST_Mem_Size - Returns the amount of space (in bytes) the geometry takes.
- ST_NPoints - Return the number of points (vertexes) in a geometry.
- ST_NumGeometries - If geometry is a GEOMETRYCOLLECTION (or MULTI*) return the number of geometries, for single geometries will return 1, otherwise return NULL.
- ST_NumPatches - Return the number of faces on a Polyhedral Surface. Will return null for non-polyhedral geometries.
- ST_Orientation - Determine surface orientation
- ST_PatchN - Return the 1-based Nth geometry (face) if the geometry is a POLYHEDRALSURFACE, POLYHEDRALSURFACEM. Otherwise, return NULL.

- ST_RemoveRepeatedPoints - Returns a version of the given geometry with duplicated points removed.
- ST_Rotate - Rotate a geometry rotRadians counter-clockwise about an origin.
- ST_RotateX - Rotate a geometry rotRadians about the X axis.
- ST_RotateY - Rotate a geometry rotRadians about the Y axis.
- ST_RotateZ - Rotate a geometry rotRadians about the Z axis.
- ST_Scale - Scales the geometry to a new size by multiplying the ordinates with the parameters. Ie: ST_Scale(geom, Xfactor, Yfactor, Zfactor).
- ST_Shift_Longitude - Reads every point/vertex in every component of every feature in a geometry, and if the longitude coordinate is <0, adds 360 to it. The result would be a 0-360 version of the data to be plotted in a 180 centric map
- ST_StraightSkeleton - Compute a straight skeleton from a geometry
- ST_Tesselate - Perform surface Tesselation
- ST_Transform - Returns a new geometry with its coordinates transformed to the SRID referenced by the integer parameter.
- && - Returns TRUE if A's 2D bounding box intersects B's 2D bounding box.
- &&& - Returns TRUE if A's n-D bounding box intersects B's n-D bounding box.
- postgis_sfcgal_version - Returns the version of SFCGAL in use

13.10 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.
- A  means the function support is provided by SFCGAL if PostGIS compiled with SFCGAL support, otherwise GEOS/built-in 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
Box2D	✓			✓		✓	✓
Box3D	✓		✓	✓		✓	✓
Find_SRID							
GeometryType	✓		✓	✓		✓	✓
ST_3DArea	✓						
ST_3DClosestPoint	✓		✓			✓	
ST_3DDFullyWithi	✓		✓			✓	
ST_3DDWithin	✓		✓		✓	✓	
ST_3DDistance	✓						
ST_3DExtent	✓		✓	✓		✓	✓
ST_3DIntersection	✓						
ST_3DIntersects	✓		✓		✓	✓	
ST_3DLength	✓		✓				
ST_3DLength_Sphe…l	✓		✓				
ST_3DLongestLine	✓		✓			✓	
ST_3DMakeBox	✓		✓				
ST_3DMaxDistanc	✓		✓			✓	
ST_3DPerimeter	✓		✓				
ST_3DShortestLine	✓		✓			✓	
ST_Accum	✓		✓	✓		✓	✓
ST_AddMeasure	✓		✓				
ST_AddPoint	✓		✓				
ST_Affine	✓		✓	✓		✓	✓
ST_Area	✓	✓					
ST_AsBinary	✓	✓	✓	✓	✓	✓	✓
ST_AsEWKB	✓		✓	✓		✓	✓
ST_AsEWKT	✓	✓	✓	✓		✓	✓
ST_AsGML	✓	✓	✓			✓	✓
ST_AsGeoJSON	✓	✓	✓				
ST_AsHEXEWKB	✓		✓	✓			
ST_AsKML	✓	✓	✓				
ST_AsLatLonText	✓						
ST_AsSVG	✓	✓					

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_AsText	✓	✓		✓	✓		
ST_AsX3D	✓		✓			✓	✓
ST_Azimuth	✓	✓					
ST_BdMPolyFromText	✓						
ST_BdPolyFromText	✓						
ST_Boundary	✓		✓		✓		✓
ST_Box2dFromGeohash	✓						
ST_Buffer	✓	✓			✓		
ST_BuildArea	✓						
ST_Centroid	✓				✓		
ST_ClosestPoint	✓						
ST_Collect	✓		✓	✓			
ST_CollectionExtract	✓						
ST_CollectionHomogenize	✓						
ST_ConcaveHull	✓						
ST_Contains	✓				✓		
ST_ContainsProperly	✓						
ST_ConvexHull	✓		✓		✓		
ST_CoordDim	✓		✓	✓	✓	✓	✓
ST_CoveredBy	✓	✓					
ST_Covers	✓	✓					
ST_Crosses	✓				✓		
ST_CurveToLine	✓		✓	✓	✓		
ST_DFullyWithin	✓						
ST_DWithin	✓	✓					
ST_DelaunayTriangles	✓		✓				✓
ST_Difference	✓		✓		✓		
ST_Dimension	✓				✓	✓	✓
ST_Disjoint	✓				✓		
ST_Distance	✓	✓		✓	✓		
ST_Distance_Spher	✓						
ST_Distance_Spher	✓						
ST_Dump	✓		✓	✓		✓	✓

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_DumpPoints	✓		✓	✓		✓	✓
ST_DumpRings	✓		✓				
ST_EndPoint	✓		✓		✓		
ST_Envelope	✓				✓		
ST_Equals	✓				✓		
ST_EstimatedExten				✓			
ST_Expand	✓					✓	✓
ST_Extent	✓					✓	✓
ST_ExteriorRing	✓		✓		✓		
ST_Extrude	✓						
ST_FlipCoordinates	✓		✓	✓		✓	✓
ST_ForceLHR	✓						
ST_ForceRHR	✓		✓			✓	
ST_ForceSFS	✓		✓	✓		✓	✓
ST_Force2D	✓		✓	✓		✓	
ST_Force3D	✓		✓	✓		✓	
ST_Force3DM	✓			✓			
ST_Force3DZ	✓		✓	✓		✓	
ST_Force4D	✓		✓	✓			
ST_ForceCollection	✓		✓	✓		✓	
ST_GMLToSQL	✓				✓	✓	
ST_GeoHash	✓			✓			
ST_GeogFromText		✓					
ST_GeogFromWKB		✓		✓			
ST_GeographyFromText		✓					
ST_GeomCollFrom	✓				✓		
ST_GeomFromEW	✓		✓	✓		✓	✓
ST_GeomFromEW	✓		✓	✓		✓	✓
ST_GeomFromGM	✓		✓			✓	✓
ST_GeomFromGeo h	✓						
ST_GeomFromGeo N	✓		✓				
ST_GeomFromKM	✓		✓				
ST_GeomFromText	✓			✓	✓		

<table>
<tr><th>Function</th><th>geom</th><th>geog</th><th>2.5D</th><th>Curves</th><th>SQL MM</th><th>PS</th><th>T</th></tr>
<tr><td>ST_GeomFromWK</td><td>✓</td><td></td><td></td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>ST_GeometryFrom</td><td>✓</td><td></td><td></td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>ST_GeometryN</td><td>✓</td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>ST_GeometryType</td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>|>></td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>ST_HasArc</td><td>✓</td><td></td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>ST_HausdorffDistar</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ST_InteriorRingN</td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>ST_InterpolatePoint</td><td>✓</td><td></td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>ST_Intersection</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ST_Intersects</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ST_IsClosed</td><td>✓</td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>ST_IsCollection</td><td>✓</td><td></td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>ST_IsEmpty</td><td>✓</td><td></td><td></td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>ST_IsRing</td><td>✓</td><td></td><td></td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>ST_IsSimple</td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>ST_IsValid</td><td>✓</td><td></td><td></td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>ST_IsValidDetail</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ST_IsValidReason</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ST_Length</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ST_Length2D</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ST_Length2D_Sphe</td><td>✓</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_Length_Spheroi	✓		✓				
ST_LineCrossingDi ion	✓						
ST_LineFromMulti ıt	✓		✓				
ST_LineFromText	✓				✓		
ST_LineFromWKB	✓				✓		
ST_LineInterpolatel t	✓		✓				
ST_LineLocatePoin	✓						
ST_LineMerge	✓						
ST_LineSubstring	✓		✓				
ST_LineToCurve	✓		✓	✓			
ST_LinestringFrom B	✓				✓		
ST_LocateAlong	✓						
ST_LocateBetween	✓						
ST_LocateBetweenl ations	✓		✓				
ST_LongestLine	✓						
ST_M	✓		✓		✓		
ST_MLineFromTex	✓				✓		
ST_MPointFromTe	✓				✓		
ST_MPolyFromTex	✓				✓		
ST_MakeBox2D	✓						
ST_MakeEnvelope	✓						
ST_MakeLine	✓		✓				
ST_MakePoint	✓		✓				
ST_MakePointM	✓						
ST_MakePolygon	✓		✓				
ST_MakeValid	✓		✓				
ST_MaxDistance	✓						
ST_MemUnion	✓		✓				
ST_Mem_Size	✓		✓	✓		✓	✓
ST_MinimumBoun Circle	✓						
ST_MinkowskiSum	✓						
ST_Multi	✓						
ST_NDims	✓		✓				

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_NPoints	✓		✓	✓		✓	
ST_NRings	✓		✓	✓			
ST_Node	✓		✓				
ST_NumGeometries	✓		✓		✓	✓	✓
ST_NumInteriorRin	✓						
ST_NumInteriorRin	✓				✓		
ST_NumPatches	✓		✓		✓	✓	
ST_NumPoints	✓				✓		
ST_OffsetCurve	✓						
ST_OrderingEquals	✓				✓		
ST_Orientation	✓						
ST_Overlaps	✓				✓		
ST_PatchN	✓		✓		✓	✓	
ST_Perimeter	✓	✓			✓		
ST_Perimeter2D	✓						
ST_Point	✓				✓		
ST_PointFromGeoHash							
ST_PointFromText	✓				✓		
ST_PointFromWKB	✓		✓	✓	✓		
ST_PointN	✓		✓	✓	✓		
ST_PointOnSurface	✓		✓		✓		
ST_Point_Inside_Ci	✓						
ST_Polygon	✓		✓		✓		
ST_PolygonFromTe	✓				✓		
ST_Polygonize	✓						
ST_Project		✓					
ST_Relate	✓				✓		
ST_RelateMatch							
ST_RemovePoint	✓		✓				
ST_RemoveRepeatedPoints	✓		✓			✓	
ST_Reverse	✓						
ST_Rotate	✓		✓	✓		✓	✓
ST_RotateX	✓		✓			✓	✓
ST_RotateY	✓		✓			✓	✓

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_RotateZ	✓		✓	✓		✓	✓
ST_SRID	✓			✓	✓		
ST_Scale	✓		✓	✓		✓	✓
ST_Segmentize	✓	✓					
ST_SetPoint	✓		✓				
ST_SetSRID	✓			✓			
ST_SharedPaths	✓						
ST_Shift_Longitude	✓		✓			✓	✓
ST_ShortestLine	✓						
ST_Simplify	✓						
ST_SimplifyPreserveTopology	✓						
ST_Snap	✓						
ST_SnapToGrid	✓		✓				
ST_Split	✓						
ST_StartPoint	✓		✓		✓		
ST_StraightSkeleton	✓		✓			✓	✓
ST_Summary	✓	✓					
ST_SymDifference	✓		✓		✓		
ST_Tesselate	✓		✓			✓	✓
ST_Touches	✓				✓		
ST_TransScale	✓		✓	✓			
ST_Transform	✓			✓	✓	✓	
ST_Translate	✓		✓	✓			
ST_UnaryUnion	✓		✓				
ST_Union	✓				✓		
ST_WKBToSQL	✓				✓		
ST_WKTToSQL	✓				✓		
ST_Within	✓				✓		
ST_X	✓		✓		✓		
ST_XMax	✓		✓	✓			
ST_XMin	✓		✓	✓			
ST_Y	✓		✓		✓		
ST_YMax	✓		✓	✓			

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_YMin	✓		✓	✓			
ST_Z	✓		✓		✓		
ST_ZMax	✓		✓	✓			
ST_ZMin	✓		✓	✓			
ST_Zmflag	✓		✓	✓			
<#>	✓						
<->	✓						
&&	✓	✓		✓		✓	
&&&	✓		✓	✓		✓	✓
postgis_sfcgal_version							

13.11 New, Enhanced or changed PostGIS Functions

13.11.1 PostGIS Functions new or enhanced in 2.1

The functions given below are PostGIS functions that were added or enhanced.

Note
More Topology performance Improvements. Please refer to Chapter 11 for more details.

Note
Bug fixes (particularly with handling of out-of-band rasters), many new functions (often shortening code you have to write to accomplish a common task) and massive speed improvements to raster functionality. Refer to Chapter 9 for more details.

Note
Tiger Geocoder upgraded to work with TIGER 2012 census data in 2.1.0 and TIGER 2013 in 2.1.1. `geocode_settings` added for debugging and tweaking rating preferences, loader made less greedy, now only downloads tables to be loaded. Please refer to Section 12.1 for more details.

Note
Raster bands can only reference the first 256 bands of out-db rasters.

Functions new in PostGIS 2.1

- AsTopoJSON - Availability: 2.1.0 Returns the TopoJSON representation of a topogeometry.
- Drop_Nation_Tables_Generate_Script - Availability: 2.1.0 Generates a script that drops all tables in the specified schema that start with county_all, state_all or stae code followed by county or state.

- Get_Geocode_Setting - Availability: 2.1.0 Returns value of specific setting stored in tiger.geocode_settings table.
- Loader_Generate_Nation_Script - Availability: 2.1.0 Generates a shell script for the specified platform that loads in the county and state lookup tables.
- Pagc_Normalize_Address - Availability: 2.1.0 Given a textual street address, returns a composite norm_addy type that has road suffix, prefix and type standardized, street, streetname etc. broken into separate fields. This function will work with just the lookup data packaged with the tiger_geocoder (no need for tiger census data). Requires address_standardizer extension.
- ST_3DArea - Availability: 2.1.0 Computes area of 3D geometries
- ST_3DIntersection - Availability: 2.1.0 Perform 3D intersection
- ST_Box2dFromGeoHash - Availability: 2.1.0 Return a BOX2D from a GeoHash string.
- ST_ColorMap - Availability: 2.1.0 Creates a new raster of up to four 8BUI bands (grayscale, RGB, RGBA) from the source raster and a specified band. Band 1 is assumed if not specified.
- ST_Contains - Availability: 2.1.0 Return true if no points of raster rastB lie in the exterior of raster rastA and at least one point of the interior of rastB lies in the interior of rastA.
- ST_ContainsProperly - Availability: 2.1.0 Return true if rastB intersects the interior of rastA but not the boundary or exterior of rastA.
- ST_CoveredBy - Availability: 2.1.0 Return true if no points of raster rastA lie outside raster rastB.
- ST_Covers - Availability: 2.1.0 Return true if no points of raster rastB lie outside raster rastA.
- ST_DFullyWithin - Availability: 2.1.0 Return true if rasters rastA and rastB are fully within the specified distance of each other.
- ST_DWithin - Availability: 2.1.0 Return true if rasters rastA and rastB are within the specified distance of each other.
- ST_DelaunayTriangles - Availability: 2.1.0 - requires GEOS >= 3.4.0. Return a Delaunay triangulation around the given input points.
- ST_Disjoint - Availability: 2.1.0 Return true if raster rastA does not spatially intersect rastB.
- ST_DumpValues - Availability: 2.1.0 Get the values of the specified band as a 2-dimension array.
- ST_Extrude - Availability: 2.1.0 Extrude a surface to a related volume
- ST_ForceLHR - Availability: 2.1.0 Force LHR orientation
- ST_FromGDALRaster - Availability: 2.1.0 Returns a raster from a supported GDAL raster file.
- ST_GeomFromGeoHash - Availability: 2.1.0 Return a geometry from a GeoHash string.
- ST_InvDistWeight4ma - Availability: 2.1.0 Raster processing function that interpolates a pixel's value from the pixel's neighborhood.
- ST_MapAlgebra - Availability: 2.1.0 Callback function version - Returns a one-band raster given one or more input rasters, band indexes and one user-specified callback function.
- ST_MapAlgebra - Availability: 2.1.0 Expression version - Returns a one-band raster given one or two input rasters, band indexes and one or more user-specified SQL expressions.
- ST_MinConvexHull - Availability: 2.1.0 Return the convex hull geometry of the raster excluding NODATA pixels.
- ST_MinDist4ma - Availability: 2.1.0 Raster processing function that returns the minimum distance (in number of pixels) between the pixel of interest and a neighboring pixel with value.
- ST_MinkowskiSum - Availability: 2.1.0 Performs Minkowski sum
- ST_NearestValue - Availability: 2.1.0 Returns the nearest non-NODATA value of a given band's pixel specified by a columnx and rowy or a geometric point expressed in the same spatial reference coordinate system as the raster.

- ST_Neighborhood - Availability: 2.1.0 Returns a 2-D double precision array of the non-NODATA values around a given band's pixel specified by either a columnX and rowY or a geometric point expressed in the same spatial reference coordinate system as the raster.
- ST_NotSameAlignmentReason - Availability: 2.1.0 Returns text stating if rasters are aligned and if not aligned, a reason why.
- ST_Orientation - Availability: 2.1.0 Determine surface orientation
- ST_Overlaps - Availability: 2.1.0 Return true if raster rastA and rastB intersect but one does not completely contain the other.
- ST_PixelAsCentroid - Availability: 2.1.0 Returns the centroid (point geometry) of the area represented by a pixel.
- ST_PixelAsCentroids - Availability: 2.1.0 Returns the centroid (point geometry) for each pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel. The point geometry is the centroid of the area represented by a pixel.
- ST_PixelAsPoint - Availability: 2.1.0 Returns a point geometry of the pixel's upper-left corner.
- ST_PixelAsPoints - Availability: 2.1.0 Returns a point geometry for each pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel. The coordinates of the point geometry are of the pixel's upper-left corner.
- ST_PixelOfValue - Availability: 2.1.0 Get the columnx, rowy coordinates of the pixel whose value equals the search value.
- ST_PointFromGeoHash - Availability: 2.1.0 Return a point from a GeoHash string.
- ST_RasterToWorldCoord - Availability: 2.1.0 Returns the raster's upper left corner as geometric X and Y (longitude and latitude) given a column and row. Column and row starts at 1.
- ST_Resize - Availability: 2.1.0 Requires GDAL 1.6.1+ Resize a raster to a new width/height
- ST_Roughness - Availability: 2.1.0 Returns a raster with the calculated "roughness" of a DEM.
- ST_SetValues - Availability: 2.1.0 Returns modified raster resulting from setting the values of a given band.
- ST_Simplify - Availability: 2.1.0 Returns a "simplified" geometry version of the given TopoGeometry using the Douglas-Peucker algorithm.
- ST_StraightSkeleton - Availability: 2.1.0 Compute a straight skeleton from a geometry
- ST_Summary - Availability: 2.1.0 Returns a text summary of the contents of the raster.
- ST_TPI - Availability: 2.1.0 Returns a raster with the calculated Topographic Position Index.
- ST_TRI - Availability: 2.1.0 Returns a raster with the calculated Terrain Ruggedness Index.
- ST_Tesselate - Availability: 2.1.0 Perform surface Tesselation
- ST_Tile - Availability: 2.1.0 Returns a set of rasters resulting from the split of the input raster based upon the desired dimensions of the output rasters.
- ST_Touches - Availability: 2.1.0 Return true if raster rastA and rastB have at least one point in common but their interiors do not intersect.
- ST_Union - Availability: 2.1.0 ST_Union(rast, unionarg) variant was introduced. Returns the union of a set of raster tiles into a single raster composed of 1 or more bands.
- ST_Within - Availability: 2.1.0 Return true if no points of raster rastA lie in the exterior of raster rastB and at least one point of the interior of rastA lies in the interior of rastB.
- ST_WorldToRasterCoord - Availability: 2.1.0 Returns the upper left corner as column and row given geometric X and Y (longitude and latitude) or a point geometry expressed in the spatial reference coordinate system of the raster.
- Set_Geocode_Setting - Availability: 2.1.0 Sets a setting that affects behavior of geocoder functions.
- UpdateRasterSRID - Availability: 2.1.0 Change the SRID of all rasters in the user-specified column and table.
- clearTopoGeom - Availability: 2.1 Clears the content of a topo geometry

- postgis_sfcgal_version - Availability: 2.1.0 Returns the version of SFCGAL in use

The functions given below are PostGIS functions that are enhanced in PostGIS 2.1.

- ST_AddBand - Enhanced: 2.1.0 support for addbandarg added.
- ST_AddBand - Enhanced: 2.1.0 support for new out-db bands added.
- ST_AsBinary - Enhanced: 2.1.0 Addition of outasin
- ST_Aspect - Enhanced: 2.1.0 Uses ST_MapAlgebra() and added optional interpolate_nodata function parameter
- ST_Clip - Enhanced: 2.1.0 Rewritten in C
- ST_Distinct4ma - Enhanced: 2.1.0 Addition of Variant 2
- ST_HillShade - Enhanced: 2.1.0 Uses ST_MapAlgebra() and added optional interpolate_nodata function parameter
- ST_Max4ma - Enhanced: 2.1.0 Addition of Variant 2
- ST_Mean4ma - Enhanced: 2.1.0 Addition of Variant 2
- ST_Min4ma - Enhanced: 2.1.0 Addition of Variant 2
- ST_PixelAsPolygons - Enhanced: 2.1.0 exclude_nodata_value optional argument was added.
- ST_Polygon - Enhanced: 2.1.0 Improved Speed (fully C-Based) and the returning multipolygon is ensured to be valid.
- ST_Range4ma - Enhanced: 2.1.0 Addition of Variant 2
- ST_SameAlignment - Enhanced: 2.1.0 addition of Aggegrate variant
- ST_SetGeoReference - Enhanced: 2.1.0 Addition of ST_SetGeoReference(raster, double precision, ...) variant
- ST_SetValue - Enhanced: 2.1.0 Geometry variant of ST_SetValue() now supports any geometry type, not just point. The geometry variant is a wrapper around the geomval[] variant of ST_SetValues()
- ST_Slope - Enhanced: 2.1.0 Uses ST_MapAlgebra() and added optional units, scale, interpolate_nodata function parameters
- ST_StdDev4ma - Enhanced: 2.1.0 Addition of Variant 2
- ST_Sum4ma - Enhanced: 2.1.0 Addition of Variant 2
- ST_Transform - Enhanced: 2.1.0 Addition of ST_Transform(rast, alignto) variant
- ST_Union - Enhanced: 2.1.0 Improved Speed (fully C-Based).
- ST_Union - Enhanced: 2.1.0 ST_Union(rast) (variant 1) unions all bands of all input rasters. Prior versions of PostGIS assumed the first band.
- ST_Union - Enhanced: 2.1.0 ST_Union(rast, uniontype) (variant 4) unions all bands of all input rasters.
- ST_AsGML - Enhanced: 2.1.0 id support was introduced, for GML 3.
- ST_Boundary - Enhanced: 2.1.0 support for Triangle was introduced
- ST_DWithin - Enhanced: 2.1.0 improved speed for geography. See Making Geography faster for details.
- ST_DWithin - Enhanced: 2.1.0 support for curved geometries was introduced.
- ST_Distance - Enhanced: 2.1.0 improved speed for geography. See Making Geography faster for details.
- ST_Distance - Enhanced: 2.1.0 - support for curved geometries was introduced.
- ST_DumpPoints - Enhanced: 2.1.0 Faster speed. Reimplemented as native-C.
- ST_MakeValid - Enhanced: 2.1.0 added support for GEOMETRYCOLLECTION and MULTIPOINT.
- ST_Segmentize - Enhanced: 2.1.0 support for geography was introduced.
- ST_Summary - Enhanced: 2.1.0 S flag to denote if has a known spatial reference system
- toTopoGeom - Enhanced: 2.1.0 adds the version taking an existing TopoGeometry.

13.11.2 PostGIS functions breaking changes in 2.1

The functions given below are PostGIS functions that have possibly breaking changes in PostGIS 2.1. If you use any of these, you may need to check your existing code.

- ST_Aspect - Changed: 2.1.0 In prior versions, return values were in radians. Now, return values default to degrees
- ST_HillShade - Changed: 2.1.0 In prior versions, azimuth and altitude were expressed in radians. Now, azimuth and altitude are expressed in degrees
- ST_Intersects - Changed: 2.1.0 The behavior of the ST_Intersects(raster, geometry) variants changed to match that of ST_Intersects(geo raster).
- ST_PixelAsCentroids - Changed: 2.1.1 Changed behavior of exclude_nodata_value.
- ST_PixelAsPoints - Changed: 2.1.1 Changed behavior of exclude_nodata_value.
- ST_PixelAsPolygons - Changed: 2.1.1 Changed behavior of exclude_nodata_value.
- ST_Polygon - Changed: 2.1.0 In prior versions would sometimes return a polygon, changed to always return multipolygon.
- ST_RasterToWorldCoordX - Changed: 2.1.0 In prior versions, this was called ST_Raster2WorldCoordX
- ST_RasterToWorldCoordY - Changed: 2.1.0 In prior versions, this was called ST_Raster2WorldCoordY
- ST_Resample - Changed: 2.1.0 Parameter srid removed. Variants with a reference raster no longer applies the reference raster's SRID. Use ST_Transform() to reproject raster. Works on rasters with no SRID.
- ST_Rescale - Changed: 2.1.0 Works on rasters with no SRID
- ST_Reskew - Changed: 2.1.0 Works on rasters with no SRID
- ST_Slope - Changed: 2.1.0 In prior versions, return values were in radians. Now, return values default to degrees
- ST_SnapToGrid - Changed: 2.1.0 Works on rasters with no SRID
- ST_WorldToRasterCoordX - Changed: 2.1.0 In prior versions, this was called ST_World2RasterCoordX
- ST_WorldToRasterCoordY - Changed: 2.1.0 In prior versions, this was called ST_World2RasterCoordY
- ST_EstimatedExtent - Changed: 2.1.0. Up to 2.0.x this was called ST_Estimated_Extent.
- ST_Force2D - Changed: 2.1.0. Up to 2.0.x this was called ST_Force_2D.
- ST_Force3D - Changed: 2.1.0. Up to 2.0.x this was called ST_Force_3D.
- ST_Force3DM - Changed: 2.1.0. Up to 2.0.x this was called ST_Force_3DM.
- ST_Force3DZ - Changed: 2.1.0. Up to 2.0.x this was called ST_Force_3DZ.
- ST_Force4D - Changed: 2.1.0. Up to 2.0.x this was called ST_Force_4D.
- ST_ForceCollection - Changed: 2.1.0. Up to 2.0.x this was called ST_Force_Collection.
- ST_LineInterpolatePoint - Changed: 2.1.0. Up to 2.0.x this was called ST_Line_Interpolate_Point.
- ST_LineLocatePoint - Changed: 2.1.0. Up to 2.0.x this was called ST_Line_Locate_Point.
- ST_LineSubstring - Changed: 2.1.0. Up to 2.0.x this was called ST_Line_Substring.
- ST_Segmentize - Changed: 2.1.0 As a result of the introduction of geography support: The construct SELECT ST_Segmentize('LINES 2, 3 4)',0.5); will result in ambiguous function error. You need to have properly typed object e.g. a geometry/geography column, use ST_GeomFromText, ST_GeogFromText or SELECT ST_Segmentize('LINESTRING(1 2, 3 4)'::geometry,0.5);

13.11.3 PostGIS Functions new, behavior changed, or enhanced in 2.0

The functions given below are PostGIS functions that were added, enhanced, or have Section 13.11.4 breaking changes in 2.0 releases.

New geometry types: TIN and Polyhedral surfaces was introduced in 2.0

Note
Greatly improved support for Topology. Please refer to Chapter 11 for more details.

Note
In PostGIS 2.0, raster type and raster functionality has been integrated. There are way too many new raster functions to list here and all are new so please refer to Chapter 9 for more details of the raster functions available. Earlier pre-2.0 versions had raster_columns/raster_overviews as real tables. These were changed to views before release. Functions such as `ST_AddRasterColumn` were removed and replaced with AddRasterConstraints, DropRasterConstraints as a result some apps that created raster tables may need changing.

Note
Tiger Geocoder upgraded to work with TIGER 2010 census data and now included in the core PostGIS documentation. A reverse geocoder function was also added. Please refer to Section 12.1 for more details.

- && - Availability: 2.0.0 Returns TRUE if A's bounding box intersects B's bounding box.
- &&& - Availability: 2.0.0 Returns TRUE if A's n-D bounding box intersects B's n-D bounding box.
- <#> - Availability: 2.0.0 -- KNN only available for PostgreSQL 9.1+ Returns the 2D distance between bounding boxes of 2 geometries.
- <-> - Availability: 2.0.0 -- KNN only available for PostgreSQL 9.1+ Returns the 2D distance between the centroids of A and B boundingboxes.
- AddEdge - Availability: 2.0.0 requires GEOS >= 3.3.0. Adds a linestring edge to the edge table and associated start and end points to the point nodes table of the specified topology schema using the specified linestring geometry and returns the edgeid of the new (or existing) edge.
- AddFace - Availability: 2.0.0 Registers a face primitive to a topology and gets its identifier.
- AddNode - Availability: 2.0.0 Adds a point node to the node table in the specified topology schema and returns the nodeid of new node. If point already exists as node, the existing nodeid is returned.
- AddOverviewConstraints - Availability: 2.0.0 Tag a raster column as being an overview of another.
- AddRasterConstraints - Availability: 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 of the constraint setting was accomplished and if issues a notice.
- AsGML - Availability: 2.0.0 Returns the GML representation of a topogeometry.
- CopyTopology - Availability: 2.0.0 Makes a copy of a topology structure (nodes, edges, faces, layers and TopoGeometries).
- DropOverviewConstraints - Availability: 2.0.0 Untag a raster column from being an overview of another.
- DropRasterConstraints - Availability: 2.0.0 Drops PostGIS raster constraints that refer to a raster table column. Useful if you need to reload data or update your raster column data.

- Drop_Indexes_Generate_Script - Availability: 2.0.0 Generates a script that drops all non-primary key and non-unique indexes on tiger schema and user specified schema. Defaults schema to tiger_data if no schema is specified.
- Drop_State_Tables_Generate_Script - Availability: 2.0.0 Generates a script that drops all tables in the specified schema that are prefixed with the state abbreviation. Defaults schema to tiger_data if no schema is specified.
- Geocode_Intersection - Availability: 2.0.0 Takes in 2 streets that intersect and a state, city, zip, and outputs a set of possible locations on the first cross street that is at the intersection, also includes a point geometry in NAD 83 long lat, a normalized address for each location, and the rating. The lower the rating the more likely the match. Results are sorted by lowest rating first. Can optionally pass in maximum results, defaults to 10
- GetEdgeByPoint - Availability: 2.0.0 - requires GEOS >= 3.3.0. Find the edge-id of an edge that intersects a given point
- GetFaceByPoint - Availability: 2.0.0 - requires GEOS >= 3.3.0. Find the face-id of a face that intersects a given point
- GetNodeByPoint - Availability: 2.0.0 - requires GEOS >= 3.3.0. Find the id of a node at a point location
- GetNodeEdges - Availability: 2.0 Returns an ordered set of edges incident to the given node.
- GetRingEdges - Availability: 2.0.0 Returns the ordered set of signed edge identifiers met by walking on ana given edge side.
- GetTopologySRID - Availability: 2.0.0 Returns the SRID of a topology in the topology.topology table given the name of the topology.
- Get_Tract - Availability: 2.0.0 Returns census tract or field from tract table of where the geometry is located. Default to returning short name of tract.
- Install_Missing_Indexes - Availability: 2.0.0 Finds all tables with key columns used in geocoder joins and filter conditions that are missing used indexes on those columns and will add them.
- Loader_Generate_Census_Script - Availability: 2.0.0 Generates a shell script for the specified platform for the specified states that will download Tiger census state tract, bg, and tabblocks data tables, stage and load into tiger_data schema. Each state script is returned as a separate record.
- Loader_Generate_Script - Availability: 2.0.0 to support Tiger 2010 structured data and load census tract (tract), block groups (bg), and blocks (tabblocks) tables . Generates a shell script for the specified platform for the specified states that will download Tiger data, stage and load into tiger_data schema. Each state script is returned as a separate record. Latest version supports Tiger 2010 structural changes and also loads census tract, block groups, and blocks tables.
- Missing_Indexes_Generate_Script - Availability: 2.0.0 Finds all tables with key columns used in geocoder joins that are missing indexes on those columns and will output the SQL DDL to define the index for those tables.
- Polygonize - Availability: 2.0.0 Find and register all faces defined by topology edges
- Reverse_Geocode - Availability: 2.0.0 Takes a geometry point in a known spatial ref sys and returns a record containing an array of theoretically possible addresses and an array of cross streets. If include_strnum_range = true, includes the street range in the cross streets.
- ST_3DClosestPoint - Availability: 2.0.0 Returns the 3-dimensional point on g1 that is closest to g2. This is the first point of the 3D shortest line.
- ST_3DDFullyWithin - Availability: 2.0.0 Returns true if all of the 3D geometries are within the specified distance of one another.
- ST_3DDWithin - Availability: 2.0.0 For 3d (z) geometry type Returns true if two geometries 3d distance is within number of units.
- ST_3DDistance - Availability: 2.0.0 For geometry type Returns the 3-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units.
- ST_3DIntersects - Availability: 2.0.0 Returns TRUE if the Geometries "spatially intersect" in 3d - only for points and linestrings
- ST_3DLongestLine - Availability: 2.0.0 Returns the 3-dimensional longest line between two geometries

- ST_3DMaxDistance - Availability: 2.0.0 For geometry type Returns the 3-dimensional cartesian maximum distance (based on spatial ref) between two geometries in projected units.
- ST_3DShortestLine - Availability: 2.0.0 Returns the 3-dimensional shortest line between two geometries
- ST_AddEdgeModFace - Availability: 2.0 Add a new edge and, if in doing so it splits a face, modify the original face and add a new face.
- ST_AddEdgeNewFaces - Availability: 2.0 Add a new edge and, if in doing so it splits a face, delete the original face and replace it with two new faces.
- ST_AsGDALRaster - Availability: 2.0.0 - requires 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_GDALRasters() to get a list of formats supported by your library.
- ST_AsJPEG - Availability: 2.0.0 - requires GDAL >= 1.6.0. Return the raster tile selected bands as a single Joint Photographic Exports Group (JPEG) image (byte array). If no band is specified and 1 or more than 3 bands, then only the first band is used. If only 3 bands then all 3 bands are used and mapped to RGB.
- ST_AsLatLonText - Availability: 2.0 Return the Degrees, Minutes, Seconds representation of the given point.
- ST_AsPNG - Availability: 2.0.0 - requires GDAL >= 1.6.0. Return the raster tile selected bands as a single portable network graphics (PNG) image (byte array). If 1, 3, or 4 bands in raster and no bands are specified, then all bands are used. If more 2 or more than 4 bands and no bands specified, then only band 1 is used. Bands are mapped to RGB or RGBA space.
- ST_AsRaster - Availability: 2.0.0 - requires GDAL >= 1.6.0. Converts a PostGIS geometry to a PostGIS raster.
- ST_AsTIFF - Availability: 2.0.0 - requires GDAL >= 1.6.0. Return the raster selected bands as a single TIFF image (byte array). If no band is specified, then will try to use all bands.
- ST_AsX3D - Availability: 2.0.0: ISO-IEC-19776-1.2-X3DEncodings-XML Returns a Geometry in X3D xml node element format: ISO-IEC-19776-1.2-X3DEncodings-XML
- ST_Aspect - Availability: 2.0.0 Returns the aspect (in degrees by default) of an elevation raster band. Useful for analyzing terrain.
- ST_Band - Availability: 2.0.0 Returns one or more bands of an existing raster as a new raster. Useful for building new rasters from existing rasters.
- ST_BandIsNoData - Availability: 2.0.0 Returns true if the band is filled with only nodata values.
- ST_Clip - Availability: 2.0.0 Returns the raster clipped by the input geometry. If band number not is specified, all bands are processed. If crop is not specified or TRUE, the output raster is cropped.
- ST_CollectionHomogenize - Availability: 2.0.0 Given a geometry collection, returns the "simplest" representation of the contents.
- ST_ConcaveHull - Availability: 2.0.0 The concave hull of a geometry represents a possibly concave geometry that encloses all geometries within the set. You can think of it as shrink wrapping.
- ST_Count - Availability: 2.0.0 Returns the number of pixels in a given band of a raster or raster coverage. If no band is specified defaults to band 1. If exclude_nodata_value is set to true, will only count pixels that are not equal to the nodata value.
- ST_CreateTopoGeo - Availability: 2.0 Adds a collection of geometries to a given empty topology and returns a message detailing success.
- ST_Distinct4ma - Availability: 2.0.0 Raster processing function that calculates the number of unique pixel values in a neighborhood.
- ST_FlipCoordinates - Availability: 2.0.0 Returns a version of the given geometry with X and Y axis flipped. Useful for people who have built latitude/longitude features and need to fix them.
- ST_GDALDrivers - Availability: 2.0.0 - requires GDAL >= 1.6.0. Returns a list of raster formats supported by your lib gdal. These are the formats you can output your raster using ST_AsGDALRaster.

- ST_GeomFromGeoJSON - Availability: 2.0.0 requires - JSON-C >= 0.9 Takes as input a geojson representation of a geometry and outputs a PostGIS geometry object
- ST_GetFaceEdges - Availability: 2.0 Returns a set of ordered edges that bound aface.
- ST_HasNoBand - Availability: 2.0.0 Returns true if there is no band with given band number. If no band number is specified, then band number 1 is assumed.
- ST_HillShade - Availability: 2.0.0 Returns the hypothetical illumination of an elevation raster band using provided azimuth, altitude, brightness and scale inputs.
- ST_Histogram - Availability: 2.0.0 Returns a set of record summarizing a raster or raster coverage data distribution separate bin ranges. Number of bins are autocomputed if not specified.
- ST_InterpolatePoint - Availability: 2.0.0 Return the value of the measure dimension of a geometry at the point closed to the provided point.
- ST_IsEmpty - Availability: 2.0.0 Returns true if the raster is empty (width = 0 and height = 0). Otherwise, returns false.
- ST_IsValidDetail - Availability: 2.0.0 - requires GEOS >= 3.3.0. Returns a valid_detail (valid,reason,location) row stating if a geometry is valid or not and if not valid, a reason why and a location where.
- ST_IsValidReason - Availability: 2.0 - requires GEOS >= 3.3.0 for the version taking flags. Returns text stating if a geometry is valid or not and if not valid, a reason why.
- ST_MakeLine - Availability: 2.0.0 - Support for linestring input elements was introduced Creates a Linestring from point or line geometries.
- ST_MakeValid - Availability: 2.0.0, requires GEOS-3.3.0 Attempts to make an invalid geometry valid without losing vertices.
- ST_MapAlgebraExpr - Availability: 2.0.0 1 raster band version: Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation on the input raster band and of pixeltype provided. Band 1 is assumed if no band is specified.
- ST_MapAlgebraExpr - Availability: 2.0.0 2 raster band version: Creates a new one band raster formed by applying a valid PostgreSQL algebraic operation on the two input raster bands and of pixeltype provided. band 1 of each raster is assumed if no band numbers are specified. The resulting raster will be aligned (scale, skew and pixel corners) on the grid defined by the first raster and have its extent defined by the "extenttype" parameter. Values for "extenttype" can be: INTERSECTION, UNION, FIRST, SECOND.
- ST_MapAlgebraFct - Availability: 2.0.0 1 band version - Creates a new one band raster formed by applying a valid PostgreSQL function on the input raster band and of pixeltype prodived. Band 1 is assumed if no band is specified.
- ST_MapAlgebraFct - Availability: 2.0.0 2 band version - Creates a new one band raster formed by applying a valid PostgreSQL function on the 2 input raster bands and of pixeltype prodived. Band 1 is assumed if no band is specified. Extent type defaults to INTERSECTION if not specified.
- ST_MapAlgebraFctNgb - Availability: 2.0.0 1-band version: Map Algebra Nearest Neighbor using user-defined PostgreSQL function. Return a raster which values are the result of a PLPGSQL user function involving a neighborhood of values from the input raster band.
- ST_Max4ma - Availability: 2.0.0 Raster processing function that calculates the maximum pixel value in a neighborhood.
- ST_Mean4ma - Availability: 2.0.0 Raster processing function that calculates the mean pixel value in a neighborhood.
- ST_Min4ma - Availability: 2.0.0 Raster processing function that calculates the minimum pixel value in a neighborhood.
- ST_ModEdgeHeal - Availability: 2.0 Heal two edges by deleting the node connecting them, modifying the first edgeand deleting the second edge. Returns the id of the deleted node.
- ST_NewEdgeHeal - Availability: 2.0 Heal two edges by deleting the node connecting them, deleting both edges,and replacing them with an edge whose direction is the same as the firstedge provided.
- ST_Node - Availability: 2.0.0 - requires GEOS >= 3.3.0. Node a set of linestrings.

- ST_NumPatches - Availability: 2.0.0 Return the number of faces on a Polyhedral Surface. Will return null for non-polyhedral geometries.
- ST_OffsetCurve - Availability: 2.0 - requires GEOS >= 3.2, improved with GEOS >= 3.3 Return an offset line at a given distance and side from an input line. Useful for computing parallel lines about a center line
- ST_PatchN - Availability: 2.0.0 Return the 1-based Nth geometry (face) if the geometry is a POLYHEDRALSURFACE, POLYHEDRALSURFACEM. Otherwise, return NULL.
- ST_PixelAsPolygon - Availability: 2.0.0 Returns the polygon geometry that bounds the pixel for a particular row and column.
- ST_PixelAsPolygons - Availability: 2.0.0 Returns the polygon geometry that bounds every pixel of a raster band along with the value, the X and the Y raster coordinates of each pixel.
- ST_Project - Availability: 2.0.0 Returns a POINT projected from a start point using a distance in meters and bearing (azimuth) in radians.
- ST_Quantile - Availability: 2.0.0 Compute quantiles for a raster or raster table coverage in the context of the sample or population. Thus, a value could be examined to be at the raster's 25%, 50%, 75% percentile.
- ST_Range4ma - Availability: 2.0.0 Raster processing function that calculates the range of pixel values in a neighborhood.
- ST_Reclass - Availability: 2.0.0 Creates a new raster composed of band types reclassified from original. The nband is the band to be changed. If nband is not specified assumed to be 1. All other bands are returned unchanged. Use case: convert a 16BUI band to a 8BUI and so forth for simpler rendering as viewable formats.
- ST_RelateMatch - Availability: 2.0.0 - requires GEOS >= 3.3.0. Returns true if intersectionMattrixPattern1 implies intersectionMatrixPattern2
- ST_RemEdgeModFace - Availability: 2.0 Removes an edge and, if the removed edge separated two faces,delete one of the them and modify the other to take the space of both.
- ST_RemEdgeNewFace - Availability: 2.0 Removes an edge and, if the removed edge separated two faces,delete the original faces and replace them with a new face.
- ST_RemoveRepeatedPoints - Availability: 2.0.0 Returns a version of the given geometry with duplicated points removed.
- ST_Resample - Availability: 2.0.0 Requires GDAL 1.6.1+ Resample a raster using a specified resampling algorithm, new dimensions, an arbitrary grid corner and a set of raster georeferencing attributes defined or borrowed from another raster.
- ST_Rescale - Availability: 2.0.0 Requires 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 or Lanczos resampling algorithm. Default is NearestNeighbor.
- ST_Reskew - Availability: 2.0.0 Requires GDAL 1.6.1+ Resample a raster by adjusting only its skew (or rotation parameters). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. Default is NearestNeighbor.
- ST_SameAlignment - Availability: 2.0.0 Returns true if rasters have same skew, scale, spatial ref, and offset (pixels can be put on same grid without cutting into pixels) and false if they don't with notice detailing issue.
- ST_SetBandIsNoData - Availability: 2.0.0 Sets the isnodata flag of the band to TRUE.
- ST_SharedPaths - Availability: 2.0.0 requires GEOS >= 3.3.0. Returns a collection containing paths shared by the two input linestrings/multilinestrings.
- ST_Slope - Availability: 2.0.0 Returns the slope (in degrees by default) of an elevation raster band. Useful for analyzing terrain.
- ST_Snap - Availability: 2.0.0 requires GEOS >= 3.3.0. Snap segments and vertices of input geometry to vertices of a reference geometry.
- ST_SnapToGrid - Availability: 2.0.0 Requires GDAL 1.6.1+ Resample a raster by snapping it to a grid. New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline or Lanczos resampling algorithm. Default is NearestNeighbor.

- ST_Split - Availability: 2.0.0 Returns a collection of geometries resulting by splitting a geometry.
- ST_StdDev4ma - Availability: 2.0.0 Raster processing function that calculates the standard deviation of pixel values in a neighborhood.
- ST_Sum4ma - Availability: 2.0.0 Raster processing function that calculates the sum of all pixel values in a neighborhood.
- ST_SummaryStats - Availability: 2.0.0 Returns record consisting of count, sum, mean, stddev, min, max for a given raster band of a raster or raster coverage. Band 1 is assumed is no band is specified.
- ST_Transform - Availability: 2.0.0 Requires GDAL 1.6.1+ Reprojects a raster in a known spatial reference system to another known spatial reference system using specified resampling algorithm. Options are NearestNeighbor, Bilinear, Cubic, CubicSpline, Lanczos defaulting to NearestNeighbor.
- ST_UnaryUnion - Availability: 2.0.0 - requires GEOS >= 3.3.0. Like ST_Union, but working at the geometry component level.
- ST_Union - Availability: 2.0.0 Returns the union of a set of raster tiles into a single raster composed of 1 or more bands.
- ST_ValueCount - Availability: 2.0.0 Returns a set of records containing a pixel band value and count of the number of pixels in a given band of a raster (or a raster coverage) that have a given set of values. If no band is specified defaults to band 1. By default nodata value pixels are not counted. and all other values in the pixel are output and pixel band values are rounded to the nearest integer.
- TopoElementArray_Agg - Availability: 2.0.0 Returns a topoelementarray for a set of element_id, type arrays (topoelements)
- TopoGeo_AddLineString - Availability: 2.0.0 Adds a linestring to an existing topology using a tolerance and possibly splitting existing edges/faces. Returns edge identifiers
- TopoGeo_AddPoint - Availability: 2.0.0 Adds a point to an existing topology using a tolerance and possibly splitting an existing edge.
- TopoGeo_AddPolygon - Availability: 2.0.0 Adds a polygon to an existing topology using a tolerance and possibly splitting existing edges/faces.
- TopologySummary - Availability: 2.0.0 Takes a topology name and provides summary totals of types of objects in topology
- Topology_Load_Tiger - Availability: 2.0.0 Loads a defined region of tiger data into a PostGIS Topology and transforming the tiger data to spatial reference of the topology and snapping to the precision tolerance of the topology.
- toTopoGeom - Availability: 2.0 Converts a simple Geometry into a topo geometry
- ~= - Availability: 2.0.0 Returns TRUE if A's bounding box is the same as B's.

The functions given below are PostGIS functions that are enhanced in PostGIS 2.0.

- AddGeometryColumn - Enhanced: 2.0.0 use_typmod argument introduced. Defaults to creating typmod geometry column instead of constraint-based.
- Box2D - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- Box3D - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- Geocode - Enhanced: 2.0.0 to support Tiger 2010 structured data and revised some logic to improve speed, accuracy of geocoding, and to offset point from centerline to side of street address is located on. New parameter max_results useful for specifying ot just return the best result.
- GeometryType - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- Populate_Geometry_Columns - Enhanced: 2.0.0 use_typmod optional argument was introduced that allows controlling if columns are created with typmodifiers or with check constraints.
- ST_Intersection - Enhanced: 2.0.0 - Intersection in the raster space was introduced. In earlier pre-2.0.0 versions, only intersection performed in vector space were supported.

- ST_Intersects - Enhanced: 2.0.0 support raster/raster intersects was introduced.
- ST_Value - Enhanced: 2.0.0 exclude_nodata_value optional argument was added.
- ST_3DExtent - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_Accum - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_Affine - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_Area - Enhanced: 2.0.0 - support for 2D polyhedral surfaces was introduced.
- ST_AsBinary - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_AsBinary - Enhanced: 2.0.0 support for higher coordinate dimensions was introduced.
- ST_AsBinary - Enhanced: 2.0.0 support for specifying endian with geography was introduced.
- ST_AsEWKB - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_AsEWKT - Enhanced: 2.0.0 support for Geography, Polyhedral surfaces, Triangles and TIN was introduced.
- ST_AsGML - Enhanced: 2.0.0 prefix support was introduced. Option 4 for GML3 was introduced to allow using LineString instead of Curve tag for lines. GML3 Support for Polyhedral surfaces and TINS was introduced. Option 32 was introduced to output the box.
- ST_AsKML - Enhanced: 2.0.0 - Add prefix namespace. Default is no prefix
- ST_Azimuth - Enhanced: 2.0.0 support for geography was introduced.
- ST_ChangeEdgeGeom - Enhanced: 2.0.0 adds topological consistency enforcement
- ST_Dimension - Enhanced: 2.0.0 support for Polyhedral surfaces and TINs was introduced. No longer throws an exception if given empty geometry.
- ST_Dump - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_DumpPoints - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_Expand - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_Extent - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_ForceRHR - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.
- ST_Force2D - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.
- ST_Force3D - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.
- ST_Force3DZ - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.
- ST_ForceCollection - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.
- ST_GMLToSQL - Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.
- ST_GMLToSQL - Enhanced: 2.0.0 default srid optional parameter added.
- ST_GeomFromEWKB - Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.
- ST_GeomFromEWKT - Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.
- ST_GeomFromGML - Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.
- ST_GeomFromGML - Enhanced: 2.0.0 default srid optional parameter added.
- ST_GeometryN - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_GeometryType - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

- ST_IsClosed - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.
- ST_MakeEnvelope - Enhanced: 2.0: Ability to specify an envelope without specifying an SRID was introduced.
- ST_MakeValid - Enhanced: 2.0.1, speed improvements requires GEOS-3.3.4
- ST_NPoints - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.
- ST_NumGeometries - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_Relate - Enhanced: 2.0.0 - added support for specifying boundary node rule (requires GEOS >= 3.0).
- ST_Rotate - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_Rotate - Enhanced: 2.0.0 additional parameters for specifying the origin of rotation were added.
- ST_RotateX - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_RotateY - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_RotateZ - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_Scale - Enhanced: 2.0.0 support for Polyhedral surfaces, Triangles and TIN was introduced.
- ST_Shift_Longitude - Enhanced: 2.0.0 support for Polyhedral surfaces and TIN was introduced.
- ST_Summary - Enhanced: 2.0.0 added support for geography
- ST_Transform - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.
- ValidateTopology - Enhanced: 2.0.0 more efficient edge crossing detection and fixes for false positives that were existent in prior versions.
- && - Enhanced: 2.0.0 support for Polyhedral surfaces was introduced.

13.11.4 PostGIS Functions changed behavior in 2.0

The functions given below are PostGIS functions that have changed behavior in PostGIS 2.0 and may require application changes.

Note
Most deprecated functions have been removed. These are functions that haven't been documented since 1.2 or some internal functions that were never documented. If you are using a function that you don't see documented, it's probably deprecated, about to be deprecated, or internal and should be avoided. If you have applications or tools that rely on deprecated functions, please refer to [?qandaentry] for more details.

Note
Bounding boxes of geometries have been changed from float4 to double precision (float8). This has an impact on answers you get using bounding box operators and casting of bounding boxes to geometries. E.g ST_SetSRID(abbox) will often return a different more accurate answer in PostGIS 2.0+ than it did in prior versions which may very well slightly change answers to view port queries.

Note
The arguments hasnodata was replaced with exclude_nodata_value which has the same meaning as the older hasnodata but clearer in purpose.

- AddGeometryColumn - Changed: 2.0.0 This function no longer updates geometry_columns since geometry_columns is a view that reads from system catalogs. It by default also does not create constraints, but instead uses the built in type modifier behavior of PostgreSQL. So for example building a wgs84 POINT column with this function is now equivalent to: ALTER TABLE some_table ADD COLUMN geom geometry(Point,4326);
- AddGeometryColumn - Changed: 2.0.0 If you require the old behavior of constraints use the default use_typmod, but set it to false.
- AddGeometryColumn - Changed: 2.0.0 Views can no longer be manually registered in geometry_columns, however views built against geometry typmod tables geometries and used without wrapper functions will register themselves correctly because they inherit the typmod behavior of their parent table column. Views that use geometry functions that output other geometries will need to be cast to typmod geometries for these view geometry columns to be registered correctly in geometry_columns. Refer to .
- DropGeometryColumn - Changed: 2.0.0 This function is provided for backward compatibility. Now that since geometry_columns is now a view against the system catalogs, you can drop a geometry column like any other table column using ALTER TABLE
- DropGeometryTable - Changed: 2.0.0 This function is provided for backward compatibility. Now that since geometry_columns is now a view against the system catalogs, you can drop a table with geometry columns like any other table using DROP TABLE
- Populate_Geometry_Columns - Changed: 2.0.0 By default, now uses type modifiers instead of check constraints to constrain geometry types. You can still use check constraint behavior instead by using the new use_typmod and setting it to false.
- Box3D - Changed: 2.0.0 In pre-2.0 versions, there used to be a box2d instead of box3d. Since box2d is a deprecated type, this was changed to box3d.
- ST_ScaleX - Changed: 2.0.0. In WKTRaster versions this was called ST_PixelSizeX.
- ST_ScaleY - Changed: 2.0.0. In WKTRaster versions this was called ST_PixelSizeY.
- ST_SetScale - Changed: 2.0.0 In WKTRaster versions this was called ST_SetPixelSize. This was changed in 2.0.0.
- ST_3DExtent - Changed: 2.0.0 In prior versions this used to be called ST_Extent3D
- ST_3DLength - Changed: 2.0.0 In prior versions this used to be called ST_Length3D
- ST_3DLength_Spheroid - Changed: 2.0.0 In prior versions this used to return 0 for anything that is not a MULTILINESTRING or LINESTRING and in 2.0.0 on returns the perimeter of if given a polgon.
- ST_3DLength_Spheroid - Changed: 2.0.0 In prior versions this used to be called ST_Length3d_Spheroid
- ST_3DMakeBox - Changed: 2.0.0 In prior versions this used to be called ST_MakeBox3D
- ST_3DPerimeter - Changed: 2.0.0 In prior versions this used to be called ST_Perimeter3D
- ST_AsBinary - Changed: 2.0.0 Inputs to this function can not be unknown -- must be geometry. Constructs such as ST_AsBinary('POI 2)') are no longer valid and you will get an n st_asbinary(unknown) is not unique error. Code like that needs to be changed to ST_AsBinary('POINT(1 2)'::geometry);. If that is not possible, then install legacy.sql.
- ST_AsGML - Changed: 2.0.0 use default named args
- ST_AsGeoJSON - Changed: 2.0.0 support default args and named args.
- ST_AsKML - Changed: 2.0.0 - uses default args and supports named args
- ST_AsSVG - Changed: 2.0.0 to use default args and support named args
- ST_EndPoint - Changed: 2.0.0 no longer works with single geometry multilinestrings. In older versions of PostGIS -- a single line multilinestring would work happily with this function and return the start point. In 2.0.0 it just returns NULL like any other multilinestring. The older behavior was an undocumented feature, but people who assumed they had their data stored as LINESTRING may experience these returning NULL in 2.0 now.

- ST_GeomFromText - Changed: 2.0.0 In prior versions of PostGIS ST_GeomFromText('GEOMETRYCOLLECTION(EMPTY)') was allowed. This is now illegal in PostGIS 2.0.0 to better conform with SQL/MM standards. This should now be written as ST_GeomFromText('GEOMETRYCOLLECTION EMPTY')
- ST_GeometryN - Changed: 2.0.0 Prior versions would return NULL for singular geometries. This was changed to return the geometry for ST_GeometryN(..,1) case.
- ST_IsEmpty - Changed: 2.0.0 In prior versions of PostGIS ST_GeomFromText('GEOMETRYCOLLECTION(EMPTY)') was allowed. This is now illegal in PostGIS 2.0.0 to better conform with SQL/MM standards
- ST_Length - Changed: 2.0.0 Breaking change -- in prior versions applying this to a MULTI/POLYGON of type geography would give you the perimeter of the POLYGON/MULTIPOLYGON. In 2.0.0 this was changed to return 0 to be in line with geometry behavior. Please use ST_Perimeter if you want the perimeter of a polygon
- ST_LocateAlong - Changed: 2.0.0 in prior versions this used to be called ST_Locate_Along_Measure. The old name has been deprecated and will be removed in the future but is still available.
- ST_LocateBetween - Changed: 2.0.0 - in prior versions this used to be called ST_Locate_Between_Measures. The old name has been deprecated and will be removed in the future but is still available for backward compatibility.
- ST_ModEdgeSplit - Changed: 2.0 - In prior versions, this was misnamed ST_ModEdgesSplit
- ST_NumGeometries - Changed: 2.0.0 In prior versions this would return NULL if the geometry was not a collection/MULTI type. 2.0.0+ now returns 1 for single geometries e.g POLYGON, LINESTRING, POINT.
- ST_NumInteriorRings - Changed: 2.0.0 - in prior versions it would return the number of interior rings for the first POLYGON in a MULTIPOLYGON.
- ST_PointN - Changed: 2.0.0 no longer works with single geometry multilinestrings. In older versions of PostGIS -- a single line multilinestring would work happily with this function and return the start point. In 2.0.0 it just returns NULL like any other multilinestring.
- ST_StartPoint - Changed: 2.0.0 no longer works with single geometry multilinestrings. In older versions of PostGIS -- a single line multilinestring would work happily with this function and return the start point. In 2.0.0 it just returns NULL like any other multilinestring. The older behavior was an undocumented feature, but people who assumed they had their data stored as LINESTRING may experience these returning NULL in 2.0 now.

13.11.5 PostGIS Functions new, behavior changed, or enhanced in 1.5

The functions given below are PostGIS functions that were introduced or enhanced in this minor release.

- PostGIS_LibXML_Version - Availability: 1.5 Returns the version number of the libxml2 library.
- ST_AddMeasure - Availability: 1.5.0 Return a derived geometry with measure elements linearly interpolated between the start and end points. If the geometry has no measure dimension, one is added. If the geometry has a measure dimension, it is over-written with new values. Only LINESTRINGS and MULTILINESTRINGS are supported.
- ST_AsBinary - Availability: 1.5.0 geography support was introduced. Return the Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- ST_AsGML - Availability: 1.5.0 geography support was introduced. Return the geometry as a GML version 2 or 3 element.
- ST_AsGeoJSON - Availability: 1.5.0 geography support was introduced. Return the geometry as a GeoJSON element.
- ST_AsText - Availability: 1.5 - support for geography was introduced. Return the Well-Known Text (WKT) representation of the geometry/geography without SRID metadata.
- 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. - requires GEOS >= 3.2 to take advantage of advanced geometry functionality. (T) For geometry: Returns a geometry that represents all points whose distance from this Geometry is less than or equal to distance. Calculations are in the Spatial Reference System of this Geometry. For geography: Uses a planar transform wrapper. Introduced in 1.5 support for different end cap and mitre settings to control shape. buffer_style options: quad_segs=#,endcap=round|flat|square,join=round|mitre|bevel,

- ST_ClosestPoint - Availability: 1.5.0 Returns the 2-dimensional point on g1 that is closest to g2. This is the first point of the shortest line.
- ST_CollectionExtract - Availability: 1.5.0 Given a (multi)geometry, returns a (multi)geometry consisting only of elements of the specified type.
- ST_Covers - Availability: 1.5 - support for geography was introduced. Returns 1 (TRUE) if no point in Geometry B is outside Geometry A
- ST_DFullyWithin - Availability: 1.5.0 Returns true if all of the geometries are within the specified distance of one another
- ST_DWithin - Availability: 1.5.0 support for geography was introduced Returns true if the geometries are within the specified distance of one another. For geometry units are in those of spatial reference and For geography units are in meters and measurement is defaulted to use_spheroid=true (measure around spheroid), for faster check, use_spheroid=false to measure along sphere.
- ST_Distance - Availability: 1.5.0 geography support was introduced in 1.5. Speed improvements for planar to better handle large or many vertex geometries For geometry type Returns the 2-dimensional cartesian minimum distance (based on spatial ref) between two geometries in projected units. For geography type defaults to return spheroidal minimum distance between two geographies in meters.
- ST_Distance_Sphere - Availability: 1.5 - support for other geometry types besides points was introduced. Prior versions only work with points. Returns minimum distance in meters between two lon/lat geometries. Uses a spherical earth and radius of 6370986 meters. Faster than ST_Distance_Spheroid , but less accurate. PostGIS versions prior to 1.5 only implemented for points.
- ST_Distance_Spheroid - Availability: 1.5 - support for other geometry types besides points was introduced. Prior versions only work with points. Returns the minimum distance between two lon/lat geometries given a particular spheroid. PostGIS versions prior to 1.5 only support points.
- ST_DumpPoints - Availability: 1.5.0 Returns a set of geometry_dump (geom,path) rows of all points that make up a geometry.
- ST_Envelope - Availability: 1.5.0 behavior changed to output double precision instead of float4 Returns a geometry representing the double precision (float8) bounding box of the supplied geometry.
- ST_GMLToSQL - Availability: 1.5, requires libxml2 1.6+ Return a specified ST_Geometry value from GML representation. This is an alias name for ST_GeomFromGML
- ST_GeomFromGML - Availability: 1.5, requires libxml2 1.6+ Takes as input GML representation of geometry and outputs a PostGIS geometry object
- ST_GeomFromKML - Availability: 1.5,libxml2 2.6+ Takes as input KML representation of geometry and outputs a PostGIS geometry object
- ~= - Availability: 1.5.0 changed behavior Returns TRUE if A's bounding box is the same as B's.
- ST_HausdorffDistance - Availability: 1.5.0 - requires GEOS >= 3.2.0 Returns the Hausdorff distance between two geometries. Basically a measure of how similar or dissimilar 2 geometries are. Units are in the units of the spatial reference system of the geometries.
- ST_Intersection - Availability: 1.5 support for geography data type was introduced. (T) Returns a geometry that represents the shared portion of geomA and geomB. The geography implementation does a transform to geometry to do the intersection and then transform back to WGS84.
- ST_Intersects - Availability: 1.5 support for geography was introduced. Returns TRUE if the Geometries/Geography "spatially intersect in 2D" - (share any portion of space) and FALSE if they don't (they are Disjoint). For geography -- tolerance is 0.00001 meters (so any points that close are considered to intersect)
- ST_Length - Availability: 1.5.0 geography support was introduced in 1.5. Returns the 2d length of the geometry if it is a linestring or multilinestring. geometry are in units of spatial reference and geography are in meters (default spheroid)
- ST_LongestLine - Availability: 1.5.0 Returns the 2-dimensional longest line points of two geometries. The function will only return the first longest line if more than one, that the function finds. The line returned will always start in g1 and end in g2. The length of the line this function returns will always be the same as st_maxdistance returns for g1 and g2.

- ST_MakeEnvelope - Availability: 1.5 Creates a rectangular Polygon formed from the given minimums and maximums. Input values must be in SRS specified by the SRID.
- ST_MaxDistance - Availability: 1.5.0 Returns the 2-dimensional largest distance between two geometries in projected units.
- ST_ShortestLine - Availability: 1.5.0 Returns the 2-dimensional shortest line between two geometries
- && - Availability: 1.5.0 support for geography was introduced. Returns TRUE if A's 2D bounding box intersects B's 2D bounding box.

13.11.6 PostGIS Functions new, behavior changed, or enhanced in 1.4

The functions given below are PostGIS functions that were introduced or enhanced in the 1.4 release.

- Populate_Geometry_Columns - Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints This ensures they will be registered correctly in geometry_columns view. By default will convert all geometry columns with no type modifier to ones with type modifiers. To get old behavior set use_typmod=false Availability: 1.4.0
- ST_AsSVG - Returns a Geometry in SVG path data given a geometry or geography object. Availability: 1.2.2. Availability: 1.4.0 Changed in PostGIS 1.4.0 to include L command in absolute path to conform to http://www.w3.org/TR/SVG/paths.html#PathDat
- ST_Collect - Return a specified ST_Geometry value from a collection of other geometries. Availability: 1.4.0 - ST_Collect(geomarray) was introduced. ST_Collect was enhanced to handle more geometries faster.
- ST_ContainsProperly - Returns true if B intersects the interior of A but not the boundary (or exterior). A does not contain properly itself, but does contain itself. Availability: 1.4.0 - requires GEOS >= 3.1.0.
- ST_Extent - an aggregate function that returns the bounding box that bounds rows of geometries. Availability: 1.4.0
- ST_GeoHash - Return a GeoHash representation of the geometry. Availability: 1.4.0
- ST_IsValidReason - Returns text stating if a geometry is valid or not and if not valid, a reason why. Availability: 1.4 - requires GEOS >= 3.1.0.
- ST_LineCrossingDirection - Given 2 linestrings, returns a number between -3 and 3 denoting what kind of crossing behavior. 0 is no crossing. Availability: 1.4
- ST_LocateBetweenElevations - Return a derived geometry (collection) value with elements that intersect the specified range of elevations inclusively. Only 3D, 4D LINESTRINGS and MULTILINESTRINGS are supported. Availability: 1.4.0
- ST_MakeLine - Creates a Linestring from point or line geometries. Availability: 1.4.0 - ST_MakeLine(geomarray) was introduced. ST_MakeLine aggregate functions was enhanced to handle more points faster.
- ST_MinimumBoundingCircle - Returns the smallest circle polygon that can fully contain a geometry. Default uses 48 segments per quarter circle. Availability: 1.4.0 - requires GEOS
- ST_Union - Returns a geometry that represents the point set union of the Geometries. Availability: 1.4.0 - ST_Union was enhanced. ST_Union(geomarray) was introduced and also faster aggregate collection in PostgreSQL. If you are using GEOS 3.1.0+ ST_Union will use the faster Cascaded Union algorithm described in http://blog.cleverelephant.ca/2009/01/must-faster-unions-in-postgis-14.html

13.11.7 PostGIS Functions new in 1.3

The functions given below are PostGIS functions that were introduced in the 1.3 release.

- ST_AsGML - Return the geometry as a GML version 2 or 3 element. Availability: 1.3.2
- ST_AsGeoJSON - Return the geometry as a GeoJSON element. Availability: 1.3.4
- ST_SimplifyPreserveTopology - Returns a "simplified" version of the given geometry using the Douglas-Peucker algorithm. Will avoid creating derived geometries (polygons in particular) that are invalid. Availability: 1.3.3

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 Subversion patch is definitely preferred. This is a four step process on Unix (assuming you already have Subversion installed):

1. Check out a copy of PostGIS' Subversion trunk. On Unix, type:

   svn checkout http://svn.osgeo.org/postgis/trunk/

   This will be stored in the directory ./trunk

2. Make your changes to the documentation with your favorite text editor. On Unix, type (for example):

   vim trunk/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:

   svn diff trunk/doc/postgis.xml > doc.patch

4. Attach the patch to a new issue in bug tracker.

Appendix A

Appendix

A.1 Release 2.1.10

Release date: 2017-XX-XX

This is a bug fix release.

A.2 Release 2.1.9

Release date: 2017-09-19

This is a critical bug fix release.

A.2.1 Bug Fixes

#2232, avoid accumulated error in SVG rounding

#2283, Import nested holey multipolygons correctly

#3222, Fix uninitialized stddev in stats computation

#3196, do not let DropTopology drop non-topology schemes

#3198, ST_AddEdgeModFace docs report wrong side of new face

#3245, Ensure lwgeom/geos returns are fully owned

#3280, Fix topology import of almost collinear linestrings

#3281, Do not export liblwgeom symbols from the PostgreSQL module

#3351, Set endnodes isolation on ST_RemoveIsoEdge

#3355, Fix geography ST_Segmentize() does not add geodetic box ST_Intersects and other relationship functions always return false as result.

#3359, Fix toTopoGeom loss of low-id primitives from TopoGeometry definition

#3375, crash in repeated point removal for collection(point)

#3378, Fix handling of hierarchical TopoGeometries with of multiple topologies

#3389, Buffer overflow in lwgeom_to_geojson

#3393, ST_Area NaN for some polygons

#3436, memory handling mistake in ptarray_clone_deep

#3461, ST_GeomFromKML crashes Postgres when there are innerBoundaryIs and no outerBoundaryIs

#3429, upgrading to 2.2 or 2.3 can cause crash/hang on some platforms

#3565, ST_SetPoint can crash backend

#3579, Crash in LWGEOM2GEOS

#3583, Crash in ST_GeomFromGeoJSON on malformed multipolygon

#3607, Fix inconsistency with multilinestring in ST_LocateBetweenElevations (Artur Zakirov)

#3608, Fix crash passing -W UTF-8 to shp2pgsql (Matt Amos)

#3644, Deadlock on interrupt

#3774, Trigonometric length for CompoundCurves

#3731, Crash on very small table of homogenous data

A.3 Release 2.1.8

Release date: 2015-07-07

This is a critical bug fix release.

A.3.1 Bug Fixes

#3159, do not force a bbox cache on ST_Affine

#3018, GROUP BY geography sometimes returns duplicate rows

#3048, shp2pgsql - illegal number format when specific system locale set

#3094, Malformed GeoJSON inputs crash backend

#3104, st_asgml introduces random characters in ID field

#3155, Remove liblwgeom.h on make uninstall

#3177, gserialized_is_empty cannot handle nested empty cases

Fix crash in ST_LineLocatePoint

A.4 Release 2.1.7

Release date: 2015-03-30

This is a critical bug fix release.

A.4.1 Bug Fixes

#3086, ST_DumpValues() crashes backend on cleanup with invalid band indexes

#3088, Do not (re)define strcasestr in a liblwgeom.h

#3094, Malformed GeoJSON inputs crash backend

A.5 Release 2.1.6

Release date: 2015-03-20

This is a bug fix and performance improvement release.

A.5.1 Enhancements

#3000, Ensure edge splitting and healing algorithms use indexes

#3048, Speed up geometry simplification (J.Santana @ CartoDB)

#3050, Speep up geometry type reading (J.Santana @ CartoDB)

A.5.2 Bug Fixes

#2941, allow geography columns with SRID other than 4326

#3069, small objects getting inappropriately fluffed up w/ boxes

#3068, Have postgis_typmod_dims return NULL for unconstrained dims

#3061, Allow duplicate points in JSON, GML, GML ST_GeomFrom* functions

#3058, Fix ND-GiST picksplit method to split on the best plane

#3052, Make operators <-> and <#> available for PostgreSQL < 9.1

#3045, Fix dimensionality confusion in &&& operator

#3016, Allow unregistering layers of corrupted topologies

#3015, Avoid exceptions from TopologySummary

#3020, ST_AddBand out-db bug where height using width value

#3031, Allow restore of Geometry(Point) tables dumped with empties in them

A.6 Release 2.1.5

Release date: 2014-12-18

This is a bug fix and performance improvement release.

A.6.1 Enhancements

#2933, Speedup construction of large multi-geometry objects

A.6.2 Bug Fixes

#2947, Fix memory leak in lwgeom_make_valid for single-component collection input

#2949, Fix memory leak in lwgeom_mindistance2d for curve input

#2931, BOX representation is case sensitive

#2942, PostgreSQL 9.5 support

#2953, 2D stats not generated when Z/M values are extreme

#3009, Geography cast may effect underlying tuple

A.7 Release 2.1.4

Release date: 2014-09-10

This is a bug fix and performance improvement release.

A.7.1 Enhancements

#2745, Speedup ST_Simplify calls against points

#2747, Support for GDAL 2.0

#2749, Make rtpostgis_upgrade_20_21.sql ACID

#2811, Do not specify index names when loading shapefiles/rasters

#2829, Shortcut ST_Clip(raster) if geometry fully contains the raster and no NODATA specified

#2895, Raise cost of ST_ConvexHull(raster) to 300 for better query plans

A.7.2 Bug Fixes

#2605, armel: _ST_Covers() returns true for point in hole

#2911, Fix output scale on ST_Rescale/ST_Resample/ST_Resize of rasters with scale 1/-1 and offset 0/0.

Fix crash in ST_Union(raster)

#2704, ST_GeomFromGML() does not work properly with array of gml:pos (Even Rouault)

#2708, updategeometrysrid doesn't update srid check when schema not specified. Patch from Marc Jansen

#2720, lwpoly_add_ring should update maxrings after realloc

#2759, Fix postgis_restore.pl handling of multiline object comments embedding sql comments

#2774, fix undefined behavior in ptarray_calculate_gbox_geodetic - Fix potential memory fault in ST_MakeValid

#2784, Fix handling of bogus argument to --with-sfcgal

#2772, Premature memory free in RASTER_getBandPath (ST_BandPath)

#2755, Fix regressions tests against all versions of SFCGAL

#2775, lwline_from_lwmpoint leaks memory

#2802, ST_MapAlgebra checks for valid callback function return value

#2803, ST_MapAlgebra handles no userarg and STRICT callback function

#2834, ST_Estimated_Extent and mixedCase table names (regression bug)

#2845, Bad geometry created from ST_AddPoint

#2870, Binary insert into geography column results geometry being inserted

#2872, make install builds documentation (Greg Troxell)

#2819, find isfinite or replacement on Centos5 / Solaris

#2899, geocode limit 1 not returning best answer (tiger geocoder)

#2903, Unable to compile on FreeBSD

#2927 reverse_geocode not filling in direction prefix (tiger geocoder) get rid of deprecated ST_Line_Locate_Point called

A.8 Release 2.1.3

Release date: 2014/05/13

This is a bug fix and security release.

A.8.1 Important changes

Starting with this version offline raster access and use of GDAL drivers are disabled by default.

An environment variable is introduced to allow for enabling specific GDAL drivers: POSTGIS_GDAL_ENABLED_DRIVERS. By default, all GDAL drivers are disabled

An environment variable is introduced to allow for enabling out-db raster bands: POSTGIS_ENABLE_OUTDB_RASTERS. By default, out-db raster bands are disabled

The environment variables must be set for the PostgreSQL process, and determines the behavior of the whole cluster.

A.8.2 Bug Fixes

#2697, invalid GeoJSON Polygon input crashes server process

#2700, Fix dumping of higher-dimension datasets with null rows

#2706, ST_DumpPoints of EMPTY geometries crashes server

A.9 Release 2.1.2

Release date: 2014/03/31

This is a bug fix release, addressing issues that have been filed since the 2.1.1 release.

A.9.1 Bug Fixes

#2666, Error out at configure time if no SQL preprocessor can be found

#2534, st_distance returning incorrect results for large geographies

#2539, Check for json-c/json.h presence/usability before json/json.h

#2543, invalid join selectivity error from simple query

#2546, GeoJSON with string coordinates parses incorrectly

#2547, Fix ST_Simplify(TopoGeometry) for hierarchical topogeoms

#2552, Fix NULL raster handling in ST_AsPNG, ST_AsTIFF and ST_AsJPEG

#2555, Fix parsing issue of range arguments of ST_Reclass

#2556, geography ST_Intersects results depending on insert order

#2580, Do not allow installing postgis twice in the same database

#2589, Remove use of unnecessary void pointers

#2607, Cannot open more than 1024 out-db files in one process

#2610, Ensure face splitting algorithm uses the edge index

#2615, EstimatedExtent (and hence, underlying stats) gathering wrong bbox

#2619, Empty rings array in GeoJSON polygon causes crash

#2634, regression in sphere distance code

#2638, Geography distance on M geometries sometimes wrong

#2648, #2653, Fix topology functions when "topology" is not in search_path

#2654, Drop deprecated calls from topology

#2655, Let users without topology privileges call postgis_full_version()

#2674, Fix missing operator = and hash_raster_ops opclass on raster

#2675, #2534, #2636, #2634, #2638, Geography distance issues with tree optimization

A.9.2 Enhancements

#2494, avoid memcopy in GiST index (hayamiz)

#2560, soft upgrade: avoid drop/recreate of aggregates that hadn't changed

A.10 Release 2.1.1

Release date: 2013/11/06

This is a bug fix release, addressing issues that have been filed since the 2.1.0 release.

A.10.1 Important Changes

#2514, Change raster license from GPL v3+ to v2+, allowing distribution of PostGIS Extension as GPLv2.

A.10.2 Bug Fixes

#2396, Make regression tests more endian-agnostic

#2434, Fix ST_Intersection(geog,geog) regression in rare cases

#2454, Fix behavior of ST_PixelAsXXX functions regarding exclude_nodata_value parameter

#2489, Fix upgrades from 2.0 leaving stale function signatures

#2525, Fix handling of SRID in nested collections

#2449, Fix potential infinite loop in index building

#2493, Fix behavior of ST_DumpValues when passed an empty raster

#2502, Fix postgis_topology_scripts_installed() install schema

#2504, Fix segfault on bogus pgsql2shp call

#2512, Support for foreign tables and materialized views in raster_columns and raster_overviews

A.10.3 Enhancements

#2478, support for tiger 2013

#2463, support for exact length calculations on arc geometries

A.11 Release 2.1.0

Release date: 2013/08/17

This is a minor release addressing both bug fixes and performance and functionality enhancements addressing issues since 2.0.3 release. If you are upgrading from 2.0+, only a soft upgrade is required. If you are upgrading from 1.5 or earlier, a hard upgrade is required.

A.11.1 Important / Breaking Changes

#1653, Removed srid parameter from ST_Resample(raster) and variants with reference raster no longer apply reference raster's SRID.

#1962 ST_Segmentize - As a result of the introduction of geography support, The construct: `SELECT ST_Segmentize('LINESTRING(1 2, 3 4)',0.5);` will result in ambiguous function error

#2026, ST_Union(raster) now unions all bands of all rasters

#2089, liblwgeom: lwgeom_set_handlers replaces lwgeom_init_allocators.

#2150, regular_blocking is no longer a constraint. column of same name in raster_columns now checks for existance of spatially_unique and coverage_tile constraints

ST_Intersects(raster, geometry) behaves in the same manner as ST_Intersects(geometry, raster).

point variant of ST_SetValue(raster) previously did not check SRID of input geometry and raster.

ST_Hillshade parameters azimuth and altitude are now in degrees instead of radians.

ST_Slope and ST_Aspect return pixel values in degrees instead of radians.

#2104, ST_World2RasterCoord, ST_World2RasterCoordX and ST_World2RasterCoordY renamed to ST_WorldToRasterCoord, ST_WorldToRasterCoordX and ST_WorldToRasterCoordY. ST_Raster2WorldCoord, ST_Raster2WorldCoordX and ST_Raster2WorldC renamed to ST_RasterToWorldCoord, ST_RasterToWorldCoordX and ST_RasterToWorldCoordY

ST_Estimated_Extent renamed to ST_EstimatedExtent

ST_Line_Interpolate_Point renamed to ST_LineInterpolatePoint

ST_Line_Substring renamed to ST_LineSubstring

ST_Line_Locate_Point renamed to ST_LineLocatePoint

ST_Force_XXX renamed to ST_ForceXXX

ST_MapAlgebraFctNgb and 1 and 2 raster variants of ST_MapAlgebraFct. Use ST_MapAlgebra instead

1 and 2 raster variants of ST_MapAlgebraExpr. Use expression variants of ST_MapAlgebra instead

A.11.2 New Features

- Refer to http://postgis.net/docs/manual-2.1/PostGIS_Special_Functions_Index.html#NewFunctions_2_1 for complete list of new functions

#310, ST_DumpPoints converted to a C function (Nathan Wagner) and much faster

#739, UpdateRasterSRID()

#945, improved join selectivity, N-D selectivity calculations, user accessible selectivity and stats reader functions for testing (Paul Ramsey / OpenGeo)

toTopoGeom with TopoGeometry sink (Sandro Santilli / Vizzuality)

clearTopoGeom (Sandro Santilli / Vizzuality)

ST_Segmentize(geography) (Paul Ramsey / OpenGeo)

ST_DelaunayTriangles (Sandro Santilli / Vizzuality)

ST_NearestValue, ST_Neighborhood (Bborie Park / UC Davis)

ST_PixelAsPoint, ST_PixelAsPoints (Bborie Park / UC Davis)

ST_PixelAsCentroid, ST_PixelAsCentroids (Bborie Park / UC Davis)

ST_Raster2WorldCoord, ST_World2RasterCoord (Bborie Park / UC Davis)

Additional raster/raster spatial relationship functions (ST_Contains, ST_ContainsProperly, ST_Covers, ST_CoveredBy, ST_Disjoint, ST_Overlaps, ST_Touches, ST_Within, ST_DWithin, ST_DFullyWithin) (Bborie Park / UC Davis)

Added array variants of ST_SetValues() to set many pixel values of a band in one call (Bborie Park / UC Davis)

#1293, ST_Resize(raster) to resize rasters based upon width/height

#1627, package tiger_geocoder as a PostgreSQL extension

#1643, #2076, Upgrade tiger geocoder to support loading tiger 2011 and 2012 (Regina Obe / Paragon Corporation) Funded by Hunter Systems Group

GEOMETRYCOLLECTION support for ST_MakeValid (Sandro Santilli / Vizzuality)

#1709, ST_NotSameAlignmentReason(raster, raster)

#1818, ST_GeomFromGeoHash and friends (Jason Smith (darkpanda))

#1856, reverse geocoder rating setting for prefer numbered highway name

ST_PixelOfValue (Bborie Park / UC Davis)

Casts to/from PostgreSQL geotypes (point/path/polygon).

Added geomval array variant of ST_SetValues() to set many pixel values of a band using a set of geometries and corresponding values in one call (Bborie Park / UC Davis)

ST_Tile(raster) to break up a raster into tiles (Bborie Park / UC Davis)

#1895, new r-tree node splitting algorithm (Alex Korotkov)

#2011, ST_DumpValues to output raster as array (Bborie Park / UC Davis)

#2018, ST_Distance support for CircularString, CurvePolygon, MultiCurve, MultiSurface, CompoundCurve

#2030, n-raster (and n-band) ST_MapAlgebra (Bborie Park / UC Davis)

#2193, Utilize PAGC parser as drop in replacement for tiger normalizer (Steve Woodbridge, Regina Obe)

#2210, ST_MinConvexHull(raster)

lwgeom_from_geojson in liblwgeom (Sandro Santilli / Vizzuality)

#1687, ST_Simplify for TopoGeometry (Sandro Santilli / Vizzuality)

#2228, TopoJSON output for TopoGeometry (Sandro Santilli / Vizzuality)

#2123, ST_FromGDALRaster

#613, ST_SetGeoReference with numerical parameters instead of text

#2276, ST_AddBand(raster) variant for out-db bands

#2280, ST_Summary(raster)

#2163, ST_TPI for raster (Nathaniel Clay)

#2164, ST_TRI for raster (Nathaniel Clay)

#2302, ST_Roughness for raster (Nathaniel Clay)

#2290, ST_ColorMap(raster) to generate RGBA bands

#2254, Add SFCGAL backend support. (Backend selection throught postgis.backend var) Functions available both throught GEOS or SFCGAL: ST_Intersects, ST_3DIntersects, ST_Intersection, ST_Area, ST_Distance, ST_3DDistance New functions available only with SFCGAL backend: ST_3DIntersection, ST_Tesselate, ST_3DArea, ST_Extrude, ST_ForceLHR ST_Orientation, ST_Minkowski, ST_StraightSkeleton postgis_sfcgal_version New function available in PostGIS: ST_ForceSFS (Olivier Courtin and Hugo Mercier / Oslandia)

A.11.3 Enhancements

For detail of new functions and function improvements, please refer to Section 13.11.1.

Much faster raster ST_Union, ST_Clip and many more function additions operations

For geometry/geography better planner selectivity and a lot more functions.

#823, tiger geocoder: Make loader_generate_script download portion less greedy

#826, raster2pgsql no longer defaults to padding tiles. Flag -P can be used to pad tiles

#1363, ST_AddBand(raster, ...) array version rewritten in C

#1364, ST_Union(raster, ...) aggregate function rewritten in C

#1655, Additional default values for parameters of ST_Slope

#1661, Add aggregate variant of ST_SameAlignment

#1719, Add support for Point and GeometryCollection ST_MakeValid inputs

#1780, support ST_GeoHash for geography

#1796, Big performance boost for distance calculations in geography

#1802, improved function interruptibility.

#1823, add parameter in ST_AsGML to use id column for GML 3 output (become mandatory since GML 3.2.1)

#1856, tiger geocoder: reverse geocoder rating setting for prefer numbered highway name

#1938, Refactor basic ST_AddBand to add multiple new bands in one call

#1978, wrong answer when calculating length of a closed circular arc (circle)

#1989, Preprocess input geometry to just intersection with raster to be clipped

#2021, Added multi-band support to ST_Union(raster, ...) aggregate function

#2006, better support of ST_Area(geography) over poles and dateline

#2065, ST_Clip(raster, ...) now a C function

#2069, Added parameters to ST_Tile(raster) to control padding of tiles

#2078, New variants of ST_Slope, ST_Aspect and ST_HillShade to provide solution to handling tiles in a coverage

#2097, Added RANGE uniontype option for ST_Union(raster)

#2105, Added ST_Transform(raster) variant for aligning output to reference raster

#2119, Rasters passed to ST_Resample(), ST_Rescale(), ST_Reskew(), and ST_SnapToGrid() no longer require an SRID

#2141, More verbose output when constraints fail to be added to a raster column

#2143, Changed blocksize constraint of raster to allow multiple values

#2148, Addition of coverage_tile constraint for raster

#2149, Addition of spatially_unique constraint for raster

TopologySummary output now includes unregistered layers and a count of missing TopoGeometry objects from their natural layer.

ST_HillShade(), ST_Aspect() and ST_Slope() have one new optional parameter to interpolate NODATA pixels before running the operation.

Point variant of ST_SetValue(raster) is now a wrapper around geomval variant of ST_SetValues(rast).

Proper support for raster band's isnodata flag in core API and loader.

Additional default values for parameters of ST_Aspect and ST_HillShade

#2178, ST_Summary now advertises presence of known srid with an [S] flag

#2202, Make libjson-c optional (--without-json configure switch)

#2213, Add support libjson-c 0.10+

#2231, raster2pgsql supports user naming of filename column with -n

#2200, ST_Union(raster, uniontype) unions all bands of all rasters

#2264, postgis_restore.pl support for restoring into databases with postgis in a custom schema

#2244, emit warning when changing raster's georeference if raster has out-db bands

#2222, add parameter OutAsIn to flag whether ST_AsBinary should return out-db bands as in-db bands

A.11.4 Fixes

#1839, handling of subdatasets in GeoTIFF in raster2pgsql.

#1840, fix logic of when to compute # of tiles in raster2pgsql.

#1870, align the docs and actual behavior of raster's ST_Intersects

#1872, fix ST_ApproxSummarystats to prevent division by zero

#1875, ST_SummaryStats returns NULL for all parameters except count when count is zero

#1932, fix raster2pgsql of syntax for index tablespaces

#1936, ST_GeomFromGML on CurvePolygon causes server crash

#1939, remove custom data types: summarystats, histogram, quantile, valuecount

#1951, remove crash on zero-length linestrings

#1957, ST_Distance to a one-point LineString returns NULL

#1976, Geography point-in-ring code overhauled for more reliability

#1981, cleanup of unused variables causing warnings with gcc 4.6+

#1996, support POINT EMPTY in GeoJSON output

#2062, improve performance of distance calculations

#2057, Fixed linking issue for raster2psql to libpq

#2077, Fixed incorrect values returning from ST_Hillshade()

#2019, ST_FlipCoordinates does not update bbox

#2100, ST_AsRaster may not return raster with specified pixel type

#2126, Better handling of empty rasters from ST_ConvexHull()

#2165, ST_NumPoints regression failure with CircularString

#2168, ST_Distance is not always commutative

#2182, Fix issue with outdb rasters with no SRID and ST_Resize

#2188, Fix function parameter value overflow that caused problems when copying data from a GDAL dataset

#2198, Fix incorrect dimensions used when generating bands of out-db rasters in ST_Tile()

#2201, ST_GeoHash wrong on boundaries

#2203, Changed how rasters with unknown SRID and default geotransform are handled when passing to GDAL Warp API

#2215, Fixed raster exclusion constraint for conflicting name of implicit index

#2251, Fix bad dimensions when rescaling rasters with default geotransform matrix

#2133, Fix performance regression in expression variant of ST_MapAlgebra

#2257, GBOX variables not initialized when testing with empty geometries

#2271, Prevent parallel make of raster

#2282, Fix call to undefined function nd_stats_to_grid() in debug mode

#2307, ST_MakeValid outputs invalid geometries

#2309, Remove confusing INFO message when trying to get SRS info

#2336, FIPS 20 (KS) causes wildcard expansion to wget all files

#2348, Provide raster upgrade path for 2.0 to 2.1

#2351, st_distance between geographies wrong

#2359, Fix handling of schema name when adding overview constraints

#2371, Support GEOS versions with more than 1 digit in micro

#2383, Remove unsafe use of \' from raster warning message

#2384, Incorrect variable datatypes for ST_Neighborhood

A.11.5 Known Issues

#2111, Raster bands can only reference the first 256 bands of out-db rasters

A.12 Release 2.0.5

Release date: 2014/03/31

This is a bug fix release, addressing issues that have been filed since the 2.0.4 release. If you are using PostGIS 2.0+ a soft upgrade is required. For users of PostGIS 1.5 or below, a hard upgrade is required.

A.12.1 Bug Fixes

#2494, avoid memcpy in GIST index

#2502, Fix postgis_topology_scripts_installed() install schema

#2504, Fix segfault on bogus pgsql2shp call

#2528, Fix memory leak in ST_Split / lwline_split_by_line

#2532, Add missing raster/geometry commutator operators

#2533, Remove duplicated signatures

#2552, Fix NULL raster handling in ST_AsPNG, ST_AsTIFF and ST_AsJPEG

#2555, Fix parsing issue of range arguments of ST_Reclass

#2589, Remove use of unnecessary void pointers

#2607, Cannot open more than 1024 out-db files in process

#2610, Ensure face splitting algorithm uses the edge index

#2619, Empty ring array in GeoJSON polygon causes crash

#2638, Geography distance on M geometries sometimes wrong

A.12.2 Important Changes

##2514, Change raster license from GPL v3+ to v2+, allowing distribution of PostGIS Extension as GPLv2.

A.13 Release 2.0.4

Release date: 2013/09/06

This is a bug fix release, addressing issues that have been filed since the 2.0.3 release. If you are using PostGIS 2.0+ a soft upgrade is required. For users of PostGIS 1.5 or below, a hard upgrade is required.

A.13.1 Bug Fixes

#2110, Equality operator between EMPTY and point on origin

Allow adding points at precision distance with TopoGeo_addPoint

#1968, Fix missing edge from toTopoGeom return

#2165, ST_NumPoints regression failure with CircularString

#2168, ST_Distance is not always commutative

#2186, gui progress bar updates too frequent

#2201, ST_GeoHash wrong on boundaries

#2257, GBOX variables not initialized when testing with empty geometries

#2271, Prevent parallel make of raster

#2267, Server crash from analyze table

#2277, potential segfault removed

#2307, ST_MakeValid outputs invalid geometries

#2351, st_distance between geographies wrong

#2359, Incorrect handling of schema for overview constraints

#2371, Support GEOS versions with more than 1 digit in micro

#2372, Cannot parse space-padded KML coordinates

Fix build with systemwide liblwgeom installed

#2383, Fix unsafe use of \' in warning message

#2410, Fix segmentize of collinear curve

#2412, ST_LineToCurve support for lines with less than 4 vertices

#2415, ST_Multi support for COMPOUNDCURVE and CURVEPOLYGON

#2420, ST_LineToCurve: require at least 8 edges to define a full circle

#2423, ST_LineToCurve: require all arc edges to form the same angle

#2424, ST_CurveToLine: add support for COMPOUNDCURVE in MULTICURVE

#2427, Make sure to retain first point of curves on ST_CurveToLine

A.13.2 Enhancements

#2269, Avoid uselessly detoasting full geometries on ANALYZE

A.13.3 Known Issues

#2111, Raster bands can only reference the first 256 bands of out-db rasters

A.14 Release 2.0.3

Release date: 2013/03/01

This is a bug fix release, addressing issues that have been filed since the 2.0.2 release. If you are using PostGIS 2.0+ a soft upgrade is required. For users of PostGIS 1.5 or below, a hard upgrade is required.

A.14.1 Bug Fixes

#2126, Better handling of empty rasters from ST_ConvexHull()

#2134, Make sure to process SRS before passing it off to GDAL functions

Fix various memory leaks in liblwgeom

#2173, Fix robustness issue in splitting a line with own vertex also affecting topology building (#2172)

#2174, Fix usage of wrong function lwpoly_free()

#2176, Fix robustness issue with ST_ChangeEdgeGeom

#2184, Properly copy topologies with Z value

postgis_restore.pl support for mixed case geometry column name in dumps

#2188, Fix function parameter value overflow that caused problems when copying data from a GDAL dataset

#2216, More memory errors in MultiPolygon GeoJSON parsing (with holes)

Fix Memory leak in GeoJSON parser

A.14.2 Enhancements

#2141, More verbose output when constraints fail to be added to a raster column

Speedup ST_ChangeEdgeGeom

A.15 Release 2.0.2

Release date: 2012/12/03

This is a bug fix release, addressing issues that have been filed since the 2.0.1 release.

A.15.1 Bug Fixes

#1287, Drop of "gist_geometry_ops" broke a few clients package of legacy_gist.sql for these cases

#1391, Errors during upgrade from 1.5

#1828, Poor selectivity estimate on ST_DWithin

#1838, error importing tiger/line data

#1869, ST_AsBinary is not unique added to legacy_minor/legacy.sql scripts

#1885, Missing field from tabblock table in tiger2010 census_loader.sql

#1891, Use LDFLAGS environment when building liblwgeom

#1900, Fix pgsql2shp for big-endian systems

#1932, Fix raster2pgsql for invalid syntax for setting index tablespace

#1936, ST_GeomFromGML on CurvePolygon causes server crash

#1955, ST_ModEdgeHeal and ST_NewEdgeHeal for doubly connected edges

#1957, ST_Distance to a one-point LineString returns NULL

#1976, Geography point-in-ring code overhauled for more reliability

#1978, wrong answer calculating length of closed circular arc (circle)

#1981, Remove unused but set variables as found with gcc 4.6+

#1987, Restore 1.5.x behaviour of ST_Simplify

#1989, Preprocess input geometry to just intersection with raster to be clipped

#1991, geocode really slow on PostgreSQL 9.2

#1996, support POINT EMPTY in GeoJSON output

#1998, Fix ST_{Mod,New}EdgeHeal joining edges sharing both endpoints

#2001, ST_CurveToLine has no effect if the geometry doesn't actually contain an arc

#2015, ST_IsEmpty('POLYGON(EMPTY)') returns False

#2019, ST_FlipCoordinates does not update bbox

#2025, Fix side location conflict at TopoGeo_AddLineString

#2026, improve performance of distance calculations

#2033, Fix adding a splitting point into a 2.5d topology

#2051, Fix excess of precision in ST_AsGeoJSON output

#2052, Fix buffer overflow in lwgeom_to_geojson

#2056, Fixed lack of SRID check of raster and geometry in ST_SetValue()

#2057, Fixed linking issue for raster2psql to libpq

#2060, Fix "dimension" check violation by GetTopoGeomElementArray

#2072, Removed outdated checks preventing ST_Intersects(raster) from working on out-db bands

#2077, Fixed incorrect answers from ST_Hillshade(raster)

#2092, Namespace issue with ST_GeomFromKML,ST_GeomFromGML for libxml 2.8+

#2099, Fix double free on exception in ST_OffsetCurve

#2100, ST_AsRaster() may not return raster with specified pixel type

#2108, Ensure ST_Line_Interpolate_Point always returns POINT

#2109, Ensure ST_Centroid always returns POINT

#2117, Ensure ST_PointOnSurface always returns POINT

#2129, Fix SRID in ST_Homogenize output with collection input

#2130, Fix memory error in MultiPolygon GeoJson parsing

Update URL of Maven jar

A.15.2 Enhancements

#1581, ST_Clip(raster, ...) no longer imposes NODATA on a band if the corresponding band from the source raster did not have NODATA

#1928, Accept array properties in GML input multi-geom input (Kashif Rasul and Shoaib Burq / SpacialDB)

#2082, Add indices on start_node and end_node of topology edge tables

#2087, Speedup topology.GetRingEdges using a recursive CTE

A.16 Release 2.0.1

Release date: 2012/06/22

This is a bug fix release, addressing issues that have been filed since the 2.0.0 release.

A.16.1 Bug Fixes

#1264, fix st_dwithin(geog, geog, 0).

#1468 shp2pgsql-gui table column schema get shifted

#1694, fix building with clang. (vince)

#1708, improve restore of pre-PostGIS 2.0 backups.

#1714, more robust handling of high topology tolerance.

#1755, ST_GeographyFromText support for higher dimensions.

#1759, loading transformed shapefiles in raster enabled db.

#1761, handling of subdatasets in NetCDF, HDF4 and HDF5 in raster2pgsql.

#1763, topology.toTopoGeom use with custom search_path.

#1766, don't let ST_RemEdge* destroy peripheral TopoGeometry objects.

#1774, Clearer error on setting an edge geometry to an invalid one.

#1775, ST_ChangeEdgeGeom collision detection with 2-vertex target.

#1776, fix ST_SymDifference(empty, geom) to return geom.

#1779, install SQL comment files.

#1782, fix spatial reference string handling in raster.

#1789, fix false edge-node crossing report in ValidateTopology.

#1790, fix toTopoGeom handling of duplicated primitives.

#1791, fix ST_Azimuth with very close but distinct points.

#1797, fix (ValidateTopology(xxx)).* syntax calls.

#1805, put back the 900913 SRID entry.

#1813, Only show readable relations in metadata tables.

#1819, fix floating point issues with ST_World2RasterCoord and ST_Raster2WorldCoord variants.

#1820 compilation on 9.2beta1.

#1822, topology load on PostgreSQL 9.2beta1.

#1825, fix prepared geometry cache lookup

#1829, fix uninitialized read in GeoJSON parser

#1834, revise postgis extension to only backup user specified spatial_ref_sys

#1839, handling of subdatasets in GeoTIFF in raster2pgsql.

#1840, fix logic of when to compute # of tiles in raster2pgsql.

#1851, fix spatial_ref_system parameters for EPSG:3844

#1857, fix failure to detect endpoint mismatch in ST_AddEdge*Face*

#1865, data loss in postgis_restore.pl when data rows have leading dashes.

#1867, catch invalid topology name passed to topogeo_add*

#1872, fix ST_ApproxSummarystats to prevent division by zero

#1873, fix ptarray_locate_point to return interpolated Z/M values for on-the-line case

#1875, ST_SummaryStats returns NULL for all parameters except count when count is zero

#1881, shp2pgsql-gui -- editing a field sometimes triggers removing row

#1883, Geocoder install fails trying to run create_census_base_tables() (Brian Panulla)

A.16.2 Enhancements

More detailed exception message from topology editing functions.

#1786, improved build dependencies

#1806, speedup of ST_BuildArea, ST_MakeValid and ST_GetFaceGeometry.

#1812, Add lwgeom_normalize in LIBLWGEOM for more stable testing.

A.17 Release 2.0.0

Release date: 2012/04/03

This is a major release. A hard upgrade is required. Yes this means a full dump reload and some special preparations if you are using obsolete functions. Refer to Section 2.9.2 for details on upgrading. Refer to Section 13.11.3 for more details and changed/new functions.

A.17.1 Testers - Our unsung heroes

We are most indebted to the numerous members in the PostGIS community who were brave enough to test out the new features in this release. No major release can be successful without these folk.

Below are those who have been most valiant, provided very detailed and thorough bug reports, and detailed analysis.

Andrea Peri - Lots of testing on topology, checking for correctness
Andreas Forø Tollefsen - raster testing
Chris English - topology stress testing loader functions
Salvatore Larosa - topology robustness testing
Brian Hamlin - Benchmarking (also experimental experimental branches before they are folded into core) , general testing of various p
Mike Pease - Tiger geocoder testing - very detailed reports of issues
Tom van Tilburg - raster testing

A.17.2 Important / Breaking Changes

#722, #302, Most deprecated functions removed (over 250 functions) (Regina Obe, Paul Ramsey)

Unknown SRID changed from -1 to 0. (Paul Ramsey)

-- (most deprecated in 1.2) removed non-ST variants buffer, length, intersects (and internal functions renamed) etc.

-- If you have been using deprecated functions CHANGE your apps or suffer the consequences. If you don't see a function documented -- it ain't supported or it is an internal function. Some constraints in older tables were built with deprecated functions. If you restore you may need to rebuild table constraints with populate_geometry_columns(). If you have applications or tools that rely on deprecated functions, please refer to [?qandaentry] for more details.

#944 geometry_columns is now a view instead of a table (Paul Ramsey, Regina Obe) for tables created the old way reads (srid, type, dims) constraints for geometry columns created with type modifiers reads rom column definition

#1081, #1082, #1084, #1088 - Mangement functions support typmod geometry column creation functions now default to typmod creation (Regina Obe)

#1083 probe_geometry_columns(), rename_geometry_table_constraints(), fix_geometry_columns(); removed - now obsolete with geometry_column view (Regina Obe)

#817 Renaming old 3D functions to the convention ST_3D (Nicklas Avén)

#548 (sorta), ST_NumGeometries,ST_GeometryN now returns 1 (or the geometry) instead of null for single geometries (Sandro Santilli, Maxime van Noppen)

A.17.3 New Features

KNN Gist index based centroid (<->) and box (<#>) distance operators (Paul Ramsey / funded by Vizzuality)

Support for TIN and PolyHedralSurface and enhancement of many functions to support 3D (Olivier Courtin / Oslandia)

Raster support integrated and documented (Pierre Racine, Jorge Arévalo, Mateusz Loskot, Sandro Santilli, David Zwarg, Regina Obe, Bborie Park) (Company developer and funding: University Laval, Deimos Space, CadCorp, Michigan Tech Research Institute, Azavea, Paragon Corporation, UC Davis Center for Vectorborne Diseases)

Making spatial indexes 3D aware - in progress (Paul Ramsey, Mark Cave-Ayland)

Topology support improved (more functions), documented, testing (Sandro Santilli / Faunalia for RT-SIGTA), Andrea Peri, Regina Obe, Jose Carlos Martinez Llari

3D relationship and measurement support functions (Nicklas Avén)

ST_3DDistance, ST_3DClosestPoint, ST_3DIntersects, ST_3DShortestLine and more...

N-Dimensional spatial indexes (Paul Ramsey / OpenGeo)

ST_Split (Sandro Santilli / Faunalia for RT-SIGTA)

ST_IsValidDetail (Sandro Santilli / Faunalia for RT-SIGTA)

ST_MakeValid (Sandro Santilli / Faunalia for RT-SIGTA)

ST_RemoveRepeatedPoints (Sandro Santilli / Faunalia for RT-SIGTA)

ST_GeometryN and ST_NumGeometries support for non-collections (Sandro Santilli)

ST_IsCollection (Sandro Santilli, Maxime van Noppen)

ST_SharedPaths (Sandro Santilli / Faunalia for RT-SIGTA)

ST_Snap (Sandro Santilli)

ST_RelateMatch (Sandro Santilli / Faunalia for RT-SIGTA)

ST_ConcaveHull (Regina Obe and Leo Hsu / Paragon Corporation)

ST_UnaryUnion (Sandro Santilli / Faunalia for RT-SIGTA)

ST_AsX3D (Regina Obe / Arrival 3D funding)

ST_OffsetCurve (Sandro Santilli, Rafal Magda)

ST_GeomFromGeoJSON (Kashif Rasul, Paul Ramsey / Vizzuality funding)

A.17.4 Enhancements

Made shape file loader tolerant of truncated multibyte values found in some free worldwide shapefiles (Sandro Santilli)

Lots of bug fixes and enhancements to shp2pgsql Beefing up regression tests for loaders Reproject support for both geometry and geography during import (Jeff Adams / Azavea, Mark Cave-Ayland)

pgsql2shp conversion from predefined list (Loic Dachary / Mark Cave-Ayland)

Shp-pgsql GUI loader - support loading multiple files at a time. (Mark Leslie)

Extras - upgraded tiger_geocoder from using old TIGER format to use new TIGER shp and file structure format (Stephen Frost)

Extras - revised tiger_geocoder to work with TIGER census 2010 data, addition of reverse geocoder function, various bug fixes, accuracy enhancements, limit max result return, speed improvements, loading routines. (Regina Obe, Leo Hsu / Paragon Corporation / funding provided by Hunter Systems Group)

Overall Documentation proofreading and corrections. (Kasif Rasul)

Cleanup PostGIS JDBC classes, revise to use Maven build. (Maria Arias de Reyna, Sandro Santilli)

A.17.5 Bug Fixes

#1335 ST_AddPoint returns incorrect result on Linux (Even Rouault)

A.17.6 Release specific credits

We thank U.S Department of State Human Information Unit (HIU) and Vizzuality for general monetary support to get PostGIS 2.0 out the door.

A.18 Release 1.5.4

Release date: 2012/05/07

This is a bug fix release, addressing issues that have been filed since the 1.5.3 release.

A.18.1 Bug Fixes

#547, ST_Contains memory problems (Sandro Santilli)

#621, Problem finding intersections with geography (Paul Ramsey)

#627, PostGIS/PostgreSQL process die on invalid geometry (Paul Ramsey)

#810, Increase accuracy of area calculation (Paul Ramsey)

#852, improve spatial predicates robustness (Sandro Santilli, Nicklas Avén)

#877, ST_Estimated_Extent returns NULL on empty tables (Sandro Santilli)

#1028, ST_AsSVG kills whole postgres server when fails (Paul Ramsey)

#1056, Fix boxes of arcs and circle stroking code (Paul Ramsey)

#1121, populate_geometry_columns using deprecated functions (Regin Obe, Paul Ramsey)

#1135, improve testsuite predictability (Andreas 'ads' Scherbaum)

#1146, images generator crashes (bronaugh)

#1170, North Pole intersection fails (Paul Ramsey)

#1179, ST_AsText crash with bad value (kjurka)

#1184, honour DESTDIR in documentation Makefile (Bryce L Nordgren)

#1227, server crash on invalid GML

#1252, SRID appearing in WKT (Paul Ramsey)

#1264, st_dwithin(g, g, 0) doesn't work (Paul Ramsey)

#1344, allow exporting tables with invalid geometries (Sandro Santilli)

#1389, wrong proj4text for SRID 31300 and 31370 (Paul Ramsey)

#1406, shp2pgsql crashes when loading into geography (Sandro Santilli)

#1595, fixed SRID redundancy in ST_Line_SubString (Sandro Santilli)

#1596, check SRID in UpdateGeometrySRID (Mike Toews, Sandro Santilli)

#1602, fix ST_Polygonize to retain Z (Sandro Santilli)

#1697, fix crash with EMPTY entries in GiST index (Paul Ramsey)

#1772, fix ST_Line_Locate_Point with collapsed input (Sandro Santilli)

#1799, Protect ST_Segmentize from max_length=0 (Sandro Santilli)

Alter parameter order in 900913 (Paul Ramsey)

Support builds with "gmake" (Greg Troxel)

A.19 Release 1.5.3

Release date: 2011/06/25

This is a bug fix release, addressing issues that have been filed since the 1.5.2 release. If you are running PostGIS 1.3+, a soft upgrade is sufficient otherwise a hard upgrade is recommended.

A.19.1 Bug Fixes

#1056, produce correct bboxes for arc geometries, fixes index errors (Paul Ramsey)

#1007, ST_IsValid crash fix requires GEOS 3.3.0+ or 3.2.3+ (Sandro Santilli, reported by Birgit Laggner)

#940, support for PostgreSQL 9.1 beta 1 (Regina Obe, Paul Ramsey, patch submitted by stl)

#845, ST_Intersects precision error (Sandro Santilli, Nicklas Avén) Reported by cdestigter

#884, Unstable results with ST_Within, ST_Intersects (Chris Hodgson)

#779, shp2pgsql -S option seems to fail on points (Jeff Adams)

#666, ST_DumpPoints is not null safe (Regina Obe)

#631, Update NZ projections for grid transformation support (jpalmer)

#630, Peculiar Null treatment in arrays in ST_Collect (Chris Hodgson) Reported by David Bitner

#624, Memory leak in ST_GeogFromText (ryang, Paul Ramsey)

#609, Bad source code in manual section 5.2 Java Clients (simoc, Regina Obe)

#604, shp2pgsql usage touchups (Mike Toews, Paul Ramsey)

#573 ST_Union fails on a group of linestrings Not a PostGIS bug, fixed in GEOS 3.3.0

#457 ST_CollectionExtract returns non-requested type (Nicklas Avén, Paul Ramsey)

#441 ST_AsGeoJson Bbox on GeometryCollection error (Olivier Courtin)

#411 Ability to backup invalid geometries (Sando Santilli) Reported by Regione Toscana

#409 ST_AsSVG - degraded (Olivier Courtin) Reported by Sdikiy

#373 Documentation syntax error in hard upgrade (Paul Ramsey) Reported by psvensso

A.20 Release 1.5.2

Release date: 2010/09/27

This is a bug fix release, addressing issues that have been filed since the 1.5.1 release. If you are running PostGIS 1.3+, a soft upgrade is sufficient otherwise a hard upgrade is recommended.

A.20.1 Bug Fixes

Loader: fix handling of empty (0-verticed) geometries in shapefiles. (Sandro Santilli)

#536, Geography ST_Intersects, ST_Covers, ST_CoveredBy and Geometry ST_Equals not using spatial index (Regina Obe, Nicklas Aven)

#573, Improvement to ST_Contains geography (Paul Ramsey)

Loader: Add support for command-q shutdown in Mac GTK build (Paul Ramsey)

#393, Loader: Add temporary patch for large DBF files (Maxime Guillaud, Paul Ramsey)

#507, Fix wrong OGC URN in GeoJSON and GML output (Olivier Courtin)

spatial_ref_sys.sql Add datum conversion for projection SRID 3021 (Paul Ramsey)

Geography - remove crash for case when all geographies are out of the estimate (Paul Ramsey)

#469, Fix for array_aggregation error (Greg Stark, Paul Ramsey)

#532, Temporary geography tables showing up in other user sessions (Paul Ramsey)

#562, ST_Dwithin errors for large geographies (Paul Ramsey)

#513, shape loading GUI tries to make spatial index when loading DBF only mode (Paul Ramsey)

#527, shape loading GUI should always append log messages (Mark Cave-Ayland)

#504, shp2pgsql should rename xmin/xmax fields (Sandro Santilli)

#458, postgis_comments being installed in contrib instead of version folder (Mark Cave-Ayland)

#474, Analyzing a table with geography column crashes server (Paul Ramsey)

#581, LWGEOM-expand produces inconsistent results (Mark Cave-Ayland)

#513, Add dbf filter to shp2pgsql-gui and allow uploading dbf only (Paul Ramsey)

Fix further build issues against PostgreSQL 9.0 (Mark Cave-Ayland)

#572, Password whitespace for Shape File (Mark Cave-Ayland)

#603, shp2pgsql: "-w" produces invalid WKT for MULTI* objects. (Mark Cave-Ayland)

A.21 Release 1.5.1

Release date: 2010/03/11

This is a bug fix release, addressing issues that have been filed since the 1.4.1 release. If you are running PostGIS 1.3+, a soft upgrade is sufficient otherwise a hard upgrade is recommended.

A.21.1 Bug Fixes

#410, update embedded bbox when applying ST_SetPoint, ST_AddPoint ST_RemovePoint to a linestring (Paul Ramsey)

#411, allow dumping tables with invalid geometries (Sandro Santilli, for Regione Toscana-SIGTA)

#414, include geography_columns view when running upgrade scripts (Paul Ramsey)

#419, allow support for multilinestring in ST_Line_Substring (Paul Ramsey, for Lidwala Consulting Engineers)

#421, fix computed string length in ST_AsGML() (Olivier Courtin)

#441, fix GML generation with heterogeneous collections (Olivier Courtin)

#443, incorrect coordinate reversal in GML 3 generation (Olivier Courtin)

#450, #451, wrong area calculation for geography features that cross the date line (Paul Ramsey)

Ensure support for upcoming 9.0 PgSQL release (Paul Ramsey)

A.22 Release 1.5.0

Release date: 2010/02/04

This release provides support for geographic coordinates (lat/lon) via a new GEOGRAPHY type. Also performance enhancements, new input format support (GML,KML) and general upkeep.

A.22.1 API Stability

The public API of PostGIS will not change during minor (0.0.X) releases.

The definition of the =~ operator has changed from an exact geometric equality check to a bounding box equality check.

A.22.2 Compatibility

GEOS, Proj4, and LibXML2 are now mandatory dependencies

The library versions below are the minimum requirements for PostGIS 1.5

PostgreSQL 8.3 and higher on all platforms

GEOS 3.1 and higher only (GEOS 3.2+ to take advantage of all features)

LibXML2 2.5+ related to new ST_GeomFromGML/KML functionality

Proj4 4.5 and higher only

A.22.3 New Features

Section 13.11.5

Added Hausdorff distance calculations (#209) (Vincent Picavet)

Added parameters argument to ST_Buffer operation to support one-sided buffering and other buffering styles (Sandro Santilli)

Addition of other Distance related visualization and analysis functions (Nicklas Aven)

- ST_ClosestPoint
- ST_DFullyWithin
- ST_LongestLine
- ST_MaxDistance
- ST_ShortestLine

ST_DumpPoints (Maxime van Noppen)

KML, GML input via ST_GeomFromGML and ST_GeomFromKML (Olivier Courtin)

Extract homogeneous collection with ST_CollectionExtract (Paul Ramsey)

Add measure values to an existing linestring with ST_AddMeasure (Paul Ramsey)

History table implementation in utils (George Silva)

Geography type and supporting functions

- Spherical algorithms (Dave Skea)
- Object/index implementation (Paul Ramsey)
- Selectivity implementation (Mark Cave-Ayland)
- Serializations to KML, GML and JSON (Olivier Courtin)
- ST_Area, ST_Distance, ST_DWithin, ST_GeogFromText, ST_GeogFromWKB, ST_Intersects, ST_Covers, ST_Buffer (Paul Ramsey)

A.22.4 Enhancements

Performance improvements to ST_Distance (Nicklas Aven)

Documentation updates and improvements (Regina Obe, Kevin Neufeld)

Testing and quality control (Regina Obe)

PostGIS 1.5 support PostgreSQL 8.5 trunk (Guillaume Lelarge)

Win32 support and improvement of core shp2pgsql-gui (Mark Cave-Ayland)

In place 'make check' support (Paul Ramsey)

A.22.5 Bug fixes

http://trac.osgeo.org/postgis/query?status=closed&milestone=PostGIS+1.5.0&order=priority

A.23 Release 1.4.0

Release date: 2009/07/24

This release provides performance enhancements, improved internal structures and testing, new features, and upgraded documentation. If you are running PostGIS 1.1+, a soft upgrade is sufficient otherwise a hard upgrade is recommended.

A.23.1 API Stability

As of the 1.4 release series, the public API of PostGIS will not change during minor releases.

A.23.2 Compatibility

The versions below are the *minimum* requirements for PostGIS 1.4

PostgreSQL 8.2 and higher on all platforms

GEOS 3.0 and higher only

PROJ4 4.5 and higher only

A.23.3 New Features

ST_Union() uses high-speed cascaded union when compiled against GEOS 3.1+ (Paul Ramsey)

ST_ContainsProperly() requires GEOS 3.1+

ST_Intersects(), ST_Contains(), ST_Within() use high-speed cached prepared geometry against GEOS 3.1+ (Paul Ramsey / funded by Zonar Systems)

Vastly improved documentation and reference manual (Regina Obe & Kevin Neufeld)

Figures and diagram examples in the reference manual (Kevin Neufeld)

ST_IsValidReason() returns readable explanations for validity failures (Paul Ramsey)

ST_GeoHash() returns a geohash.org signature for geometries (Paul Ramsey)

GTK+ multi-platform GUI for shape file loading (Paul Ramsey)

ST_LineCrossingDirection() returns crossing directions (Paul Ramsey)

ST_LocateBetweenElevations() returns sub-string based on Z-ordinate. (Paul Ramsey)

Geometry parser returns explicit error message about location of syntax errors (Mark Cave-Ayland)

ST_AsGeoJSON() return JSON formatted geometry (Olivier Courtin)

Populate_Geometry_Columns() -- automatically add records to geometry_columns for TABLES and VIEWS (Kevin Neufeld)

ST_MinimumBoundingCircle() -- returns the smallest circle polygon that can encompass a geometry (Bruce Rindahl)

A.23.4 Enhancements

Core geometry system moved into independent library, liblwgeom. (Mark Cave-Ayland)

New build system uses PostgreSQL "pgxs" build bootstrapper. (Mark Cave-Ayland)

Debugging framework formalized and simplified. (Mark Cave-Ayland)

All build-time #defines generated at configure time and placed in headers for easier cross-platform support (Mark Cave-Ayland)

Logging framework formalized and simplified (Mark Cave-Ayland)

Expanded and more stable support for CIRCULARSTRING, COMPOUNDCURVE and CURVEPOLYGON, better parsing, wider support in functions (Mark Leslie & Mark Cave-Ayland)

Improved support for OpenSolaris builds (Paul Ramsey)

Improved support for MSVC builds (Mateusz Loskot)

Updated KML support (Olivier Courtin)

Unit testing framework for liblwgeom (Paul Ramsey)

New testing framework to comprehensively exercise every PostGIS function (Regine Obe)

Performance improvements to all geometry aggregate functions (Paul Ramsey)

Support for the upcoming PostgreSQL 8.4 (Mark Cave-Ayland, Talha Bin Rizwan)

Shp2pgsql and pgsql2shp re-worked to depend on the common parsing/unparsing code in liblwgeom (Mark Cave-Ayland)

Use of PDF DbLatex to build PDF docs and preliminary instructions for build (Jean David Techer)

Automated User documentation build (PDF and HTML) and Developer Doxygen Documentation (Kevin Neufeld)

Automated build of document images using ImageMagick from WKT geometry text files (Kevin Neufeld)

More attractive CSS for HTML documentation (Dane Springmeyer)

A.23.5 Bug fixes

http://trac.osgeo.org/postgis/query?status=closed&milestone=PostGIS+1.4.0&order=priority

A.24 Release 1.3.6

Release date: 2009/05/04

If you are running PostGIS 1.1+, a soft upgrade is sufficient otherwise a hard upgrade is recommended. This release adds support for PostgreSQL 8.4, exporting prj files from the database with shape data, some crash fixes for shp2pgsql, and several small bug fixes in the handling of "curve" types, logical error importing dbf only files, improved error handling of AddGeometryColumns.

A.25 Release 1.3.5

Release date: 2008/12/15

If you are running PostGIS 1.1+, a soft upgrade is sufficient otherwise a hard upgrade is recommended. This release is a bug fix release to address a failure in ST_Force_Collection and related functions that critically affects using MapServer with LINE layers.

A.26 Release 1.3.4

Release date: 2008/11/24

This release adds support for GeoJSON output, building with PostgreSQL 8.4, improves documentation quality and output aesthetics, adds function-level SQL documentation, and improves performance for some spatial predicates (point-in-polygon tests).

Bug fixes include removal of crashers in handling circular strings for many functions, some memory leaks removed, a linear referencing failure for measures on vertices, and more. See the NEWS file for details.

A.27 Release 1.3.3

Release date: 2008/04/12

This release fixes bugs shp2pgsql, adds enhancements to SVG and KML support, adds a ST_SimplifyPreserveTopology function, makes the build more sensitive to GEOS versions, and fixes a handful of severe but rare failure cases.

A.28 Release 1.3.2

Release date: 2007/12/01

This release fixes bugs in ST_EndPoint() and ST_Envelope, improves support for JDBC building and OS/X, and adds better support for GML output with ST_AsGML(), including GML3 output.

A.29 Release 1.3.1

Release date: 2007/08/13

This release fixes some oversights in the previous release around version numbering, documentation, and tagging.

A.30 Release 1.3.0

Release date: 2007/08/09

This release provides performance enhancements to the relational functions, adds new relational functions and begins the migration of our function names to the SQL-MM convention, using the spatial type (SP) prefix.

A.30.1 Added Functionality

JDBC: Added Hibernate Dialect (thanks to Norman Barker)

Added ST_Covers and ST_CoveredBy relational functions. Description and justification of these functions can be found at http://lin-ear-th-inking.blogspot.com/2007/06/subtleties-of-ogc-covers-spatial.html

Added ST_DWithin relational function.

A.30.2 Performance Enhancements

Added cached and indexed point-in-polygon short-circuits for the functions ST_Contains, ST_Intersects, ST_Within and ST_Disjoint

Added inline index support for relational functions (except ST_Disjoint)

A.30.3 Other Changes

Extended curved geometry support into the geometry accessor and some processing functions

Began migration of functions to the SQL-MM naming convention; using a spatial type (ST) prefix.

Added initial support for PostgreSQL 8.3

A.31 Release 1.2.1

Release date: 2007/01/11

This release provides bug fixes in PostgreSQL 8.2 support and some small performance enhancements.

A.31.1 Changes

Fixed point-in-polygon shortcut bug in Within().

Fixed PostgreSQL 8.2 NULL handling for indexes.

Updated RPM spec files.

Added short-circuit for Transform() in no-op case.

JDBC: Fixed JTS handling for multi-dimensional geometries (thanks to Thomas Marti for hint and partial patch). Additionally, now JavaDoc is compiled and packaged. Fixed classpath problems with GCJ. Fixed pgjdbc 8.2 compatibility, losing support for jdk 1.3 and older.

A.32 Release 1.2.0

Release date: 2006/12/08

This release provides type definitions along with serialization/deserialization capabilities for SQL-MM defined curved geometries, as well as performance enhancements.

A.32.1 Changes

Added curved geometry type support for serialization/deserialization

Added point-in-polygon shortcircuit to the Contains and Within functions to improve performance for these cases.

A.33 Release 1.1.6

Release date: 2006/11/02

This is a bugfix release, in particular fixing a critical error with GEOS interface in 64bit systems. Includes an updated of the SRS parameters and an improvement in reprojections (take Z in consideration). Upgrade is *encouraged*.

A.33.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.33.2 Bug fixes

fixed CAPI change that broke 64-bit platforms

loader/dumper: fixed regression tests and usage output

Fixed setSRID() bug in JDBC, thanks to Thomas Marti

A.33.3 Other changes

use Z ordinate in reprojections

spatial_ref_sys.sql updated to EPSG 6.11.1

Simplified Version.config infrastructure to use a single pack of version variables for everything.

Include the Version.config in loader/dumper USAGE messages

Replace hand-made, fragile JDBC version parser with Properties

A.34 Release 1.1.5

Release date: 2006/10/13

This is an bugfix release, including a critical segfault on win32. Upgrade is *encouraged*.

A.34.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.34.2 Bug fixes

Fixed MingW link error that was causing pgsql2shp to segfault on Win32 when compiled for PostgreSQL 8.2

fixed nullpointer Exception in Geometry.equals() method in Java

Added EJB3Spatial.odt to fulfill the GPL requirement of distributing the "preferred form of modification"

Removed obsolete synchronization from JDBC Jts code.

Updated heavily outdated README files for shp2pgsql/pgsql2shp by merging them with the manpages.

Fixed version tag in jdbc code that still said "1.1.3" in the "1.1.4" release.

A.34.3 New Features

Added -S option for non-multi geometries to shp2pgsql

A.35 Release 1.1.4

Release date: 2006/09/27

This is an bugfix release including some improvements in the Java interface. Upgrade is *encouraged*.

A.35.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.35.2 Bug fixes

Fixed support for PostgreSQL 8.2

Fixed bug in collect() function discarding SRID of input

Added SRID match check in MakeBox2d and MakeBox3d

Fixed regress tests to pass with GEOS-3.0.0

Improved pgsql2shp run concurrency.

A.35.3 Java changes

reworked JTS support to reflect new upstream JTS developers' attitude to SRID handling. Simplifies code and drops build depend on GNU trove.

Added EJB2 support generously donated by the "Geodetix s.r.l. Company" http://www.geodetix.it/

Added EJB3 tutorial / examples donated by Norman Barker <nbarker@ittvis.com>

Reorganized java directory layout a little.

A.36 Release 1.1.3

Release date: 2006/06/30

This is an bugfix release including also some new functionalities (most notably long transaction support) and portability enhancements. Upgrade is *encouraged*.

A.36.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.36.2 Bug fixes / correctness

BUGFIX in distance(poly,poly) giving wrong results.

BUGFIX in pgsql2shp successful return code.

BUGFIX in shp2pgsql handling of MultiLine WKT.

BUGFIX in affine() failing to update bounding box.

WKT parser: forbidden construction of multigeometries with EMPTY elements (still supported for GEOMETRYCOLLECTION).

A.36.3 New functionalities

NEW Long Transactions support.

NEW DumpRings() function.

NEW AsHEXEWKB(geom, XDR|NDR) function.

A.36.4 JDBC changes

Improved regression tests: MultiPoint and scientific ordinates

Fixed some minor bugs in jdbc code

Added proper accessor functions for all fields in preparation of making those fields private later

A.36.5 Other changes

NEW regress test support for loader/dumper.

Added --with-proj-libdir and --with-geos-libdir configure switches.

Support for build Tru64 build.

Use Jade for generating documentation.

Don't link pgsql2shp to more libs then required.

Initial support for PostgreSQL 8.2.

A.37 Release 1.1.2

Release date: 2006/03/30

This is an bugfix release including some new functions and portability enhancements. Upgrade is *encouraged*.

A.37.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.37.2 Bug fixes

BUGFIX in SnapToGrid() computation of output bounding box

BUGFIX in EnforceRHR()

jdbc2 SRID handling fixes in JTS code

Fixed support for 64bit archs

A.37.3 New functionalities

Regress tests can now be run *before* postgis installation

New affine() matrix transformation functions

New rotate{,X,Y,Z}() function

Old translating and scaling functions now use affine() internally

Embedded access control in estimated_extent() for builds against pgsql >= 8.0.0

A.37.4 Other changes

More portable ./configure script

Changed ./run_test script to have more sane default behaviour

A.38 Release 1.1.1

Release date: 2006/01/23

This is an important Bugfix release, upgrade is *highly recommended*. Previous version contained a bug in postgis_restore.pl preventing hard upgrade procedure to complete and a bug in GEOS-2.2+ connector preventing GeometryCollection objects to be used in topological operations.

A.38.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.38.2 Bug fixes

Fixed a premature exit in postgis_restore.pl

BUGFIX in geometrycollection handling of GEOS-CAPI connector

Solaris 2.7 and MingW support improvements

BUGFIX in line_locate_point()

Fixed handling of postgresql paths

BUGFIX in line_substring()

Added support for localized cluster in regress tester

A.38.3 New functionalities

New Z and M interpolation in line_substring()

New Z and M interpolation in line_interpolate_point()

added NumInteriorRing() alias due to OpenGIS ambiguity

A.39 Release 1.1.0

Release date: 2005/12/21

This is a Minor release, containing many improvements and new things. Most notably: build procedure greatly simplified; transform() performance drastically improved; more stable GEOS connectivity (CAPI support); lots of new functions; draft topology support.

It is *highly recommended* that you upgrade to GEOS-2.2.x before installing PostGIS, this will ensure future GEOS upgrades won't require a rebuild of the PostGIS library.

A.39.1 Credits

This release includes code from Mark Cave Ayland for caching of proj4 objects. Markus Schaber added many improvements in his JDBC2 code. Alex Bodnaru helped with PostgreSQL source dependency relief and provided Debian specfiles. Michael Fuhr tested new things on Solaris arch. David Techer and Gerald Fenoy helped testing GEOS C-API connector. Hartmut Tschauner provided code for the azimuth() function. Devrim GUNDUZ provided RPM specfiles. Carl Anderson helped with the new area building functions. See the credits section for more names.

A.39.2 Upgrading

If you are upgrading from release 1.0.3 or later you *DO NOT* need a dump/reload. Simply sourcing the new lwpostgis_upgrade.sql script in all your existing databases will work. See the soft upgrade chapter for more information.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.39.3 New functions

scale() and transscale() companion methods to translate()

line_substring()

line_locate_point()

M(point)

LineMerge(geometry)

shift_longitude(geometry)

azimuth(geometry)

locate_along_measure(geometry, float8)

locate_between_measures(geometry, float8, float8)

SnapToGrid by point offset (up to 4d support)

BuildArea(any_geometry)

OGC BdPolyFromText(linestring_wkt, srid)

OGC BdMPolyFromText(linestring_wkt, srid)

RemovePoint(linestring, offset)

ReplacePoint(linestring, offset, point)

A.39.4 Bug fixes

Fixed memory leak in polygonize()

Fixed bug in lwgeom_as_anytype cast functions

Fixed USE_GEOS, USE_PROJ and USE_STATS elements of postgis_version() output to always reflect library state.

A.39.5 Function semantic changes

SnapToGrid doesn't discard higher dimensions

Changed Z() function to return NULL if requested dimension is not available

A.39.6 Performance improvements

Much faster transform() function, caching proj4 objects

Removed automatic call to fix_geometry_columns() in AddGeometryColumns() and update_geometry_stats()

A.39.7 JDBC2 works

Makefile improvements

JTS support improvements

Improved regression test system

Basic consistency check method for geometry collections

Support for (Hex)(E)wkb

Autoprobing DriverWrapper for HexWKB / EWKT switching

fix compile problems in ValueSetter for ancient jdk releases.

fix EWKT constructors to accept SRID=4711; representation

added preliminary read-only support for java2d geometries

A.39.8 Other new things

Full autoconf-based configuration, with PostgreSQL source dependency relief

GEOS C-API support (2.2.0 and higher)

Initial support for topology modelling

Debian and RPM specfiles

New lwpostgis_upgrade.sql script

A.39.9 Other changes

JTS support improvements

Stricter mapping between DBF and SQL integer and string attributes

Wider and cleaner regression test suite

old jdbc code removed from release

obsoleted direct use of postgis_proc_upgrade.pl

scripts version unified with release version

A.40 Release 1.0.6

Release date: 2005/12/06

Contains a few bug fixes and improvements.

A.40.1 Upgrading

If you are upgrading from release 1.0.3 or later you *DO NOT* need a dump/reload.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.40.2 Bug fixes

Fixed palloc(0) call in collection deserializer (only gives problem with --enable-cassert)

Fixed bbox cache handling bugs

Fixed geom_accum(NULL, NULL) segfault

Fixed segfault in addPoint()

Fixed short-allocation in lwcollection_clone()

Fixed bug in segmentize()

Fixed bbox computation of SnapToGrid output

A.40.3 Improvements

Initial support for postgresql 8.2

Added missing SRID mismatch checks in GEOS ops

A.41 Release 1.0.5

Release date: 2005/11/25

Contains memory-alignment fixes in the library, a segfault fix in loader's handling of UTF8 attributes and a few improvements and cleanups.

Note
Return code of shp2pgsql changed from previous releases to conform to unix standards (return 0 on success).

A.41.1 Upgrading

If you are upgrading from release 1.0.3 or later you *DO NOT* need a dump/reload.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.41.2 Library changes

Fixed memory alignment problems

Fixed computation of null values fraction in analyzer

Fixed a small bug in the getPoint4d_p() low-level function

Speedup of serializer functions

Fixed a bug in force_3dm(), force_3dz() and force_4d()

A.41.3 Loader changes

Fixed return code of shp2pgsql

Fixed back-compatibility issue in loader (load of null shapefiles)

Fixed handling of trailing dots in dbf numerical attributes

Segfault fix in shp2pgsql (utf8 encoding)

A.41.4 Other changes

Schema aware postgis_proc_upgrade.pl, support for pgsql 7.2+

New "Reporting Bugs" chapter in manual

A.42 Release 1.0.4

Release date: 2005/09/09

Contains important bug fixes and a few improvements. In particular, it fixes a memory leak preventing successful build of GiST indexes for large spatial tables.

A.42.1 Upgrading

If you are upgrading from release 1.0.3 you *DO NOT* need a dump/reload.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.42.2 Bug fixes

Memory leak plugged in GiST indexing

Segfault fix in transform() handling of proj4 errors

Fixed some proj4 texts in spatial_ref_sys (missing +proj)

Loader: fixed string functions usage, reworked NULL objects check, fixed segfault on MULTILINESTRING input.

Fixed bug in MakeLine dimension handling

Fixed bug in translate() corrupting output bounding box

A.42.3 Improvements

Documentation improvements

More robust selectivity estimator

Minor speedup in distance()

Minor cleanups

GiST indexing cleanup

Looser syntax acceptance in box3d parser

A.43 Release 1.0.3

Release date: 2005/08/08

Contains some bug fixes - *including a severe one affecting correctness of stored geometries* - and a few improvements.

A.43.1 Upgrading

Due to a bug in a bounding box computation routine, the upgrade procedure requires special attention, as bounding boxes cached in the database could be incorrect.

An hard upgrade procedure (dump/reload) will force recomputation of all bounding boxes (not included in dumps). This is *required* if upgrading from releases prior to 1.0.0RC6.

If you are upgrading from versions 1.0.0RC6 or up, this release includes a perl script (utils/rebuild_bbox_caches.pl) to force recomputation of geometries' bounding boxes and invoke all operations required to propagate eventual changes in them (geometry statistics update, reindexing). Invoke the script after a make install (run with no args for syntax help). Optionally run utils/postgis_proc_upgrade.pl to refresh postgis procedures and functions signatures (see Soft upgrade).

A.43.2 Bug fixes

Severe bugfix in lwgeom's 2d bounding box computation

Bugfix in WKT (-w) POINT handling in loader

Bugfix in dumper on 64bit machines

Bugfix in dumper handling of user-defined queries

Bugfix in create_undef.pl script

A.43.3 Improvements

Small performance improvement in canonical input function

Minor cleanups in loader

Support for multibyte field names in loader

Improvement in the postgis_restore.pl script

New rebuild_bbox_caches.pl util script

A.44 Release 1.0.2

Release date: 2005/07/04

Contains a few bug fixes and improvements.

A.44.1 Upgrading

If you are upgrading from release 1.0.0RC6 or up you *DO NOT* need a dump/reload.

Upgrading from older releases requires a dump/reload. See the upgrading chapter for more informations.

A.44.2 Bug fixes

Fault tolerant btree ops

Memory leak plugged in pg_error

Rtree index fix

Cleaner build scripts (avoided mix of CFLAGS and CXXFLAGS)

A.44.3 Improvements

New index creation capabilities in loader (-I switch)

Initial support for postgresql 8.1dev

A.45 Release 1.0.1

Release date: 2005/05/24

Contains a few bug fixes and some improvements.

A.45.1 Upgrading

If you are upgrading from release 1.0.0RC6 or up you *DO NOT* need a dump/reload.

Upgrading from older releases requires a dump/reload. See the upgrading chapter for more informations.

A.45.2 Library changes

BUGFIX in 3d computation of length_spheroid()

BUGFIX in join selectivity estimator

A.45.3 Other changes/additions

BUGFIX in shp2pgsql escape functions

better support for concurrent postgis in multiple schemas

documentation fixes

jdbc2: compile with "-target 1.2 -source 1.2" by default

NEW -k switch for pgsql2shp

NEW support for custom createdb options in postgis_restore.pl

BUGFIX in pgsql2shp attribute names unicity enforcement

BUGFIX in Paris projections definitions

postgis_restore.pl cleanups

A.46 Release 1.0.0

Release date: 2005/04/19

Final 1.0.0 release. Contains a few bug fixes, some improvements in the loader (most notably support for older postgis versions), and more docs.

A.46.1 Upgrading

If you are upgrading from release 1.0.0RC6 you *DO NOT* need a dump/reload.

Upgrading from any other precedent release requires a dump/reload. See the upgrading chapter for more informations.

A.46.2 Library changes

BUGFIX in transform() releasing random memory address

BUGFIX in force_3dm() allocating less memory then required

BUGFIX in join selectivity estimator (defaults, leaks, tuplecount, sd)

A.46.3 Other changes/additions

BUGFIX in shp2pgsql escape of values starting with tab or single-quote

NEW manual pages for loader/dumper

NEW shp2pgsql support for old (HWGEOM) postgis versions

NEW -p (prepare) flag for shp2pgsql

NEW manual chapter about OGC compliancy enforcement

NEW autoconf support for JTS lib

BUGFIX in estimator testers (support for LWGEOM and schema parsing)

A.47 Release 1.0.0RC6

Release date: 2005/03/30

Sixth release candidate for 1.0.0. Contains a few bug fixes and cleanups.

A.47.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.47.2 Library changes

BUGFIX in multi()

early return [when noop] from multi()

A.47.3 Scripts changes

dropped {x,y}{min,max}(box2d) functions

A.47.4 Other changes

BUGFIX in postgis_restore.pl scrip

BUGFIX in dumper's 64bit support

A.48 Release 1.0.0RC5

Release date: 2005/03/25

Fifth release candidate for 1.0.0. Contains a few bug fixes and a improvements.

A.48.1 Upgrading

If you are upgrading from release 1.0.0RC4 you *DO NOT* need a dump/reload.

Upgrading from any other precedent release requires a dump/reload. See the upgrading chapter for more informations.

A.48.2 Library changes

BUGFIX (segfaulting) in box3d computation (yes, another!).

BUGFIX (segfaulting) in estimated_extent().

A.48.3 Other changes

Small build scripts and utilities refinements.

Additional performance tips documented.

A.49 Release 1.0.0RC4

Release date: 2005/03/18

Fourth release candidate for 1.0.0. Contains bug fixes and a few improvements.

A.49.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.49.2 Library changes

BUGFIX (segfaulting) in geom_accum().

BUGFIX in 64bit architectures support.

BUGFIX in box3d computation function with collections.

NEW subselects support in selectivity estimator.

Early return from force_collection.

Consistency check fix in SnapToGrid().

Box2d output changed back to 15 significant digits.

A.49.3 Scripts changes

NEW distance_sphere() function.

Changed get_proj4_from_srid implementation to use PL/PGSQL instead of SQL.

A.49.4 Other changes

BUGFIX in loader and dumper handling of MultiLine shapes

BUGFIX in loader, skipping all but first hole of polygons.

jdbc2: code cleanups, Makefile improvements

FLEX and YACC variables set *after* pgsql Makefile.global is included and only if the pgsql *stripped* version evaluates to the empty string

Added already generated parser in release

Build scripts refinements

improved version handling, central Version.config

improvements in postgis_restore.pl

A.50 Release 1.0.0RC3

Release date: 2005/02/24

Third release candidate for 1.0.0. Contains many bug fixes and improvements.

A.50.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.50.2 Library changes

BUGFIX in transform(): missing SRID, better error handling.

BUGFIX in memory alignment handling

BUGFIX in force_collection() causing mapserver connector failures on simple (single) geometry types.

BUGFIX in GeometryFromText() missing to add a bbox cache.

reduced precision of box2d output.

prefixed DEBUG macros with PGIS_ to avoid clash with pgsql one

plugged a leak in GEOS2POSTGIS converter

Reduced memory usage by early releasing query-context palloced one.

A.50.3 Scripts changes

BUGFIX in 72 index bindings.

BUGFIX in probe_geometry_columns() to work with PG72 and support multiple geometry columns in a single table

NEW bool::text cast

Some functions made IMMUTABLE from STABLE, for performance improvement.

A.50.4 JDBC changes

jdbc2: small patches, box2d/3d tests, revised docs and license.

jdbc2: bug fix and testcase in for pgjdbc 8.0 type autoregistration

jdbc2: Removed use of jdk1.4 only features to enable build with older jdk releases.

jdbc2: Added support for building against pg72jdbc2.jar

jdbc2: updated and cleaned makefile

jdbc2: added BETA support for jts geometry classes

jdbc2: Skip known-to-fail tests against older PostGIS servers.

jdbc2: Fixed handling of measured geometries in EWKT.

A.50.5 Other changes

new performance tips chapter in manual

documentation updates: pgsql72 requirement, lwpostgis.sql

few changes in autoconf

BUILDDATE extraction made more portable

fixed spatial_ref_sys.sql to avoid vacuuming the whole database.

spatial_ref_sys: changed Paris entries to match the ones distributed with 0.x.

A.51 Release 1.0.0RC2

Release date: 2005/01/26

Second release candidate for 1.0.0 containing bug fixes and a few improvements.

A.51.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.51.2 Library changes

BUGFIX in pointarray box3d computation

BUGFIX in distance_spheroid definition

BUGFIX in transform() missing to update bbox cache

NEW jdbc driver (jdbc2)

GEOMETRYCOLLECTION(EMPTY) syntax support for backward compatibility

Faster binary outputs

Stricter OGC WKB/WKT constructors

A.51.3 Scripts changes

More correct STABLE, IMMUTABLE, STRICT uses in lwpostgis.sql

stricter OGC WKB/WKT constructors

A.51.4 Other changes

Faster and more robust loader (both i18n and not)

Initial autoconf script

A.52 Release 1.0.0RC1

Release date: 2005/01/13

This is the first candidate of a major postgis release, with internal storage of postgis types redesigned to be smaller and faster on indexed queries.

A.52.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.52.2 Changes

Faster canonical input parsing.

Lossless canonical output.

EWKB Canonical binary IO with PG>73.

Support for up to 4d coordinates, providing lossless shapefile->postgis->shapefile conversion.

New function: UpdateGeometrySRID(), AsGML(), SnapToGrid(), ForceRHR(), estimated_extent(), accum().

Vertical positioning indexed operators.

JOIN selectivity function.

More geometry constructors / editors.

PostGIS extension API.

UTF8 support in loader.