

PostGIS 3.5.0alpha2 ☒☒☒☒☒☒

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Abstract

PostGIS 是 PostgreSQL 数据库的 GIS(地理信息系统) 扩展。PostGIS 使用 GiST 和 R-Tree 索引, GIS 应用广泛。

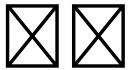


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Chapter 1



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

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

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

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- [OSGeo](#)
- [Oslandia](#)
- [Palantir Technologies](#)
- [Paragon Corporation](#)
- [R3 GIS](#)
- [Refractions Research](#)
- [Regione Toscana - SITA](#)
- [Safe Software](#)
- [Sirius Corporation plc](#)
- [Stadt Uster](#)
- [UC Davis Center for Vectorborne Diseases](#)
- [Université Laval](#)
- [U.S. Department of State \(HIU\)](#)
- [Zonar Systems](#)

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postgistopology - 10 toTopGeometry
250

postgis64windows - 20 64 PostGIS 100
PostgreSQL PostGIS 2.0.1 64

The **GEOS** geometry operations library

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

The **PROJ** cartographic projection library

PostgreSQL DBMS - PostGIS
PostgreSQL, GiST, SQL

Chapter 2

PostGIS

PostGIS

2.1

```
tar -xvzf postgis-3.5.0alpha2.tar.gz
cd postgis-3.5.0alpha2
./configure
make
make install
```

PostGIS, PostGIS (Section 3.3) (Section 3.4)

2.2

Note



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

The PostGIS module is an extension to the PostgreSQL backend server. As such, PostGIS 3.5.0alpha2 requires full PostgreSQL server headers access in order to compile. It can be built against PostgreSQL versions 12 - 17. Earlier versions of PostgreSQL are not supported.

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

Note

GEOS requires PostgreSQL C++ headers.



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

PostGIS requires C++ headers. (PostgreSQL headers) PostgreSQL headers.

PostGIS requires PostgreSQL headers. PostgreSQL headers.

2.2.1

PostGIS source tarball <https://download.osgeo.org/postgis/source/postgis-3.5.0alpha2.tar.gz>

```
wget https://download.osgeo.org/postgis/source/postgis-3.5.0alpha2.tar.gz
tar -xvzf postgis-3.5.0alpha2.tar.gz
cd postgis-3.5.0alpha2
```

postgis-3.5.0alpha2 () headers.

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

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

postgis-3.5.0alpha2 headers.

```
./configure
```

2.2.2

PostGIS headers.

headers

- PostgreSQL 12 - 17. A complete installation of PostgreSQL (including server headers) is required. PostgreSQL is available from <https://www.postgresql.org> . For a full PostgreSQL / PostGIS support matrix and PostGIS/GEOS support matrix refer to <https://trac.osgeo.org/postgis/wiki/UsersWikiPostgreSQLPostGIS>
- GNU C (gcc). PostGIS ANSI C headers gcc headers.
- GNU Make(gmake make). GNU make make headers. make -v headers. make PostGIS Makefile headers.
- Proj reprojection library. Proj 6.1 or above is required. The Proj library is used to provide coordinate reprojection support within PostGIS. Proj is available for download from <https://proj.org/> .
- GEOS geometry library, version 3.8.0 or greater, but GEOS 3.12+ is required to take full advantage of all the new functions and features. GEOS is available for download from <https://libgeos.org> .

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

Dependencies

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

2.2.3

Makefile

./configure

PostGIS

--help --help=short

--with-sfcgal=PATH Path to PostGIS sfcgal. PATH sfcgal-config

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



Note

PostGIS SVN, configure

./autogen.sh

configure PostGIS

tar PostGIS configure ./autogen.sh

2.2.4

Makefile PostGIS

make

"PostGIS was built successfully. Ready to install."

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

make comments

PostGIS 2.0. xsltproc, doc topology_cheatsheet.html, tiger_geocoder_cheatsheet.html, raster_cheatsheet.html, postgis_cheatsheet.html 4

html pdf PostGIS / PostgreSQL Study Guides

make cheatsheets

2.2.5 PostGIS Extensions

PostgreSQL 9.1 PostGIS extentions

function descriptions docbook

make comments

tar tar comments

PostgreSQL 9.1 extensions

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

```

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

```



Note

make check uses psql to run tests and as such can use psql environment variables. Common ones useful to override are PGUSER,PGPORT, and PHOST. Refer to [psql environment variables](#)

extension files OS specific PostGIS binaries. PostGIS binaries are located in the PostGIS installation directory.

extension files PostgreSQL PostgreSQL / share / extension extensions PostGIS extensions.

- extension files extension files. postgres.control, postgis_topology.control.
- extension /sql files. PostgreSQL share/extension extensions/postgis/sql/*.sql, extensions/postgis_topology/sql/*.sql

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

psql files.

```

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

```

name	default_version	installed_version
address_standardizer	3.5.0alpha2	3.5.0alpha2
address_standardizer_data_us	3.5.0alpha2	3.5.0alpha2
postgis	3.5.0alpha2	3.5.0alpha2
postgis_raster	3.5.0alpha2	3.5.0alpha2
postgis_sfcgal	3.5.0alpha2	
postgis_tiger_geocoder	3.5.0alpha2	3.5.0alpha2
postgis_topology	3.5.0alpha2	

(6 rows)

extension files, installed_version files. PostGIS extension files. PgAdmin III 1.14 extensions files.

extension files pgAdmin extension files sql files postgis extension files:

```

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

```

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

PSQL

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

```
List of installed extensions
-[ RECORD 1 ]-----
Name          | postgis
Version       | 3.5.0alpha2
Schema        | public
Description   | PostGIS geometry, geography, and raster spat..
-[ RECORD 2 ]-----
Name          | postgis_raster
Version       | 3.0.0dev
Schema        | public
Description   | PostGIS raster types and functions
-[ RECORD 3 ]-----
Name          | postgis_tiger_geocoder
Version       | 3.5.0alpha2
Schema        | tiger
Description   | PostGIS tiger geocoder and reverse geocoder
-[ RECORD 4 ]-----
Name          | postgis_topology
Version       | 3.5.0alpha2
Schema        | topology
Description   | PostGIS topology spatial types and functions
```

Warning



spatial_ref_sys, layer, topology extensions. The postgis and postgis_topology extension are installed. PostgreSQL 12.1. PostGIS 2.0.1 uses srid 31466. The trac extension is installed. CREATE EXTENSION is used to install PostgreSQL extension.

PostGIS 3.5.0alpha2, raster_upgrade_22_minor.sql, topology_upgrade_22_minor.sql.

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

2.2.6

PostGIS, make check.

make check

PostgreSQL make check.

**Note**

PostgreSQL, GEOS, Proj4, LD_LIBRARY_PATH.

**Caution**

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

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

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

.
.
.

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

.
.
.

Running tests

.
.
.

Run tests: 134
Failed: 0

-- if you build with SFCGAL

.
.
.

Running tests

.
.
.

Run tests: 13
Failed: 0

-- if you built with raster support

.
```

```

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

```

```

.
.
Running tests

```

```

.
.
Run tests: 101
Failed: 0

```

-- topology regress

```

.
.
Running tests

```

```

.
.
Run tests: 51
Failed: 0

```

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

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

```

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

```

postgis_tiger_geocoder address_standardizer PostgreSQL (installcheck) make install

address_standardizer:

```

cd extensions/address_standardizer
make install
make installcheck

```

:


```

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

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

```

TIGER, PostgreSQL, PostGIS, fuzzystmatch, address_standardizer, PostGIS, address_standardizer.

```

cd extensions/postgis_tiger_geocoder
make install
make installcheck

```

:

```

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

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

```

2.2.7

PostGIS.

make install

--prefix PostgreSQL.

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

Execute `postgis_comments.sql`, `raster_comments.sql` and `make comments` to install the comments, and `sql` to install the comments.

make comments-install



Note

xsitproc is required to install `postgis_comments.sql`, `raster_comments.sql`, `topology_comments.sql`.

2.3 Installing the address_standardizer extension

The `address_standardizer` extension is included in PostGIS 2.2 and later. See Section 12.1 for details.

The **Normalize Address** extension in PostGIS uses the TIGER geocoder (geocoder) extension. See Section 2.4.2 for details. The geocoder extension is used to geocode (building block) addresses.

The PCRE extension is required. PCRE is a regular expression engine. See <http://www.pcre.org> for details. Section 2.2.3 describes PCRE. To install PCRE, use `--with-pcre=/path/to/pcre` or `/path/to/pcre` to specify the PCRE include and lib paths.

In PostGIS 2.1, the `address_standardizer` extension is installed using `CREATE EXTENSION`.

The following SQL creates the extension:

```
CREATE EXTENSION address_standardizer;
```

The extension includes rules, gaz, and lex tables.

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

The following table shows the results:

num	street	city	state	zip
1	Devonshire Place PH301	Boston	MA	02109

2.4 Installing, Upgrading Tiger Geocoder, and loading data

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

2.4.1 Tiger Geocoder Enabling your PostGIS database

1. These directions assume your PostgreSQL installation already has the `postgis_tiger_geocoder` extension installed.
2. PSQL, pgAdmin or SQL client. `fuzzystrmatch`.

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

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

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

3. SQL:

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

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

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

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

```
debbie pg, unzip,shp2pgsql, PSQL declare_sect
```

```
loader_platform (common case)
```

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

To enable it, do the following:

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

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

6. On the PC, create a directory `gisdata` in the `TIGER` directory. Create a file `tiger.loader_variables` in the `staging_fold` directory.
7. Create a directory `staging_fold` in the `temp` directory. Create a file `TIGER` in the `temp` directory.

8. Then run the **Loader_Generate_Nation_Script** SQL function make sure to use the name of your custom profile and copy the script to a `.sh` or `.bat` file. So for example to build the nation load:

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

9. Run the generated nation load commandline scripts.

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

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

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

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

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

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

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

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

```
count
-----
 33931
(1 row)
```

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

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

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

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



Warning

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

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

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

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

2.4.2 TIGER Data Loading

The `Normalize Address` script is used to standardize the address data. It uses the `address_standardizer` tool, described in Section 2.3, to standardize the addresses.

The `postgis_tiger_geocoder` script uses the `Normalize Address` script to generate the `Pagc Normalize Address` script. This script is used to load the TIGER data into the database. The `TIGER` data is loaded into the `rules table` (`tiger.pagc_rules`), `gaz table` (`tiger.pagc_gaz`), and `lex table` (`tiger.pagc_lex`).

2.4.3 Required tools for tiger data loading

The `Drop_State_Tables_Generate_Script` script is used to drop the state tables and generate the state script.

The following tools are required for loading the TIGER data:

- `unzip` (Unix) or `7-zip` (Windows).
<http://www.7-zip.org/>

- PostGIS shp2pgsql
- wget Unix/Linux <http://gnuwin32.sourceforge.net/packages/wget.htm>.

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

Loader_Generate_Script. **Drop_Nation_Tables_Generate_Script**. **Loader_Generate_Nation_Script**.

Install_Missing_Indexes:

```
SELECT install_missing_indexes();
```

Geocode.

2.4.4 Upgrading your Tiger Geocoder Install and Data

First upgrade your postgis_tiger_geocoder extension as follows:

```
ALTER EXTENSION postgis_tiger_geocoder UPDATE;
```

Drop_Nation_Tables_Generate_Script

```
SELECT drop_nation_tables_generate_script();
```

drop SQL

Loader_Generate_Nation_Script

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

unix/linux

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

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



Note

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

2.5

Chapter 3

PostGIS Administration

3.1 Performance Tuning

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

For general details about optimizing PostgreSQL, refer to [Tuning your PostgreSQL Server](#).

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

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

In addition to the Postgres settings, PostGIS has some custom settings which are listed in [Section 7.22](#).

3.1.1 Startup

These settings are configured in `postgresql.conf`:

`constraint_exclusion`

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

`shared_buffers`

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

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

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

3.1.2 Runtime

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

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

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

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

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

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

max_parallel_workers_per_gather

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

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

3.2 Configuring raster support

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

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

If you want to enable offline raster:

```
POSTGIS_ENABLE_OUTDB_RASTERS=1
```

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

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

```
POSTGIS_GDAL_ENABLED_DRIVERS=ENABLE_ALL
```

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

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



Note

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

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

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

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

3.3 ☒☒☒☒☒☒☒☒

3.3.1 Spatially enable database using EXTENSION

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

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

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

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

3.3.2 Spatially enable database without using EXTENSION (discouraged)



Note

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

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

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

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

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

Run the following Shell commands in your terminal:

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

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

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

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

3.4 Upgrading spatial databases

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

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

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

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

3.4.1 Soft upgrade

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

3.4.1.1 Soft Upgrade 9.1+ using extensions

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

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

```
SELECT postgis_extensions_upgrade();
```

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

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

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

```
ALTER EXTENSION postgis UPDATE TO "3.5.0alpha2";
ALTER EXTENSION postgis_topology UPDATE TO "3.5.0alpha2";
```

If you get an error notice something like:

```
No migration path defined for b'...' to 3.5.0alpha2
```

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

If you get a notice message like:

```
Version "3.5.0alpha2" of extension "postgis" is already installed
```

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

```
ALTER EXTENSION postgis UPDATE TO "3.5.0alpha2next";
ALTER EXTENSION postgis_topology UPDATE TO "3.5.0alpha2next";
```



Note

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



Note

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

```
DROP EXTENSION postgis_raster;
```

3.4.1.2 Soft Upgrade Pre 9.1+ or without extensions

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

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

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

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

```
ls `pg_config --sharedir`/contrib/postgis-3.5.0alpha2/*_upgrade.sql
```

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

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

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

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

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

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

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

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

**Note**

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

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

3.4.2 Hard upgrade

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

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

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

The Procedure is as follows:

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

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

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

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

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

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

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

Errors may arise in the following cases:

1. Some of your views or functions make use of deprecated PostGIS objects. In order to fix this you may try loading `legacy.sql` script prior to restore or you'll have to restore to a version of PostGIS which still contains those objects and try a migration again after porting your code. If the `legacy.sql` way works for you, don't forget to fix your code to stop using deprecated functions and drop them loading `uninstall_legacy.sql`.
2. Some custom records of `spatial_ref_sys` in dump file have an invalid SRID value. Valid SRID values are bigger than 0 and smaller than 999000. Values in the 999000.999999 range are reserved for internal use while values > 999999 can't be used at all. All your custom records with invalid SRIDs will be retained, with those > 999999 moved into the reserved range, but the `spatial_ref_sys` table would lose a check constraint guarding for that invariant to hold and possibly also its primary key (when multiple invalid SRIDS get converted to the same reserved SRID value).

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

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

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

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

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

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

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

run this command :

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

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

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

Chapter 4

Data Management

4.1 GIS (OGC) Geometry

4.1.1 OGC Geometry

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

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

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

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

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

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

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

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

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

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

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

4.1.1.1 Point

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

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

4.1.1.2 LineString

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

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

4.1.1.3 LinearRing

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

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

4.1.1.4 Polygon

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

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

4.1.1.5 MultiPoint

A MultiPoint is a collection of Points.

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


4.1.1.6 MultiLineString

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

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

4.1.1.7 MultiPolygon

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

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

4.1.1.8 GeometryCollection

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

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

4.1.1.9 PolyhedralSurface

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

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

4.1.1.10 Triangle

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

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

4.1.1.11 TIN

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

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

4.1.2 SQL-MM Part 3

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



Note

SQL-MM ϵ is 1E-8.

4.1.2.1 CircularString

CIRCULARSTRING is a subtype of LINESTRING. It is defined as a sequence of circular arcs. The arcs are defined by their start and end points and a control point. The control point is the point that is equidistant from the start and end points and lies on the arc. The arcs are connected at their end points. The control point is not necessarily on the line segment connecting the start and end points. The control point is the point that is equidistant from the start and end points and lies on the arc. The arcs are connected at their end points. The control point is not necessarily on the line segment connecting the start and end points.

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

4.1.2.2 CompoundCurve

CompoundCurve (compound curve) is a subtype of Curve. It is defined as a sequence of curves. The curves are defined by their start and end points and a control point. The control point is the point that is equidistant from the start and end points and lies on the curve. The curves are connected at their end points. The control point is not necessarily on the line segment connecting the start and end points.

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

4.1.2.3 CurvePolygon

CURVEPOLYGON is a subtype of Polygon. It is defined as a sequence of curves. The curves are defined by their start and end points and a control point. The control point is the point that is equidistant from the start and end points and lies on the curve. The curves are connected at their end points. The control point is not necessarily on the line segment connecting the start and end points.

PostGIS 1.4 ϵ is 1E-8.

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

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

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

4.1.2.4 MultiCurve

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

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

4.1.2.5 MultiSurface

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

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

4.1.3 OpenGIS WKB & WKT

OpenGIS `WKB` (Well-Known Binary) and `WKT` (Well-Known Text) are used to represent geometric objects. `WKT` is a text-based representation, while `WKB` is a binary representation.

`WKT` is used to represent geometric objects. `WKT` SRS is used to represent the spatial reference system.

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

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

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

OGC `WKB` (Well-Known Binary) and `WKT` (Well-Known Text) are used to represent geometric objects.

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

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

- POINT(0 0)

WKB: 010100000000000000000000F03F000000000000F03
- LINESTRING(0 0,1 1,1 2)

WKB: 010200000002000000000000000000004000000000000000400000000000002240000000000000

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

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


OGC Well-Known Binary (WKB) representation:

```
INSERT INTO geotable ( geom, name )
VALUES ( ST_GeomFromWKB('\x010100000000000000000000f03f000000000000f03f', 312), 'A Place');
```

4.2 Geometry Data Type

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

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

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

OpenGIS Well-Known Text (WKT) representation (SRID):

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

4.2.1 OpenGIS WKB WKT

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

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

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

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

```
SELECT 'SRID=4;POINT(0 0) '::geometry;
 geometry
-----
0101000020040000000000000000000000000000000000000000000000000000
```

PostGIS EWKT output has a few differences to OGC WKT:

- For 3DZ geometries the Z qualifier is omitted:
POINT(0 0)
POINT(0 0)
- For 3DM geometries the M qualifier is included:
POINT(0 0)
POINT(0 0)
- For 4D geometries the ZM qualifier is omitted:
POINT(0 0)
POINT(0 0)

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

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



Caution

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

(WKT) :

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

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

PostGIS 3.5.0alpha2

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

PostGIS 3.5.0alpha2

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

4.3 PostGIS Geography

Geography (SRID=4326) is a data type for storing geodetic (long/lat based) spatial reference system defined in the spatial_ref_sys table can be used. (Prior to PostGIS 2.2, the geography type supported only WGS 84 geodetic (SRID:4326)). You can add your own custom geodetic spatial reference system as described in Section 4.5.2.

PostGIS 3.5.0alpha2. PostGIS 3.5.0alpha2. PostGIS 3.5.0alpha2 (球面) PostGIS 3.5.0alpha2.

PostGIS 3.5.0alpha2. PostGIS 3.5.0alpha2 (大圈; great circle arc) PostGIS 3.5.0alpha2 (球面) PostGIS 3.5.0alpha2 (spheroidal shape) PostGIS 3.5.0alpha2.

PostGIS 3.5.0alpha2, PostGIS 3.5.0alpha2. PostGIS 3.5.0alpha2.

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

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

4.3.1 Geography

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

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

The geography type supports two optional type modifiers:

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

Examples of creating tables with geography columns:

- POINT: 2D**:

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

- POINT: 2D**:

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

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

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

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

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

- POINT: 2D**:

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

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

```
SELECT * FROM geography_columns;
```

```
PostGIS
```

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

4.3.2 PostGIS

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

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

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

```
-- NAD 83 lon/lat
SELECT 'SRID=4269;POINT(-123 34)::geography;
       geography
-----
0101000020AD100000000000000000C05EC00000000000004140
```

```
-- NAD27 lon/lat
SELECT 'SRID=4267;POINT(-123 34)::geography;
       geography
-----
0101000020AB100000000000000000C05EC00000000000004140
```

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

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

Geography is a spatial data type that stores geodetic data. It is based on the **SRID** (Spatial Reference ID) and the **SRID** is used to identify the coordinate system. The **SRID** is a number that identifies the coordinate system. The **SRID** is used to identify the coordinate system. The **SRID** is a number that identifies the coordinate system.

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

Geography is a spatial data type that stores geodetic data. It is based on the **SRID** (Spatial Reference ID) and the **SRID** is used to identify the coordinate system. The **SRID** is a number that identifies the coordinate system. The **SRID** is used to identify the coordinate system. The **SRID** is a number that identifies the coordinate system.

Geography is a spatial data type that stores geodetic data. It is based on the **SRID** (Spatial Reference ID) and the **SRID** is used to identify the coordinate system. The **SRID** is a number that identifies the coordinate system. The **SRID** is used to identify the coordinate system. The **SRID** is a number that identifies the coordinate system.

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

Geography (Great Circle mapper) is a spatial data type that stores geodetic data. It is based on the **SRID** (Spatial Reference ID) and the **SRID** is used to identify the coordinate system. The **SRID** is a number that identifies the coordinate system. The **SRID** is used to identify the coordinate system. The **SRID** is a number that identifies the coordinate system.

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


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

4.4.1 Simple Geometry

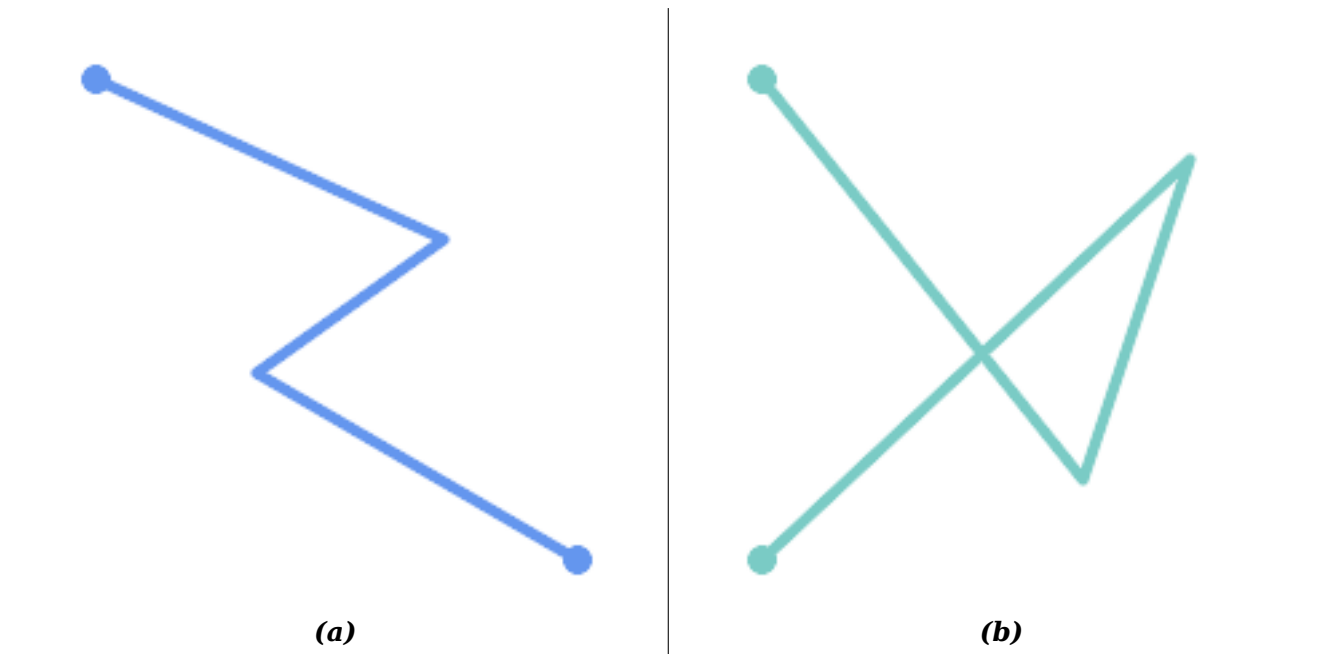
A *simple* geometry is one that has no anomalous geometric points, such as self intersection or self tangency.

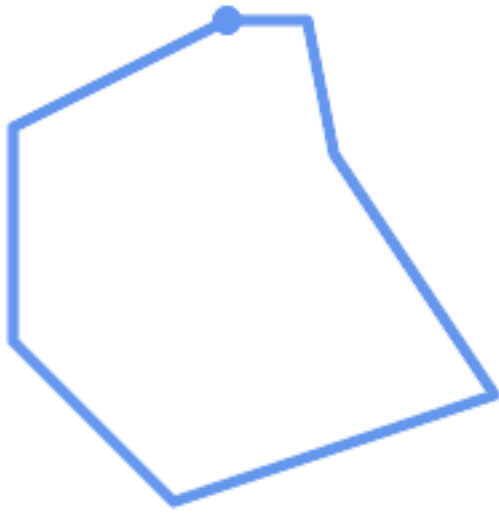
POINT 0

MULTIPOINT (POINT)

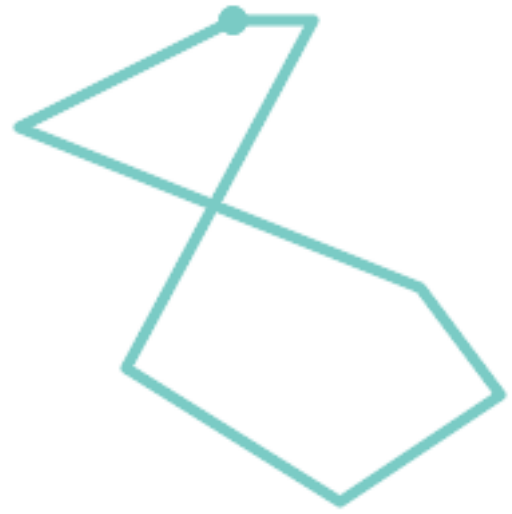
A LINESTRING is *simple* if it does not pass through the same point twice, except for the endpoints. If the endpoints of a simple LineString are identical it is called *closed* and referred to as a Linear Ring.

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





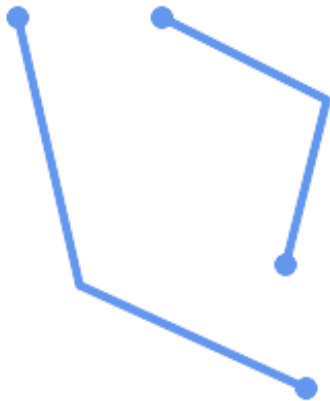
(c)



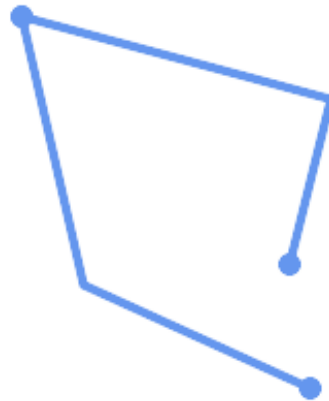
(d)

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

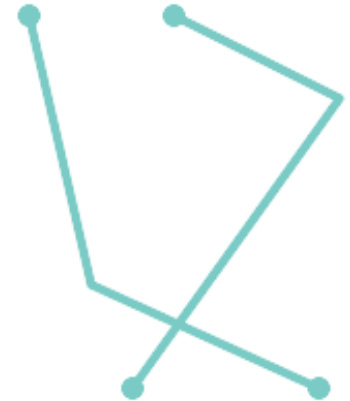
(e) and (f) are simple MULTILINESTRINGs. (g) is not simple.



(e)



(f)



(g)

POLYGONS are formed from linear rings, so valid polygonal geometry is always *simple*.

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

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

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

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

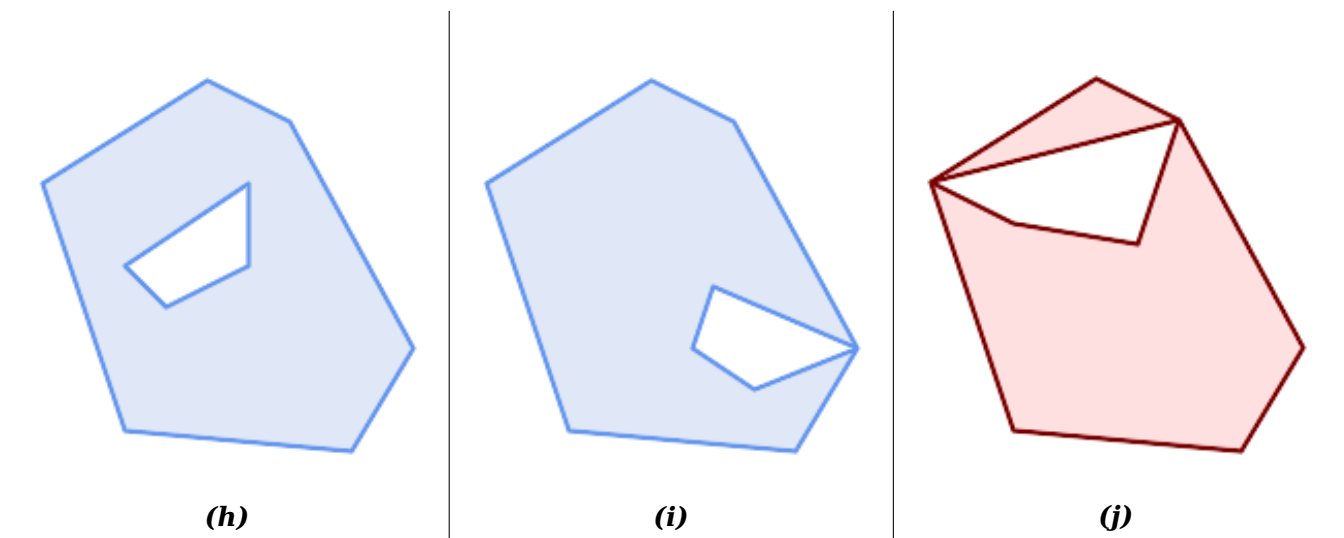
4.4.2 Valid Geometry

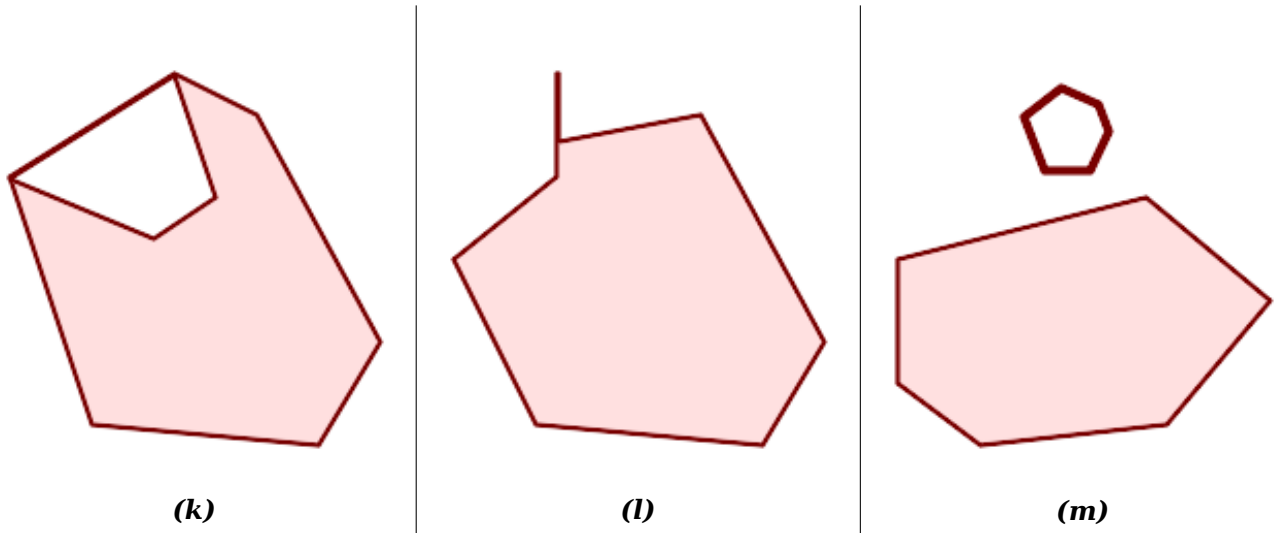
Geometry validity primarily applies to 2-dimensional geometries (POLYGONS and MULTIPOLYGONS). Validity is defined by rules that allow polygonal geometry to model planar areas unambiguously.

A POLYGON is *valid* if:

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

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

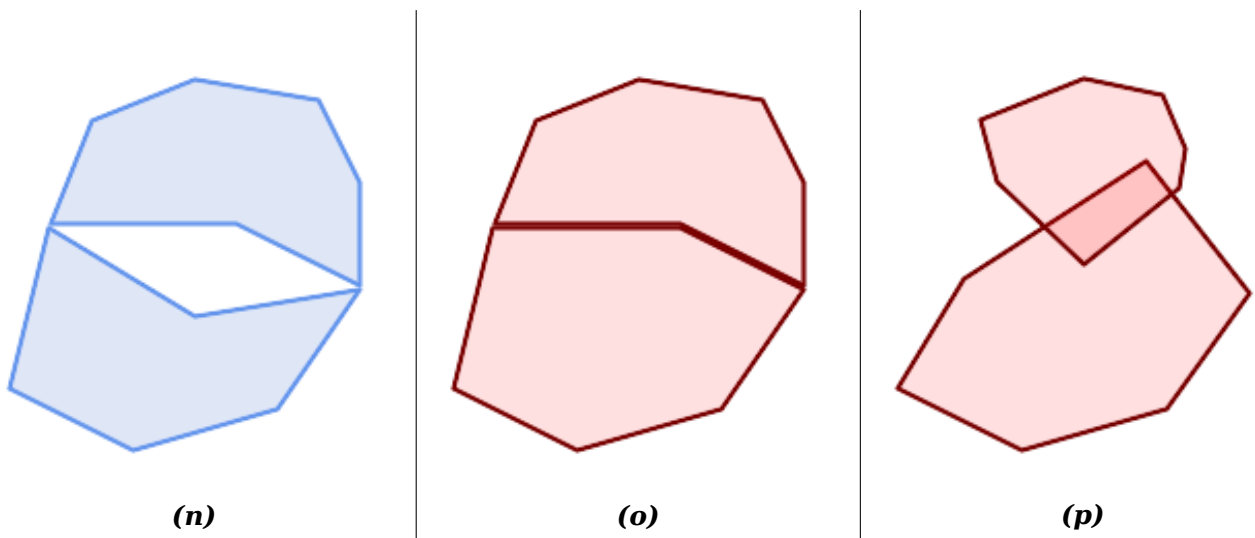




A MULTIPOLYGON is *valid* if:

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

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



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

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

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

```

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

```

POINT and MULTIPOINT geometries have no validity rules.

4.4.3 Managing Validity

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

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

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



Note

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

To test if a geometry is valid use the [ST_IsValid](#) function:

```

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

```

Information about the nature and location of an geometry invalidity are provided by the [ST_IsValidDetail](#) function:

```

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

```

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

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

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

```

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

```

4.5 SPATIAL_REF_SYS

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

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

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

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

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

4.5.1 SPATIAL_REF_SYS Table

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

SPATIAL_REF_SYS:

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

Columns:

srid (SRS) ID.

auth_name Authority name. “EPSG” AUTH_NAME.

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

srtext WKT(Well-Known Text) SRS:

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

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

4.6 Geometry

4.6.1 Creating Geometry Tables

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

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

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

- **Dimensional modifiers**. POINT, LINESTRING, POLYGON, MULTIPOINT, MULTILINESTRING, MULTIPOLYGON. Z, M ZM. POINTZ, POINTM, POINTZM, POINTMZ, LINESTRINGM, LINESTRINGZ, LINESTRINGZM, LINESTRINGMZ, POLYGONZ, POLYGONM, POLYGONZM, POLYGONMZ. POINTZM, POINTMZ, LINESTRINGZM, LINESTRINGMZ, POLYGONZM, POLYGONMZ.
- the **SRID modifier** restricts the **spatial reference system** SRID to a particular number. If omitted, the SRID defaults to 0.

Examples of creating tables with geometry columns:

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

CREATE TABLE pois_ny(gid SERIAL PRIMARY KEY, poi_name text, cat text, geom geometry(Point, 4326));

```
SELECT AddGeometryColumn('pois_ny', 'geom_2160', 2160, 'POINT', 2, false);
```

PSQL

```
\d pois_ny;
```

Table "public.pois_ny"

Column	Type	Modifiers
gid	integer	not null default nextval('pois_ny_gid_seq'::regclass)
poi_name	text	
cat	character varying(20)	
geom	geometry(Point,4326)	
geom_2160	geometry	

Indexes:

"pois_ny_pkey" PRIMARY KEY, btree (gid)

Check constraints:

- "enforce_dims_geom_2160" CHECK (st_ndims(geom_2160) = 2)
- "enforce_geotype_geom_2160" CHECK (geometrytype(geom_2160) = 'POINT'::text OR geom_2160 IS NULL)
- "enforce_srid_geom_2160" CHECK (st_srid(geom_2160) = 2160)

geometry_columns

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

f_table_name	f_geometry_column	srid	type
pois_ny	geom	4326	POINT
pois_ny	geom_2160	2160	POINT

--

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

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

typmod

f_table_name	f_geometry_column	srid	type
vw_pois_ny_parks	geom	4326	POINT
vw_pois_ny_parks	geom_2160	0	GEOMETRY

PostGIS, shapefile

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

f_table_name	f_geometry_column	srid	type
vw_pois_ny_parks	geom	4326	POINT
vw_pois_ny_parks	geom_2160	2160	POINT

4.7 GIS (shapefile)

shapefile, GIS, SQL, shapefile, PostGIS/PostgreSQL

4.7.1 SQL 脚本

PostGIS 支持 (formatted) SQL 脚本。Oracle SQL 脚本, SQL "INSERT" (piping) 脚本。

脚本 (roads.sql) 如下:

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

"psql" SQL 脚本 PostgreSQL 脚本。

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

4.7.2 shp2pgsql: ESRI shapefile 脚本

shp2pgsql 将 ESRI shapefile 转换为 PostGIS/PostgreSQL 脚本。 (command line) 脚本。

shp2pgsql 脚本, 脚本 PostGIS 脚本 shp2pgsql-gui 脚本。 shp2pgsql-gui 脚本 pgAdmin III 脚本。

- c|a|d|p** -- 脚本:
- c 脚本 shapefile 脚本。 脚本。
- a 脚本 shapefile 脚本。 脚本。
- d 脚本 (drop) 脚本 shapefile 脚本。
- p 脚本 SQL 脚本, 脚本。 脚本。
- ? 脚本。
- D 脚本 PostgreSQL " 脚本 (dump)" 脚本。 脚本 -a, -c 脚本 -d 脚本 脚本。 脚本 " 脚本" SQL 脚本。 脚本。
- s [**<FROM_SRID>**:]**<SRID>** 脚本 SRID 脚本。 脚本 shapefile 脚本 FROM_SRID 脚本。 脚本 SRID 脚本 FROM_SRID 脚本 -D 脚本。
- k 脚本 (, 脚本) 脚本。 shapefile 脚本。

4.8

SQL shapefile /... SQL ...

4.8.1 SQL

SQL (select) ...

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

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

(6 rows)

SQL ...

ST_Intersects This function tells whether two geometries share any space.

```
= ST_Intersects('POLYGON((0 0,1 1,1 0,0 0))', 'POLYGON((0 0,1 1,1 0,0 0))')
```

SQL "ST_GeomFromText()" ...

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

"ROADS_GEOM" ...

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

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

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

"&&" BOX3D ...

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

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

SRID 312

4.8.2 使用 pgsqll2shp

pgsql2shp 是一个命令行工具，用于将 PostgreSQL 数据库中的地理数据导出为 shapefile 格式。其基本用法如下：

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

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

选项列表如下：

- f <filename> 输出文件的名称。
- h <host> 数据库所在的主机名。
- p <port> 数据库的端口号。
- P <password> 数据库用户的密码。
- u <user> 数据库用户的名称。
- g <geometry column> 指定 shapefile 中的几何列名。
- b 指定几何列的数据类型。默认为 GEOMETRY。如果指定为 POINT、POLYGON 等，则会自动进行类型转换 (cast)。
- r 以原始格式 (raw) 输出。gid 列将包含原始记录的 ID。
- m filename 指定 remap 文件。该文件用于指定非常长的符号 (VERYLONGSYMBOL) 和非常短的符号 (SHORTONE) 的映射。

4.9 索引

PostgreSQL 提供了多种索引方法。对于空间数据，B-Tree、R-Tree 和 GiST 索引是常用的。B-Tree 索引适用于一维数据，而 R-Tree 和 GiST 索引适用于多维空间数据。

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

- **GiST (Generalized Search Tree)** 索引适用于多维空间数据。PostGIS 中的 GiST 索引是 GIS 数据的首选索引方法。它比 R-Tree 索引更高效。
- **BRIN (Block Range Index)** 索引通过总结表的范围来操作。BRIN 索引适用于某些类型的数据 (空间排序、更新频率低)。它提供了更快的索引创建时间和更小的索引大小。

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

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

See also the [PostGIS Workshop section on spatial indexes](#), and the [PostgreSQL manual](#).

4.9.1 GiST

GiST is a general-purpose index method. GIS is a B-Tree index method. (GIS, GIS) is a GiST index method.

GIS is a B-Tree index method. (GIS, GIS) is a GiST index method.

"GIS" is a GiST index method:

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

GIS is a 2D GIS index method. GIS is a PostGIS 2.0 GIS index method n GIS index method.

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

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

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

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

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

4.9.2 GiST

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

GIS is a B-Tree index method. (GIS, GIS) is a GiST index method.

A BRIN index stores the bounding box enclosing all the geometries contained in the rows in a contiguous set of table blocks, called a *block range*. When executing a query using the index the block ranges are scanned to find the ones that intersect the query extent. This is efficient only if the data is physically ordered so that the bounding boxes for block ranges have minimal overlap (and ideally are

mutually exclusive). The resulting index is very small in size, but is typically less performant for read than a GiST index over the same data.

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

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

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

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

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

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

” ” GiST :

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

2D . PostGIS 2.0 n , :

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

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

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

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

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

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

” ” GiST :

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

2D . PostGIS 2.0 n , :

Chapter 5

Spatial Queries

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

5.1 Determining Spatial Relationships

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

5.1.1 Dimensionally Extended 9-Intersection Model

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

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

Boundary

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

Interior

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

Exterior

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

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

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



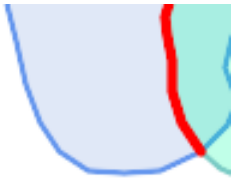

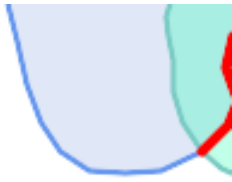
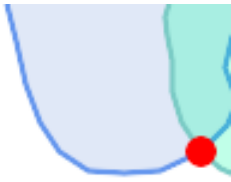
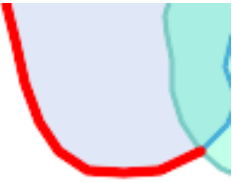
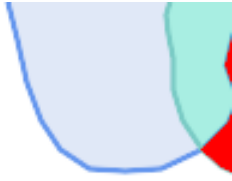
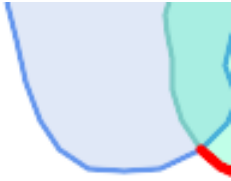
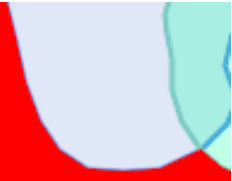
- 0 => point
- 1 => line
- 2 => area
- F => empty set

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

	Interior	Boundary	Exterior
Interior	$dim(I(a) \cap I(b))$	$dim(I(a) \cap B(b))$	$dim(I(a) \cap E(b))$
Boundary	$dim(B(a) \cap I(b))$	$dim(B(a) \cap B(b))$	$dim(B(a) \cap E(b))$
Exterior	$dim(E(a) \cap I(b))$	$dim(E(a) \cap B(b))$	$dim(E(a) \cap E(b))$

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



		Interior	Boundary	Exterior
	Interior	 $dim(I(a) \cap I(b)) = 2$	 $dim(I(a) \cap B(b)) = 1$	 $dim(I(a) \cap E(b)) = 2$
	Boundary	 $dim(B(a) \cap I(b)) = 1$	 $dim(B(a) \cap B(b)) = 0$	 $dim(B(a) \cap E(b)) = 1$
	Exterior	 $dim(E(a) \cap I(b)) = 2$	 $dim(E(a) \cap B(b)) = 1$	 $dim(E(a) \cap E(b)) = 2$

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

For more information, refer to:

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

5.1.2 Named Spatial Relationships

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

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

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

For more details and illustrations, see the [PostGIS Workshop](#).

5.1.3 General Spatial Relationships

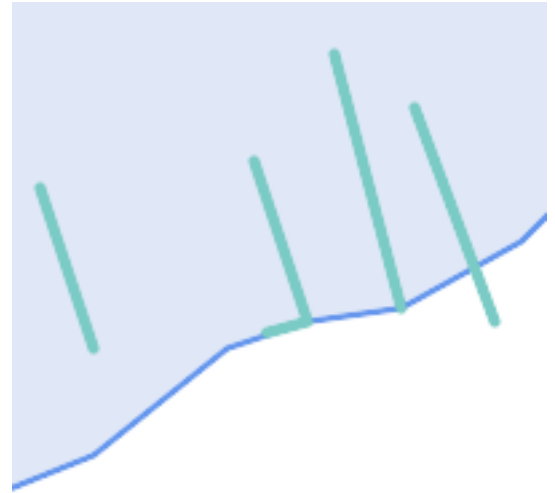
In some cases the named spatial relationships are insufficient to provide a desired spatial filter condition.



For example, consider a linear dataset representing a road network. It may be required to identify all road segments that cross each other, not at a point, but in a line (perhaps to validate some business rule). In this case **ST_Crosses** does not provide the necessary spatial filter, since for linear features it returns `true` only where they cross at a point.

A two-step solution would be to first compute the actual intersection (**ST_Intersection**) of pairs of road lines that spatially intersect (**ST_Intersects**), and then check if the intersection's **ST_GeometryType** is 'LINESTRING' (properly dealing with cases that return **GEOMETRYCOLLECTIONs** of [MULTI]POINTs, [MULTI]LINESTRINGs, etc.).

Clearly, a simpler and faster solution is desirable.



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

- `ST_Contains(lake, wharf) = TRUE`
- `ST_ContainsProperly(lake, wharf) = FALSE`
- `ST_GeometryType(ST_Intersection(wharf, lake)) = 'LINESTRING'`
- `ST_NumGeometries(ST_Multi(ST_Intersection(ST_Boundary(wharf), ST_Boundary(lake)))) = 1`
... but needless to say, this is quite complicated.

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

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

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

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

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

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

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

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

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

5.2 Using Spatial Indexes

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

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

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

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

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

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

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

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

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

For more information and examples see the [PostGIS Workshop](#).

5.3 Examples of Spatial SQL

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

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

The definition of the `bc_municipality` table is:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

name	roads_km
SURREY	1539.47553551242
VANCOUVER	1450.33093486576
LANGLEY DISTRICT	833.793392535662
BURNABY	773.769091404338
PRINCE GEORGE	694.37554369147
...	

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

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

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

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

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

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

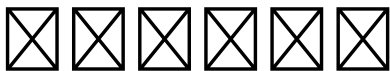
```
kilometers
-----
4.89151904172838
```

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

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

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

Chapter 6



6.1

6.1.1

PostgreSQL (8.0) optimizer TOAST (extension room) the PostgreSQL Documentation for TOAST

TOAST 80 TOAST 8,225

TOAST TOAST

EXPLAIN ANALYZE PostgreSQL http://archives.postgresql.org/pgsql-performance/2005-02/msg00030.php

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

6.1.2

PostgreSQL TOAST

SET enable_seqscan TO off; SET enable_seqscan TO on;

TOAST

Chapter 7

PostGIS Reference

PostGIS is a spatial database, PostGIS is a PostGIS extension.

Note

PostGIS is a SQL-MM-compliant Spatial Type (ST) extension. It provides a set of functions for working with spatial data. The ST_ prefix is used for all spatial functions.

7.1 PostgreSQL PostGIS Geometry/Geography/Box

7.1.1 box2d

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

box3d is a PostGIS extension. ST_3DExtent is a PostGIS extension.

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

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

box3d	box3d
geometry	geometry

geography	
text	

Section 4.1, Section 4.3

7.1.4 geometry_dump

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

geometry_dump is a composite data type containing the fields:

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

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

Section 13.6

7.1.5 geography

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

geography

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

geometry	

☒☒

```
-- 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
```


ST_SRID

7.2.5 Populate_Geometry_Columns

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

Synopsis

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

Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints. `use_typmod=false` ensures every geometry has the same dimension (see `ST_NDims`), every geometry is of the same type (see `GeometryType`), and every geometry is in the same projection (see `ST_SRID`). `use_typmod=true` ensures every geometry has the same dimension (see `ST_NDims`), every geometry is of the same type (see `GeometryType`), and every geometry is in the same projection (see `ST_SRID`). `use_typmod=false` ensures every geometry has the same dimension (see `ST_NDims`), every geometry is of the same type (see `GeometryType`), and every geometry is in the same projection (see `ST_SRID`). `use_typmod=true` ensures every geometry has the same dimension (see `ST_NDims`), every geometry is of the same type (see `GeometryType`), and every geometry is in the same projection (see `ST_SRID`).

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

`oid` `enforce_dims_the_geom`, `enforce_geotype_the_geom`, `enforce_srid_the_geom`, `SRID`, `use_typmod`, `geometry_columns`

`oid` `enforce_dims_the_geom`, `enforce_geotype_the_geom`, `enforce_srid_the_geom`, `SRID`, `use_typmod`, `geometry_columns`

`truncate` `geometry_columns`

1.4.0

2.0.0 `use_typmod`

2.0.0 `use_typmod`

☒☒

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

```
populate_geometry_columns
```

```
-----
                1
```

```
\d myspatial_table
```

```

          Table "public.myspatial_table"
Column |          Type          |          Modifiers
-----+-----+-----
gid    | integer                | not null default nextval('myspatial_table_gid_seq':: ↵
      regclass)
geom   | geometry(LineString,4326) |
```

```
-- This will change the geometry columns to use constraints if they are not typmod or have ↵
constraints already.
```

```
--For this to work, there must exist data
```

```
CREATE TABLE public.myspatial_table_cs(gid serial, geom geometry);
INSERT INTO myspatial_table_cs(geom) VALUES(ST_GeomFromText('LINESTRING(1 2, 3 4)',4326) );
SELECT Populate_Geometry_Columns('public.myspatial_table_cs'::regclass, false);
populate_geometry_columns
```

```
-----
                1
```

```
\d myspatial_table_cs
```

```

          Table "public.myspatial_table_cs"
Column |  Type  |          Modifiers
-----+-----+-----
gid    | integer | not null default nextval('myspatial_table_cs_gid_seq'::regclass)
geom   | geometry |
```

```
Check constraints:
```

```
    "enforce_dims_geom" CHECK (st_ndims(geom) = 2)
```

```
    "enforce_geotype_geom" CHECK (geometrytype(geom) = 'LINESTRING'::text OR geom IS NULL)
```

```
    "enforce_srid_geom" CHECK (st_srid(geom) = 4326)
```

7.2.6 UpdateGeometrySRID

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

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);
```



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

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

Example 7.3.1: ST_Collect

Using an array constructor for a subquery.

```
SELECT ST_Collect( ARRAY( SELECT geom FROM sometable ) );
```

Using an array constructor for values.

```
SELECT ST_AsText( ST_Collect(
                    ARRAY[ ST_GeomFromText('LINESTRING(1 2, 3 4)'),
                          ST_GeomFromText('LINESTRING(3 4, 4 5)') ] ) ) As wktcollect;

--wkt collect --
MULTILINESTRING((1 2,3 4),(3 4,4 5))
```

Example 7.3.2: ST_Collect

Creating multiple collections by grouping geometries in a table.

```
SELECT stusps, ST_Collect(f.geom) as geom
      FROM (SELECT stusps, (ST_Dump(geom)).geom As geom
            FROM
            somestatetable ) As f
      GROUP BY stusps
```

Example 7.3.3: ST_Dump

[ST_Dump](#), [ST_AsBinary](#)

7.3.2 ST_LineFromMultiPoint

`ST_LineFromMultiPoint` — [ST_LineFromMultiPoint](#).

Synopsis

geometry **ST_LineFromMultiPoint**(geometry aMultiPoint);

Example 7.3.4: ST_LineFromMultiPoint

[ST_LineFromMultiPoint](#).

Use [ST_MakeLine](#) to create lines from Point or LineString inputs.



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

Synopsis

```
geometry ST_MakeLine(geometry geom1, geometry geom2);
geometry ST_MakeLine(geometry[] geoms_array);
geometry ST_MakeLine(geometry set geoms);
```

Geometry


Creates a LineString containing the points of Point, MultiPoint, or LineString geometries. Other geometry types cause an error.

Variation 1: accepts two input geometries

Variation 2: accepts an array of geometries

Variation 3: aggregate function accepting a rowset of geometries. To ensure the order of the input geometries use ORDER BY in the function call, or a subquery with an ORDER BY clause.

Repeated nodes at the beginning of input LineStrings are collapsed to a single point. Repeated points in Point and MultiPoint inputs are not collapsed. **ST_RemoveRepeatedPoints** can be used to collapse repeated points from the output LineString.

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

2.0.0 **ST_MakeLine**(geometry geom1, geometry geom2);

2.0.0 **ST_MakeLine**(geometry[] geoms_array);

1.4.0 **ST_MakeLine**(geometry set geoms);. **ST_MakeLine**(geometry geom1, geometry geom2). **ST_MakeLine**(geometry[] geoms_array). **ST_MakeLine**(geometry set geoms);

Examples:

Create a line composed of two points.

```
SELECT ST_AsText( ST_MakeLine(ST_Point(1,2), ST_Point(3,4)) );
```

```
      st_astext
-----
LINESTRING(1 2,3 4)
```

3D **ST_MakeLine** **BOX3D**

```
SELECT ST_AsEWKT( ST_MakeLine(ST_MakePoint(1,2,3), ST_MakePoint(3,4,5)) );
```

```
      st_asewkt
-----
LINESTRING(1 2 3,3 4 5)
```

Concatenation

```
select ST_AsText( ST_MakeLine( 'LINESTRING(0 0, 1 1)', 'LINESTRING(2 2, 3 3)' ) );
```

```
      st_astext
-----
LINESTRING(0 0,1 1,2 2,3 3)
```

ST_MakeLine

Create a line from an array formed by a subquery with ordering.

```
SELECT ST_MakeLine( ARRAY( SELECT ST_Centroid(geom) FROM visit_locations ORDER BY
    visit_time) );
```

Create a 3D line from an array of 3D points

```
SELECT ST_AsEWKT( ST_MakeLine(
    ARRAY[ ST_MakePoint(1,2,3), ST_MakePoint(3,4,5), ST_MakePoint(6,6,6) ] ) );
-----
st_asewkt
-----
LINESTRING(1 2 3,3 4 5,6 6 6)
```

ST_MakeLine

Using aggregate `ST_MakeLine` with `ORDER BY` provides a correctly-ordered LineString.

Using aggregate `ORDER BY` provides a correctly-ordered LineString.

```
SELECT gps.track_id, ST_MakeLine(gps.geom ORDER BY gps_time) As geom
FROM gps_points As gps
GROUP BY track_id;
```

Prior to PostgreSQL 9, ordering in a subquery can be used. However, sometimes the query plan may not respect the order of the subquery.

```
SELECT gps.track_id, ST_MakeLine(gps.geom) As geom
FROM ( SELECT track_id, gps_time, geom
        FROM gps_points ORDER BY track_id, gps_time ) As gps
GROUP BY track_id;
```

ST_RemoveRepeatedPoints

[ST_RemoveRepeatedPoints](#), [ST_AsText](#), [ST_GeomFromText](#), [ST_MakePoint](#)

7.3.5 ST_MakePoint

`ST_MakePoint` — Creates a 2D, 3DZ or 4D Point.

Synopsis

geometry **ST_MakePoint**(float x, float y);

geometry **ST_MakePoint**(float x, float y, float z);

geometry **ST_MakePoint**(float x, float y, float z, float m);

7.3.7 ST_MakePolygon

ST_MakePolygon — Creates a Polygon from a shell and optional list of holes.

Synopsis

```
geometry ST_MakePolygon(geometry linestring);
geometry ST_MakePolygon(geometry outerlinestring, geometry[] interiorlinestrings);
```

⚠

⚠ (shell) ⚠. ⚠.

Variant 1: Accepts one shell LineString.

Variant 2: Accepts a shell LineString and an array of inner (hole) LineStrings. A geometry array can be constructed using the PostgreSQL array_agg(), ARRAY[] or ARRAY() constructs.



Note

⚠. ⚠ **ST_LineMerge** ⚠ **ST_Dump** ⚠.



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

⚠: ⚠

⚠.

```
SELECT ST_MakePolygon( ST_GeomFromText('LINESTRING(75 29,77 29,77 29, 75 29)'));
```

Create a Polygon from an open LineString, using **ST_StartPoint** and **ST_AddPoint** to close it.

```
SELECT ST_MakePolygon( ST_AddPoint(foo.open_line, ST_StartPoint(foo.open_line)) )
FROM (
  SELECT ST_GeomFromText('LINESTRING(75 29,77 29,77 29, 75 29)') As open_line) As foo;
```

⚠.

```
SELECT ST_AsEWKT( ST_MakePolygon( 'LINESTRING(75.15 29.53 1,77 29 1,77.6 29.5 1, 75.15
  29.53 1)'));
```

```
st_asewkt
-----
POLYGON((75.15 29.53 1,77 29 1,77.6 29.5 1,75.15 29.53 1))
```

Create a Polygon from a LineString with measures

```
SELECT ST_AsEWKT( ST_MakePolygon( 'LINESTRINGM(75.15 29.53 1,77 29 1,77.6 29.5 2, 75.15
  29.53 2)') ));
```

```
st_asewkt
-----
POLYGONM((75.15 29.53 1,77 29 1,77.6 29.5 2,75.15 29.53 2))
```

Example: Creating a polygon with a hole.

The following SQL query creates a polygon with a hole.

```
SELECT ST_MakePolygon( ST_ExteriorRing( ST_Buffer(ring.line,10)),
    ARRAY[ ST_Translate(ring.line, 1, 1),
          ST_ExteriorRing(ST_Buffer(ST_Point(20,20),1)) ]
    )
FROM (SELECT ST_ExteriorRing(
    ST_Buffer(ST_Point(10,10),10,10)) AS line ) AS ring;
```

Create a set of province boundaries with holes representing lakes. The input is a table of province Polygons/MultiPolygons and a table of water linestrings. Lines forming lakes are determined by using [ST_IsClosed](#). The province linework is extracted by using [ST_Boundary](#). As required by [ST_MakePolygon](#), the boundary is forced to be a single LineString by using [ST_LineMerge](#). (However, note that if a province has more than one region or has islands this will produce an invalid polygon.) Using a LEFT JOIN ensures all provinces are included even if they have no lakes.



Note

NULL values in the `array_agg` function will result in a NULL value for the `ST_MakePolygon` function. Use `CASE` to handle NULL values.

```
SELECT p.gid, p.province_name,
    CASE WHEN array_agg(w.geom) IS NULL
    THEN p.geom
    ELSE ST_MakePolygon( ST_LineMerge(ST_Boundary(p.geom)),
        array_agg(w.geom)) END
FROM
    provinces p LEFT JOIN waterlines w
        ON (ST_Within(w.geom, p.geom) AND ST_IsClosed(w.geom))
GROUP BY p.gid, p.province_name, p.geom;
```

Another technique is to utilize a correlated subquery and the `ARRAY()` constructor that converts a row set to an array.

```
SELECT p.gid, p.province_name,
    CASE WHEN EXISTS( SELECT w.geom
        FROM waterlines w
        WHERE ST_Within(w.geom, p.geom)
        AND ST_IsClosed(w.geom))
    THEN ST_MakePolygon(
        ST_LineMerge(ST_Boundary(p.geom)),
        ARRAY( SELECT w.geom
            FROM waterlines w
            WHERE ST_Within(w.geom, p.geom)
            AND ST_IsClosed(w.geom)))
    ELSE p.geom
    END AS geom
FROM provinces p;
```

Example:

[ST_BuildArea](#) [ST_Polygon](#)

7.3.8 ST_Point

`ST_Point` — Creates a Point with X, Y and SRID values.

Synopsis

geometry **ST_Point**(float x, float y);

geometry **ST_Point**(float x, float y, integer srid=unknown);

☒☒

Returns a Point with the given X and Y coordinate values. This is the SQL-MM equivalent for **ST_MakePoint** that takes just X and Y.



Note

For geodetic coordinates, X is longitude and Y is latitude

Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with **ST_SetSRID** to mark the srid on the geometry.



This method implements the SQL/MM specification. SQL-MM 3: 6.1.2

☒☒: ☒☒

```
SELECT ST_Point( -71.104, 42.315);
```

Creating a point with SRID specified:

```
SELECT ST_Point( -71.104, 42.315, 4326);
```

Alternative way of specifying SRID:

```
SELECT ST_SetSRID( ST_Point( -71.104, 42.315), 4326);
```

☒☒: ☒☒☒

Create **geography** points using the `::` cast syntax:

```
SELECT ST_Point( -71.104, 42.315, 4326)::geography;
```

Pre-PostGIS 3.2 code, using **CAST**:

```
SELECT CAST( ST_SetSRID(ST_Point( -71.104, 42.315), 4326) AS geography);
```

If the point coordinates are not in a geodetic coordinate system (such as WGS84), then they must be reprojected before casting to a geography. In this example a point in Pennsylvania State Plane feet (SRID 2273) is projected to WGS84 (SRID 4326).

```
SELECT ST_Transform( ST_Point( 3637510, 3014852, 2273), 4326)::geography;
```

☒☒

ST_MakePoint, **ST_PointZ**, **ST_PointM**, **ST_PointZM**, **ST_SetSRID**, **ST_Transform**

7.3.9 ST_PointZ

ST_PointZ — Creates a Point with X, Y, Z and SRID values.

Synopsis

geometry **ST_PointZ**(float x, float y, float z, integer srid=unknown);

☒☒

☒☒☒☒☒☒☒☒ ST_Point ☒☒☒☒☒☒☒. ST_MakePoint ☒☒☒☒ OGC ☒☒☒☒☒☒.

Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry.

☒☒

```
SELECT ST_PointZ(-71.104, 42.315, 3.4, 4326)
```

```
SELECT ST_PointZ(-71.104, 42.315, 3.4, srid => 4326)
```

```
SELECT ST_PointZ(-71.104, 42.315, 3.4)
```

☒☒

[ST_MakePoint](#), [ST_PointFromText](#), [ST_SetSRID](#), [ST_MakePointM](#)

7.3.10 ST_PointM

ST_PointM — Creates a Point with X, Y, M and SRID values.

Synopsis

geometry **ST_PointM**(float x, float y, float m, integer srid=unknown);

☒☒

☒☒☒☒☒☒☒☒ ST_Point ☒☒☒☒☒☒☒. ST_MakePoint ☒☒☒☒ OGC ☒☒☒☒☒☒.

Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry.

☒☒

```
SELECT ST_PointM(-71.104, 42.315, 3.4, 4326)
```

```
SELECT ST_PointM(-71.104, 42.315, 3.4, srid => 4326)
```

```
SELECT ST_PointM(-71.104, 42.315, 3.4)
```

☒☒

[ST_MakePoint](#), [ST_PointFromText](#), [ST_SetSRID](#), [ST_MakePointM](#)

7.3.11 ST_PointZM

`ST_PointZM` — Creates a Point with X, Y, Z, M and SRID values.

Synopsis

geometry **ST_PointZM**(float x, float y, float z, float m, integer srid=unknown);

☒☒

☒☒☒☒☒☒☒☒ `ST_Point` ☒☒☒☒☒☒☒. `ST_MakePoint` ☒☒☒☒ OGC ☒☒☒☒☒☒.

Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with `ST_SetSRID` to mark the srid on the geometry.

☒☒

```
SELECT ST_PointZM(-71.104, 42.315, 3.4, 4.5, 4326)
```

```
SELECT ST_PointZM(-71.104, 42.315, 3.4, 4.5, srid => 4326)
```

```
SELECT ST_PointZM(-71.104, 42.315, 3.4, 4.5)
```

☒☒

[ST_MakePoint](#), [ST_Point](#), [ST_PointM](#), [ST_PointZ](#), [ST_SetSRID](#)

7.3.12 ST_Polygon

`ST_Polygon` — Creates a Polygon from a LineString with a specified SRID.

Synopsis

geometry **ST_Polygon**(geometry lineString, integer srid);

☒☒

Returns a polygon built from the given LineString and sets the spatial reference system from the `srid`.

`ST_Polygon` is similar to [ST_MakePolygon](#) Variant 1 with the addition of setting the SRID.

, [ST_MakePoint](#), [ST_SetSRID](#)

**Note**

ST_LineMerge and ST_Dump.

- ✔ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).
- ✔ This method implements the SQL/MM specification. SQL-MM 3: 8.3.2
- ✔ This function supports 3d and will not drop the z-index.

☒

Create a 2D polygon.

```
SELECT ST_AsText( ST_Polygon('LINESTRING(75 29, 77 29, 77 29, 75 29)::geometry, 4326) );
-- result --
POLYGON((75 29, 77 29, 77 29, 75 29))
```

Create a 3D polygon.

```
SELECT ST_AsEWKT( ST_Polygon( ST_GeomFromEWKT('LINESTRING(75 29 1, 77 29 2, 77 29 3, 75 29 1)'), 4326) );
-- result --
SRID=4326;POLYGON((75 29 1, 77 29 2, 77 29 3, 75 29 1))
```

☒

[ST_AsEWKT](#), [ST_AsText](#), [ST_GeomFromEWKT](#), [ST_GeomFromText](#), [ST_LineMerge](#), [ST_MakePolygon](#)

7.3.13 ST_TileEnvelope

ST_TileEnvelope — Creates a rectangular Polygon in [Web Mercator](#) (SRID:3857) using the [XYZ tile system](#).

Synopsis

```
geometry ST_TileEnvelope(integer tileZoom, integer tileX, integer tileY, geometry bounds=SRID=3857;LID=20037508.342789 -20037508.342789,20037508.342789 20037508.342789), float margin=0.0);
```

☒

Creates a rectangular Polygon giving the extent of a tile in the [XYZ tile system](#). The tile is specified by the zoom level Z and the XY index of the tile in the grid at that level. Can be used to define the tile bounds required by [ST_AsMVTGeom](#) to convert geometry into the MVT tile coordinate space.

By default, the tile envelope is in the [Web Mercator](#) coordinate system (SRID:3857) using the standard range of the Web Mercator system (-20037508.342789, 20037508.342789). This is the most common coordinate system used for MVT tiles. The optional bounds parameter can be used to generate tiles in

any coordinate system. It is a geometry that has the SRID and extent of the "Zoom Level zero" square within which the XYZ tile system is inscribed.

The optional `margin` parameter can be used to expand a tile by the given percentage. E.g. `margin=0.125` expands the tile by 12.5%, which is equivalent to `buffer=512` when the tile extent size is 4096, as used in [ST_AsMVTGeom](#). This is useful to create a tile buffer to include data lying outside of the tile's visible area, but whose existence affects the tile rendering. For example, a city name (a point) could be near an edge of a tile, so its label should be rendered on two tiles, even though the point is located in the visible area of just one tile. Using expanded tiles in a query will include the city point in both tiles. Use a negative value to shrink the tile instead. Values less than -0.5 are prohibited because that would eliminate the tile completely. Do not specify a margin when using with `ST_AsMVTGeom`. See the example for [ST_AsMVT](#).

`ST_AsText(ST_TileEnvelope(2, 1, 1))` SRID `4326`.

`2.1.0` `ST_AsText(ST_TileEnvelope(2, 1, 1))`.

`ST_AsText(ST_TileEnvelope(2, 1, 1))`

```
SELECT ST_AsText( ST_TileEnvelope(2, 1, 1) );
```

```
st_astext
```

```
-----  
POLYGON((-10018754.1713945 0,-10018754.1713945 10018754.1713945,0 10018754.1713945,0 ←  
0,-10018754.1713945 0))
```

```
SELECT ST_AsText( ST_TileEnvelope(3, 1, 1, ST_MakeEnvelope(-180, -90, 180, 90, 4326) ) );
```

```
st_astext
```

```
-----  
POLYGON((-135 45,-135 67.5,-90 67.5,-90 45,-135 45))
```

`ST_MakeEnvelope`

[ST_MakeEnvelope](#)

7.3.14 ST_HexagonGrid

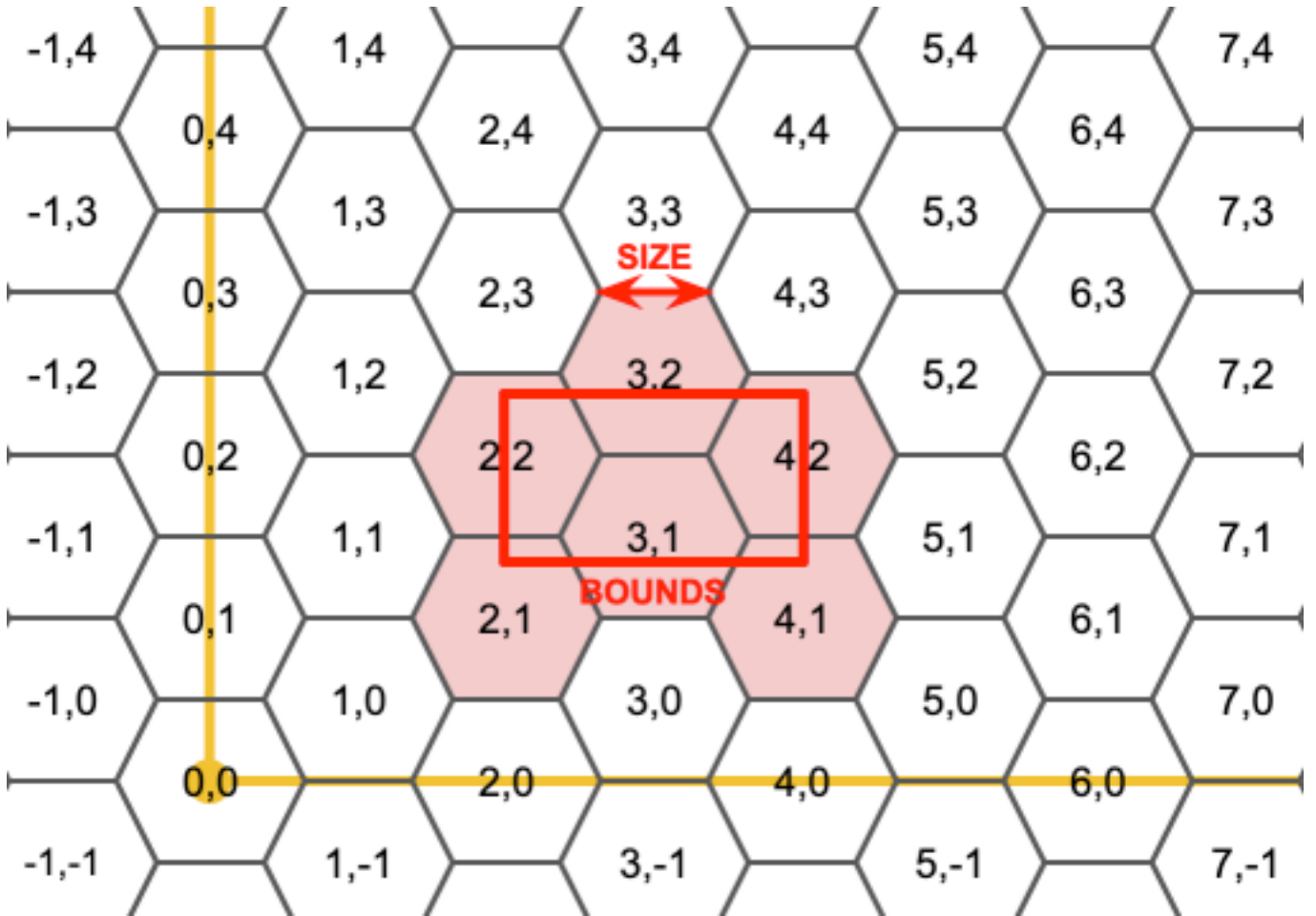
`ST_HexagonGrid` — Returns a set of hexagons and cell indices that completely cover the bounds of the geometry argument.

Synopsis

setof record `ST_HexagonGrid`(float8 size, geometry bounds);

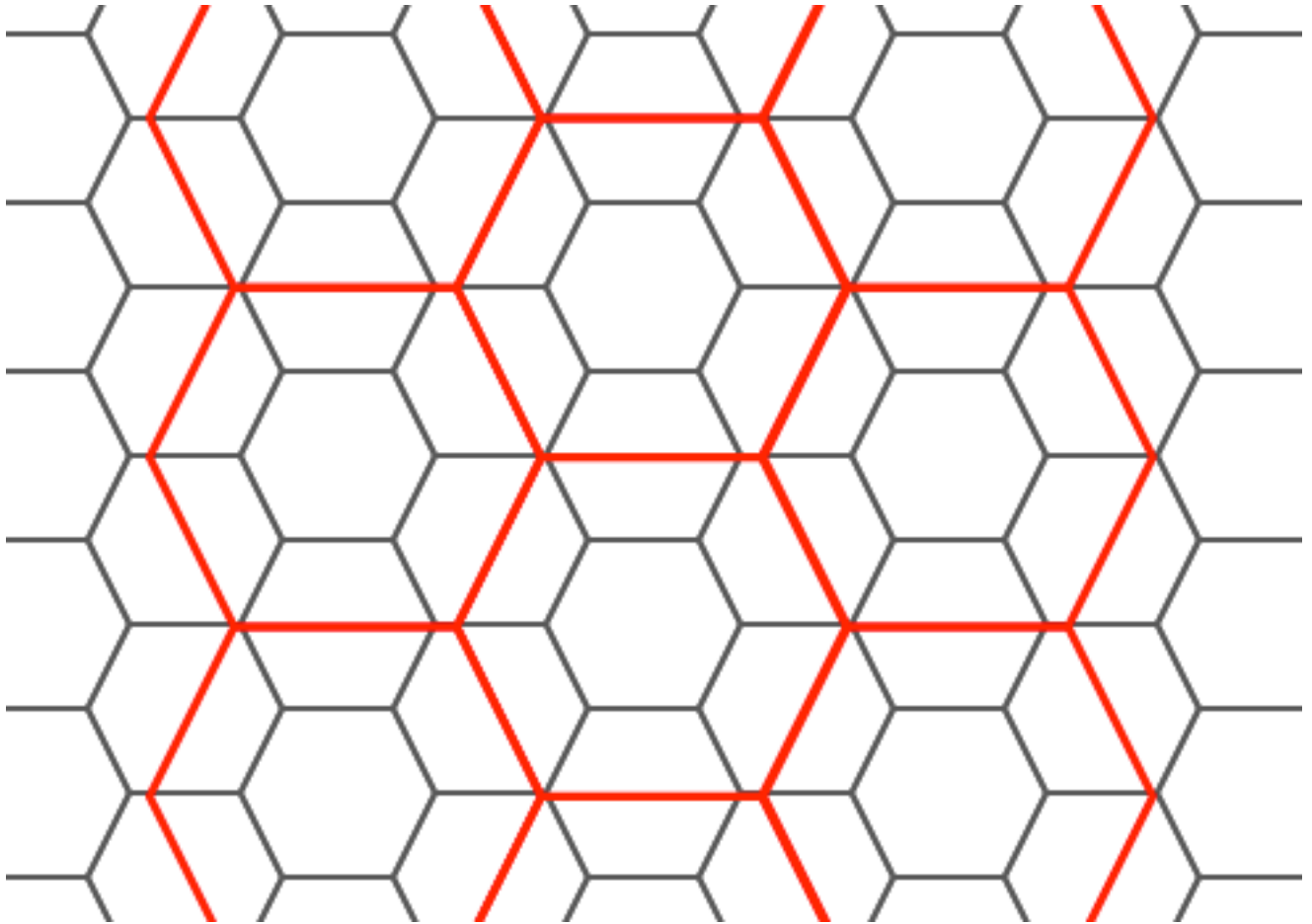
`ST_HexagonGrid`

Starts with the concept of a hexagon tiling of the plane. (Not a hexagon tiling of the globe, this is not the [H3](#) tiling scheme.) For a given planar SRS, and a given edge size, starting at the origin of the SRS, there is one unique hexagonal tiling of the plane, `Tiling(SRS, Size)`. This function answers the question: what hexagons in a given `Tiling(SRS, Size)` overlap with a given bounds.



The SRS for the output hexagons is the SRS provided by the bounds geometry.

Doubling or tripling the edge size of the hexagon generates a new parent tiling that fits with the origin tiling. Unfortunately, it is not possible to generate parent hexagon tilings that the child tiles perfectly fit inside.



2.1.0 ☒☒☒☒☒☒☒☒☒☒.

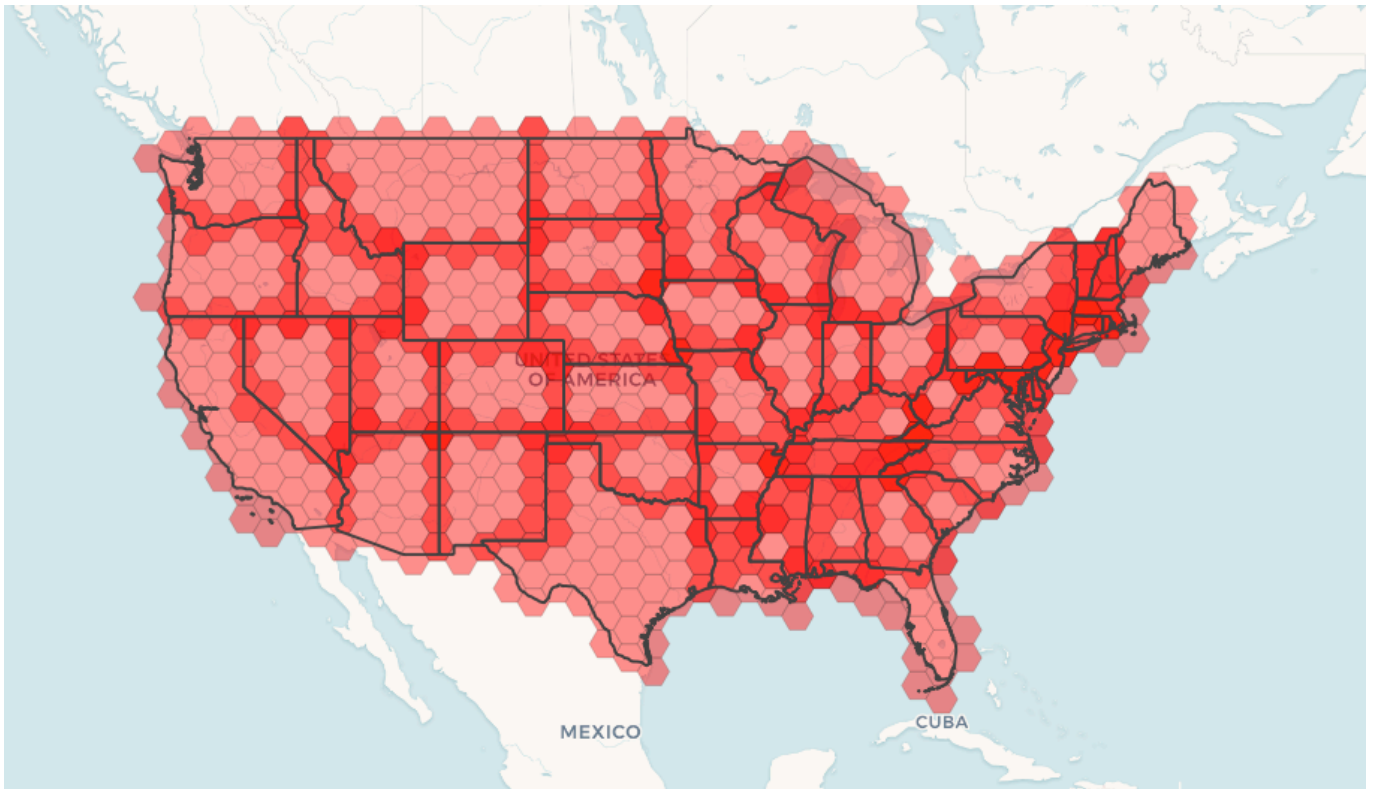
☒☒: ☒☒☒☒☒☒☒☒

To do a point summary against a hexagonal tiling, generate a hexagon grid using the extent of the points as the bounds, then spatially join to that grid.

```
SELECT COUNT(*), hexes.geom
FROM
  ST_HexagonGrid(
    10000,
    ST_SetSRID(ST_EstimatedExtent('pointtable', 'geom'), 3857)
  ) AS hexes
INNER JOIN
  pointtable AS pts
  ON ST_Intersects(pts.geom, hexes.geom)
GROUP BY hexes.geom;
```

☒☒: ☒☒☒☒☒☒☒☒☒☒

If we generate a set of hexagons for each polygon boundary and filter out those that do not intersect their hexagons, we end up with a tiling for each polygon.



Tiling states results in a hexagon coverage of each state, and multiple hexagons overlapping at the borders between states.

**Note**

The LATERAL keyword is implied for set-returning functions when referring to a prior table in the FROM list. So CROSS JOIN LATERAL, CROSS JOIN, or just plain , are equivalent constructs for this example.

```
SELECT admin1.gid, hex.geom
FROM
  admin1
  CROSS JOIN
  ST_HexagonGrid(100000, admin1.geom) AS hex
WHERE
  adm0_a3 = 'USA'
  AND
  ST_Intersects(admin1.geom, hex.geom)
```



[ST_EstimatedExtent](#), [ST_MakePoint](#), [ST_Point](#), [ST_SRID](#)

7.3.15 ST_Hexagon

`ST_Hexagon` — Returns a single hexagon, using the provided edge size and cell coordinate within the hexagon grid space.

Synopsis

geometry **ST_Hexagon**(float8 size, integer cell_i, integer cell_j, geometry origin);

☒☒

Uses the same hexagon tiling concept as [ST_HexagonGrid](#), but generates just one hexagon at the desired cell coordinate. Optionally, can adjust origin coordinate of the tiling, the default origin is at 0,0.

Hexagons are generated with no SRID set, so use [ST_SetSRID](#) to set the SRID to the one you expect.

2.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Example: Creating a hexagon at the origin

```
SELECT ST_AsText(ST_SetSRID(ST_Hexagon(1.0, 0, 0), 3857));

POLYGON((-1 0,-0.5
          -0.866025403784439,0.5
          -0.866025403784439,1
          0,0.5
          0.866025403784439,-0.5
          0.866025403784439,-1 0))
```

☒☒

[ST_TileEnvelope](#), [ST_MakePoint](#), [ST_SetSRID](#)

7.3.16 ST_SquareGrid

ST_SquareGrid — Returns a set of grid squares and cell indices that completely cover the bounds of the geometry argument.

Synopsis

setof record **ST_SquareGrid**(float8 size, geometry bounds);

☒☒

Starts with the concept of a square tiling of the plane. For a given planar SRS, and a given edge size, starting at the origin of the SRS, there is one unique square tiling of the plane, `Tiling(SRS, Size)`. This function answers the question: what grids in a given `Tiling(SRS, Size)` overlap with a given bounds.

The SRS for the output squares is the SRS provided by the bounds geometry.

Doubling or edge size of the square generates a new parent tiling that perfectly fits with the original tiling. Standard web map tilings in mercator are just powers-of-two square grids in the mercator plane.

2.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_Square**(float8 size, integer cell_i, integer cell_j, geometry origin);

☒☒

Uses the same square tiling concept as [ST_SquareGrid](#), but generates just one square at the desired cell coordinate. Optionally, can adjust origin coordinate of the tiling, the default origin is at 0,0.

Squares are generated with no SRID set, so use [ST_SetSRID](#) to set the SRID to the one you expect.

2.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Example: Creating a square at the origin

```
SELECT ST_AsText(ST_SetSRID(ST_Square(1.0, 0, 0), 3857));
POLYGON((0 0,0 1,1 1,1 0,0 0))
```

☒☒

[ST_TileEnvelope](#), [ST_MakeLine](#), [ST_MakePolygon](#)

7.3.18 ST_Letters

ST_Letters — Returns the input letters rendered as geometry with a default start position at the origin and default text height of 100.

Synopsis

geometry **ST_Letters**(text letters, json font);

☒☒

Uses a built-in font to render out a string as a multipolygon geometry. The default text height is 100.0, the distance from the bottom of a descender to the top of a capital. The default start position places the start of the baseline at the origin. Over-riding the font involves passing in a json map, with a character as the key, and base64 encoded TWKB for the font shape, with the fonts having a height of 1000 units from the bottom of the descenders to the tops of the capitals.

The text is generated at the origin by default, so to reposition and resize the text, first apply the [ST_Scale](#) function and then apply the [ST_Translate](#) function.

Availability: 3.3.0

Example: `ST_AsText(ST_Letters('Yo'))`

```
SELECT ST_AsText(ST_Letters('Yo'), 1);
```



Letters generated by ST_Letters

Example: Scaling and moving words

```
SELECT ST_Translate(ST_Scale(ST_Letters('Yo'), 10, 10), 100,100);
```

Example:

`ST_AsTWKB`, `ST_Scale`, `ST_Translate`

7.4 ST_AsText (accessor)

7.4.1 GeometryType

GeometryType — ST_Geometry

Synopsis

```
text GeometryType(geometry geomA);
```

Example:

`ST_AsText(ST_GeometryFromText('LINESTRING(0 0,1 1)'))`. Returns: 'LINESTRING'.

OGC Simple Features for SQL — Part 1, Section 2.1.1.1 - GeometryType, `ST_GeometryFromText`, `ST_GeometryFromText`.



Note

'POINTM' 2D geometry type.

PostGIS 2.0.0 introduced the ST_GeomFromText function to create TIN geometries.

- ✔ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).
- ✔ This method supports Circular Strings and Curves.
- ✔ This function supports 3d and will not drop the z-index.
- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

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
```


7.4.4 ST_CoordDim

ST_CoordDim — ST_Geometry

Synopsis

```
integer ST_CoordDim(geometry geomA);
```

ST_Geometry

MM, **ST_NDims**

- ✔ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).
- ✔ This method implements the SQL/MM specification. SQL-MM 3: 5.1.3
- ✔ This method supports Circular Strings and Curves.
- ✔ This function supports 3d and will not drop the z-index.
- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

```
SELECT ST_CoordDim('CIRCULARSTRING(1 2 3, 1 3 4, 5 6 7, 8 9 10, 11 12 13)');
      ---result--
      3

      SELECT ST_CoordDim(ST_Point(1,2));
      --result--
      2
```

ST_NDims

7.4.5 ST_Dimension

ST_Dimension — ST_Geometry

Synopsis

```
integer ST_Dimension(geometry g);
```




Note

1.3.4 (curve) 1.3.4

- ✔ This method supports Circular Strings and Curves.
- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).
- ✔ This function supports 3d and will not drop the z-index.

Examples

```
SELECT sometable.field1, sometable.field1,
       (ST_Dump(sometable.geom)).geom AS geom
FROM sometable;

-- Break a compound curve into its constituent linestrings and circularstrings
SELECT ST_AsEWKT(a.geom), ST_HasArc(a.geom)
FROM ( SELECT (ST_Dump(p_geom)).geom AS geom
       FROM (SELECT ST_GeomFromEWKT('COMPOUNDCURVE(CIRCULARSTRING(0 0, 1 1, 1 0),(1 0, 0
1))') AS p_geom) AS b
       ) AS a;
       st_asewkt          | st_hasarc
-----+-----
CIRCULARSTRING(0 0,1 1,1 0) | t
LINESTRING(1 0,0 1)         | f
(2 rows)
```

Examples, TIN

```
-- Polyhedral surface example
-- Break a Polyhedral surface into its faces
SELECT (a.p_geom).path[1] As path, ST_AsEWKT((a.p_geom).geom) As geom_ewkt
FROM (SELECT ST_Dump(ST_GeomFromEWKT('POLYHEDRALSURFACE(
((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)), ((1 1 0, 1 1
1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1))
)') ) AS p_geom ) AS a;

path | geom_ewkt
-----+-----
1 | POLYGON((0 0 0,0 0 1,0 1 1,0 1 0,0 0 0))
2 | POLYGON((0 0 0,0 1 0,1 1 0,1 0 0,0 0 0))
3 | POLYGON((0 0 0,1 0 0,1 0 1,0 0 1,0 0 0))
4 | POLYGON((1 1 0,1 1 1,1 0 1,1 0 0,1 1 0))
5 | POLYGON((0 1 0,0 1 1,1 1 1,1 1 0,0 1 0))
6 | POLYGON((0 0 1,1 0 1,1 1 1,0 1 1,0 0 1))
```

```
-- TIN --
SELECT (g.gdump).path, ST_AsEWKT((g.gdump).geom) as wkt
FROM
```


- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).
- ✔ This function supports 3d and will not drop the z-index.

Classic Explode a Table of LineStrings into nodes

```
SELECT edge_id, (dp).path[1] As index, ST_AsText((dp).geom) As wktnode
FROM (SELECT 1 As edge_id
      , ST_DumpPoints(ST_GeomFromText('LINESTRING(1 2, 3 4, 10 10)')) AS dp
      UNION ALL
      SELECT 2 As edge_id
      , ST_DumpPoints(ST_GeomFromText('LINESTRING(3 5, 5 6, 9 10)')) AS dp
      ) As foo;
edge_id | index | wktnode
-----+-----+-----
1 | 1 | POINT(1 2)
1 | 2 | POINT(3 4)
1 | 3 | POINT(10 10)
2 | 1 | POINT(3 5)
2 | 2 | POINT(5 6)
2 | 3 | POINT(9 10)
```

☒☒☒☒



```
SELECT path, ST_AsText(geom)
FROM (
  SELECT (ST_DumpPoints(g.geom)).*
  FROM
    (SELECT
      'GEOMETRYCOLLECTION(
        POINT ( 0 1 ),
        LINESTRING ( 0 3, 3 4 ),
        POLYGON (( 2 0, 2 3, 0 2, 2 0 )),
        POLYGON (( 3 0, 3 3, 6 3, 6 0, 3 0 ),
          ( 5 1, 4 2, 5 2, 5 1 )),
        MULTIPOLYGON (
          (( 0 5, 0 8, 4 8, 4 5, 0 5 ),
           ( 1 6, 3 6, 2 7, 1 6 )),
```

```

        (( 5 4, 5 8, 6 7, 5 4 ))
    )
)>::geometry AS geom
) AS g
) j;

```

path	st_astext
{1,1}	POINT(0 1)
{2,1}	POINT(0 3)
{2,2}	POINT(3 4)
{3,1,1}	POINT(2 0)
{3,1,2}	POINT(2 3)
{3,1,3}	POINT(0 2)
{3,1,4}	POINT(2 0)
{4,1,1}	POINT(3 0)
{4,1,2}	POINT(3 3)
{4,1,3}	POINT(6 3)
{4,1,4}	POINT(6 0)
{4,1,5}	POINT(3 0)
{4,2,1}	POINT(5 1)
{4,2,2}	POINT(4 2)
{4,2,3}	POINT(5 2)
{4,2,4}	POINT(5 1)
{5,1,1,1}	POINT(0 5)
{5,1,1,2}	POINT(0 8)
{5,1,1,3}	POINT(4 8)
{5,1,1,4}	POINT(4 5)
{5,1,1,5}	POINT(0 5)
{5,1,2,1}	POINT(1 6)
{5,1,2,2}	POINT(3 6)
{5,1,2,3}	POINT(2 7)
{5,1,2,4}	POINT(1 6)
{5,2,1,1}	POINT(5 4)
{5,2,1,2}	POINT(5 8)
{5,2,1,3}	POINT(6 7)
{5,2,1,4}	POINT(5 4)

(29 rows)

TIN

```

-- Polyhedral surface cube --
SELECT (g.gdump).path, ST_AsEWKT((g.gdump).geom) as wkt
FROM
  (SELECT
    ST_DumpPoints(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 ←
    0)),
    ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
    ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
    ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )' ) AS gdump
  ) AS g;
-- result --

```

path	wkt
{1,1,1}	POINT(0 0 0)
{1,1,2}	POINT(0 0 1)
{1,1,3}	POINT(0 1 1)
{1,1,4}	POINT(0 1 0)
{1,1,5}	POINT(0 0 0)
{2,1,1}	POINT(0 0 0)


```

{2,1,2} | POINT(0 1 0)
{2,1,3} | POINT(1 1 0)
{2,1,4} | POINT(1 0 0)
{2,1,5} | POINT(0 0 0)
{3,1,1} | POINT(0 0 0)
{3,1,2} | POINT(1 0 0)
{3,1,3} | POINT(1 0 1)
{3,1,4} | POINT(0 0 1)
{3,1,5} | POINT(0 0 0)
{4,1,1} | POINT(1 1 0)
{4,1,2} | POINT(1 1 1)
{4,1,3} | POINT(1 0 1)
{4,1,4} | POINT(1 0 0)
{4,1,5} | POINT(1 1 0)
{5,1,1} | POINT(0 1 0)
{5,1,2} | POINT(0 1 1)
{5,1,3} | POINT(1 1 1)
{5,1,4} | POINT(1 1 0)
{5,1,5} | POINT(0 1 0)
{6,1,1} | POINT(0 0 1)
{6,1,2} | POINT(1 0 1)
{6,1,3} | POINT(1 1 1)
{6,1,4} | POINT(0 1 1)
{6,1,5} | POINT(0 0 1)
(30 rows)

```

```

-- Triangle --
SELECT (g.gdump).path, ST_AsText((g.gdump).geom) as wkt
FROM
  (SELECT
    ST_DumpPoints( ST_GeomFromEWKT('TRIANGLE ((
      0 0,
      0 9,
      9 0,
      0 0
    ))') ) AS gdump
  ) AS g;
-- result --
path | wkt
-----+-----
{1} | POINT(0 0)
{2} | POINT(0 9)
{3} | POINT(9 0)
{4} | POINT(0 0)

```

```

-- TIN --
SELECT (g.gdump).path, ST_AsEWKT((g.gdump).geom) as wkt
FROM
  (SELECT
    ST_DumpPoints( ST_GeomFromEWKT('TIN (((
      0 0 0,
      0 0 1,
      0 1 0,
      0 0 0
    )), ((
      0 0 0,
      0 1 0,
      1 1 0,
      0 0 0
    ))
  )') ) AS gdump

```



```

SELECT path, ST_AsText(geom)
FROM (
  SELECT (ST_DumpSegments(g.geom)).*
  FROM (SELECT 'GEOMETRYCOLLECTION(
  LINESTRING(1 1, 3 3, 4 4),
  POLYGON((5 5, 6 6, 7 7, 5 5))
  )'::geometry AS geom
        ) AS g
) j;

```

path	b'' b''	st_astext
{1,1}	b'' b''	LINESTRING(1 1,3 3)
{1,2}	b'' b''	LINESTRING(3 3,4 4)
{2,1,1}	b'' b''	LINESTRING(5 5,6 6)
{2,1,2}	b'' b''	LINESTRING(6 6,7 7)
{2,1,3}	b'' b''	LINESTRING(7 7,5 5)

(5 rows)

GEOMETRYCOLLECTION, TIN

```

-- Triangle --
SELECT path, ST_AsText(geom)
FROM (
  SELECT (ST_DumpSegments(g.geom)).*
  FROM (SELECT 'TRIANGLE((
    0 0,
    0 9,
    9 0,
    0 0
  ))'::geometry AS geom
        ) AS g
) j;

```

path	b'' b''	st_astext
{1,1}	b'' b''	LINESTRING(0 0,0 9)
{1,2}	b'' b''	LINESTRING(0 9,9 0)
{1,3}	b'' b''	LINESTRING(9 0,0 0)

(3 rows)

```

-- TIN --
SELECT path, ST_AsEWKT(geom)
FROM (
  SELECT (ST_DumpSegments(g.geom)).*
  FROM (SELECT 'TIN(((
    0 0 0,
    0 0 1,
    0 1 0,
    0 0 0
  )), ((
    0 0 0,
    0 1 0,
    1 1 0,
    0 0 0
  )))
  )'::geometry AS geom
        ) AS g
) j;

```


☒☒

```

SELECT ST_AsText(ST_Envelope('POINT(1 3)::geometry'));
  st_astext
-----
POINT(1 3)
(1 row)

SELECT ST_AsText(ST_Envelope('LINESTRING(0 0, 1 3)::geometry'));
  st_astext
-----
POLYGON((0 0,0 3,1 3,1 0,0 0))
(1 row)

SELECT ST_AsText(ST_Envelope('POLYGON((0 0, 0 1, 1.0000001 1, 1.0000001 0, 0 0))::geometry ←
));
  st_astext
-----
POLYGON((0 0,0 1,1.00000011920929 1,1.00000011920929 0,0 0))
(1 row)
SELECT ST_AsText(ST_Envelope('POLYGON((0 0, 0 1, 1.0000000001 1, 1.0000000001 0, 0 0))':: ←
geometry));
  st_astext
-----
POLYGON((0 0,0 1,1.00000011920929 1,1.00000011920929 0,0 0))
(1 row)

SELECT Box3D(geom), Box2D(geom), ST_AsText(ST_Envelope(geom)) As envelopewkt
FROM (SELECT 'POLYGON((0 0, 0 1000012333334.34545678, 1.0000001 1, 1.0000001 0, 0 ←
0))'::geometry As geom) As foo;

```



Envelope of a point and linestring.

```

SELECT ST_AsText(ST_Envelope(
  ST_Collect(
    ST_GeomFromText('LINESTRING(55 75,125 150)'),
    ST_Point(20, 80)
  )
));

```


☒☒☒☒

```
--Extracting a subset of points from a 3d multipoint
SELECT n, ST_AsEWKT(ST_GeometryN(geom, n)) As geomewkt
FROM (
VALUES (ST_GeomFromEWKT('MULTIPOINT((1 2 7), (3 4 7), (5 6 7), (8 9 10))') ),
( ST_GeomFromEWKT('MULTICURVE(CIRCULARSTRING(2.5 2.5,4.5 2.5, 3.5 3.5), (10 11, 12 11))') )
)As foo(geom)
CROSS JOIN generate_series(1,100) n
WHERE n <= ST_NumGeometries(geom);
```

```

n |          geomewkt
---+-----
1 | POINT(1 2 7)
2 | POINT(3 4 7)
3 | POINT(5 6 7)
4 | POINT(8 9 10)
1 | CIRCULARSTRING(2.5 2.5,4.5 2.5,3.5 3.5)
2 | LINESTRING(10 11,12 11)
```

```
--Extracting all geometries (useful when you want to assign an id)
SELECT gid, n, ST_GeometryN(geom, n)
FROM sometable CROSS JOIN generate_series(1,100) n
WHERE n <= ST_NumGeometries(geom);
```

☒☒☒☒☒, TIN ☒☒☒☒☒☒☒

```
-- Polyhedral surface example
-- Break a Polyhedral surface into its faces
SELECT ST_AsEWKT(ST_GeometryN(p_geom,3)) As geom_ewkt
FROM (SELECT ST_GeomFromEWKT('POLYHEDRALSURFACE(
((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1))
)') AS p_geom ) AS a;
```

```

          geom_ewkt
-----
POLYGON((0 0 0,1 0 0,1 0 1,0 0 1,0 0 0))
```

```
-- TIN --
SELECT ST_AsEWKT(ST_GeometryN(geom,2)) as wkt
FROM
(SELECT
ST_GeomFromEWKT('TIN (((
0 0 0,
0 0 1,
0 1 0,
0 0 0
)), ((
0 0 0,
0 1 0,
1 1 0,
0 0 0
)))
```



```
SELECT ST_GeometryType(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0
0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)
),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)
) )'));
--result
ST_PolyhedralSurface
```

```
SELECT ST_GeometryType(geom) as result
FROM
(SELECT
ST_GeomFromEWKT('TIN (((
0 0 0,
0 0 1,
0 1 0,
0 0 0
)), ((
0 0 0,
0 1 0,
1 1 0,
0 0 0
))
)') AS geom
) AS g;
result
-----
ST_Tin
```

☒☒

GeometryType

7.4.15 ST_HasArc

ST_HasArc — Tests if a geometry contains a circular arc

Synopsis

boolean **ST_HasArc**(geometry geomA);

☒☒

☒☒☒☒☒☒☒☒☒☒, ☒☒☒, ☒☒☒☒☒☒☒ TRUE ☒☒☒☒☒☒☒.

1.2.2 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

- ✔ This function supports 3d and will not drop the z-index.
- ✔ This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_HasArc(ST_Collect('LINESTRING(1 2, 3 4, 5 6)', 'CIRCULARSTRING(1 1, 2 3, 4 5, 6 7, 5 6)'));
      st_hasarc
      -
      t
```

☒☒

[ST_CurveToLine](#), [ST_PointN](#)

7.4.16 ST_InteriorRingN

ST_InteriorRingN — Returns the Nth interior ring of a polygon.

Synopsis

geometry **ST_InteriorRingN**(geometry a_polygon, integer n);

☒☒

ST_InteriorRingN returns the Nth interior ring of a polygon. N is an integer (range) from 1 to the number of interior rings. If N is NULL, the function returns NULL.



Note

ST_InteriorRingN returns the Nth interior ring of a polygon. ST_Dump returns all interior rings.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).



This method implements the SQL/MM specification. SQL-MM 3: 8.2.6, 8.3.5



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

☒☒

```
SELECT ST_AsText(ST_InteriorRingN(geom, 1)) As geom
FROM (SELECT ST_BuildArea(
      ST_Collect(ST_Buffer(ST_Point(1,2), 20,3),
      ST_Buffer(ST_Point(1, 2), 10,3))) As geom
      ) as foo;
```

☒☒

[ST_ExteriorRing](#), [ST_M](#), [ST_X](#), [ST_Y](#), [ST_ZMax](#), [ST_ZMin](#)

7.4.17 ST_NumCurves

ST_NumCurves — Return the number of component curves in a CompoundCurve.

Synopsis

integer **ST_NumCurves**(geometry a_compoundcurve);

☒☒

Return the number of component curves in a CompoundCurve, zero for an empty CompoundCurve, or NULL for a non-CompoundCurve input.



This method implements the SQL/MM specification. SQL-MM 3: 8.2.6, 8.3.5



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

☒☒

```
-- Returns 3
SELECT ST_NumCurves('COMPOUNDCURVE(
  (2 2, 2.5 2.5),
  CIRCULARSTRING(2.5 2.5, 4.5 2.5, 3.5 3.5),
  (3.5 3.5, 2.5 4.5, 3 5, 2 2)
)');

-- Returns 0
SELECT ST_NumCurves('COMPOUNDCURVE EMPTY');
```

☒☒

[ST_CurveN](#), [ST_Dump](#), [ST_ExteriorRing](#), [ST_NumInteriorRings](#), [ST_NumGeometries](#)

7.4.18 ST_CurveN

ST_CurveN — Returns the Nth component curve geometry of a CompoundCurve.

Synopsis

geometry **ST_CurveN**(geometry a_compoundcurve, integer index);

☒☒

Returns the Nth component curve geometry of a CompoundCurve. The index starts at 1. Returns NULL if the geometry is not a CompoundCurve or the index is out of range.



This method implements the SQL/MM specification. SQL-MM 3: 8.2.6, 8.3.5



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


```

postgis=# SELECT ST_IsClosed('LINESTRING(0 0, 1 1)::geometry');
 st_isclosed
-----
f
(1 row)

postgis=# SELECT ST_IsClosed('LINESTRING(0 0, 0 1, 1 1, 0 0)::geometry');
 st_isclosed
-----
t
(1 row)

postgis=# SELECT ST_IsClosed('MULTILINESTRING((0 0, 0 1, 1 1, 0 0),(0 0, 1 1))::geometry');
 st_isclosed
-----
f
(1 row)

postgis=# SELECT ST_IsClosed('POINT(0 0)::geometry');
 st_isclosed
-----
t
(1 row)

postgis=# SELECT ST_IsClosed('MULTIPOINT((0 0), (1 1))::geometry');
 st_isclosed
-----
t
(1 row)

```

☒☒☒☒☒☒

```

-- A cube --
SELECT ST_IsClosed(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 ←
1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0) ←
),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1) ←
) )'));

 st_isclosed
-----
t

-- Same as cube but missing a side --
SELECT ST_IsClosed(ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 ←
0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0) ←
),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)) )'));

 st_isclosed
-----
f

```


☒☒

```

SELECT ST_IsEmpty(ST_GeomFromText('GEOMETRYCOLLECTION EMPTY'));
  st_isempty
-----
t
(1 row)

SELECT ST_IsEmpty(ST_GeomFromText('POLYGON EMPTY'));
  st_isempty
-----
t
(1 row)

SELECT ST_IsEmpty(ST_GeomFromText('POLYGON((1 2, 3 4, 5 6, 1 2))'));

  st_isempty
-----
f
(1 row)

SELECT ST_IsEmpty(ST_GeomFromText('POLYGON((1 2, 3 4, 5 6, 1 2)))') = false;
?column?
-----
t
(1 row)

SELECT ST_IsEmpty(ST_GeomFromText('CIRCULARSTRING EMPTY'));
  st_isempty
-----
t
(1 row)

```

7.4.22 ST_IsPolygonCCW

`ST_IsPolygonCCW` — Tests if Polygons have exterior rings oriented counter-clockwise and interior rings oriented clockwise.

Synopsis

boolean **ST_IsPolygonCCW** (geometry geom);

☒☒

Returns true if all polygonal components of the input geometry use a counter-clockwise orientation for their exterior ring, and a clockwise direction for all interior rings.

Returns true if the geometry has no polygonal components.



Note

Closed linestrings are not considered polygonal components, so you would still get a true return by passing a single closed linestring no matter its orientation.

**Note**

If a polygonal geometry does not use reversed orientation for interior rings (i.e., if one or more interior rings are oriented in the same direction as an exterior ring) then both `ST_IsPolygonCW` and `ST_IsPolygonCCW` will return false.

2.2.0



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



This function supports M coordinates.

`ST_ForcePolygonCW` , `ST_ForcePolygonCCW` , `ST_IsPolygonCW`

7.4.23 ST_IsPolygonCW

`ST_IsPolygonCW` — Tests if Polygons have exterior rings oriented clockwise and interior rings oriented counter-clockwise.

Synopsis

boolean `ST_IsPolygonCW` (geometry geom);

Returns true if all polygonal components of the input geometry use a clockwise orientation for their exterior ring, and a counter-clockwise direction for all interior rings.

Returns true if the geometry has no polygonal components.

**Note**

Closed linestrings are not considered polygonal components, so you would still get a true return by passing a single closed linestring no matter its orientation.

**Note**

If a polygonal geometry does not use reversed orientation for interior rings (i.e., if one or more interior rings are oriented in the same direction as an exterior ring) then both `ST_IsPolygonCW` and `ST_IsPolygonCCW` will return false.

2.2.0



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



This function supports M coordinates.

¶¶

¶¶¶ M ¶¶¶¶¶¶¶¶. M ¶¶¶¶¶¶¶ NULL ¶¶¶¶¶. ¶¶¶¶¶¶¶¶¶¶¶¶.



Note

¶¶¶ (¶¶) OGC ¶¶¶¶¶¶¶¶¶¶, ¶¶¶¶¶¶¶¶ (extractor) ¶¶¶¶¶¶¶¶¶¶¶¶¶¶.

- ✔ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).
- ✔ This method implements the SQL/MM specification.
- ✔ This function supports 3d and will not drop the z-index.

¶¶

```
SELECT ST_M(ST_GeomFromEWKT('POINT(1 2 3 4)'));
 st_m
-----
      4
(1 row)
```

¶¶

[ST_GeomFromEWKT](#), [ST_X](#), [ST_Y](#), [ST_Z](#)

7.4.27 ST_MemSize

ST_MemSize — ST_Geometry ¶¶¶¶¶¶¶¶¶¶¶¶.

Synopsis

integer **ST_MemSize**(geometry geomA);

¶¶

ST_Geometry ¶¶¶¶¶¶¶¶¶¶¶¶.

This complements the PostgreSQL built-in [database object functions](#) `pg_column_size`, `pg_size_pretty`, `pg_relation_size`, `pg_total_relation_size`.



Note

`pg_relation_size` which gives the byte size of a table may return byte size lower than `ST_MemSize`. This is because `pg_relation_size` does not add toasted table contribution and large geometries are stored in TOAST tables.

`pg_total_relation_size` ¶¶¶¶¶¶, TOAST ¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶.

`pg_column_size` returns how much space a geometry would take in a column considering compression, so may be lower than `ST_MemSize`

- ✔ This function supports 3d and will not drop the z-index.
- ✔ This method supports Circular Strings and Curves.
- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Changed: 2.2.0 name changed to ST_MemSize to follow naming convention.

☒

```
--Return how much byte space Boston takes up in our Mass data set
SELECT pg_size_pretty(SUM(ST_MemSize(geom))) as totgeomsum,
pg_size_pretty(SUM(CASE WHEN town = 'BOSTON' THEN ST_MemSize(geom) ELSE 0 END)) As bossum,
CAST(SUM(CASE WHEN town = 'BOSTON' THEN ST_MemSize(geom) ELSE 0 END)*1.00 /
      SUM(ST_MemSize(geom))*100 As numeric(10,2)) As perbos
FROM towns;
```

totgeomsum	bossum	perbos
1522 kB	30 kB	1.99

```
SELECT ST_MemSize(ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 150505,220227 150406)'));
---
```

73

```
--What percentage of our table is taken up by just the geometry
SELECT pg_total_relation_size('public.neighborhoods') As fulltable_size, sum(ST_MemSize(geom)) As geomsize,
sum(ST_MemSize(geom))*1.00/pg_total_relation_size('public.neighborhoods')*100 As pergeom
FROM neighborhoods;
fulltable_size geomsize pergeom
-----
262144 96238 36.71188354492187500000
```

7.4.28 ST_NDims

ST_NDims — ST_Geometry

Synopsis

integer **ST_NDims**(geometry g1);

☒

PostGIS 2 - 2 (x,y), 3 - 3 (x,y,z), 3 - 2 (x,y,m), 4 - 3 (x,y,z,m)

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

☒☒

```
--If you have a regular polygon
SELECT gid, field1, field2, ST_NumInteriorRings(geom) AS numholes
FROM sometable;

--If you have multipolygons
--And you want to know the total number of interior rings in the MULTIPOLYGON
SELECT gid, field1, field2, SUM(ST_NumInteriorRings(geom)) AS numholes
FROM (SELECT gid, field1, field2, (ST_Dump(geom)).geom As geom
      FROM sometable) As foo
GROUP BY gid, field1,field2;
```

☒☒

[ST_NumInteriorRing](#), [ST_PointN](#)

7.4.33 ST_NumInteriorRing

`ST_NumInteriorRing` — Returns the number of interior rings in a polygon. `ST_NumInteriorRings` is the preferred name.

Synopsis

integer `ST_NumInteriorRing`(geometry a_polygon);

☒☒

[ST_NumInteriorRings](#), [ST_PointN](#)

7.4.34 ST_NumPatches

`ST_NumPatches` — Returns the number of patches in a geometry. Returns NULL if the geometry is NULL.

Synopsis

integer `ST_NumPatches`(geometry g1);

☒☒

2.0.0 `ST_NumPatches` is deprecated. Use `ST_NumGeometries` instead. `ST_NumGeometries` is the preferred name. `ST_NumGeometries` is the preferred name.

2.0.0 `ST_NumPatches` is deprecated.



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



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).

7.4.36 ST_PatchN

ST_PatchN — ST_Geometry

Synopsis

geometry **ST_PatchN**(geometry geomA, integer n);

POLYHEDRALSURFACE, POLYHEDRALSURFACEM 1- N () . NULL . ST_GeometryN . ST_GeometryN .



Note

1-



Note

ST_Dump

2.0.0

- ✔ This method implements the SQL/MM specification. SQL-MM ISO/IEC 13249-3: 8.5
- ✔ This function supports 3d and will not drop the z-index.
- ✔ This function supports Polyhedral surfaces.

```
--Extract the 2nd face of the polyhedral surface
SELECT ST_AsEWKT(ST_PatchN(geom, 2)) As geomewkt
FROM (
VALUES (ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )') ) ←
As foo(geom);

geomewkt
-----+-----
POLYGON((0 0 0,0 1 0,1 1 0,1 0 0,0 0 0))
```

[ST_AsEWKT](#), [ST_GeomFromEWKT](#), [ST_Dump](#), [ST_GeometryN](#), [ST_NumGeometries](#)

7.4.37 ST_PointN

ST_PointN — ST_LineString ST_CircularString

Synopsis

geometry **ST_PointN**(geometry a_linestring, integer n);

Extracts the Nth point from a linestring. If N is 0, the first point is returned. If N is -1, the last point is returned. If N is NULL, NULL is returned.



Note

0.8.0 implements OGC Simple Features Implementation Specification for SQL 1.1. OGC Simple Features Implementation Specification (SQL/MM) 0-1. Implements 0-1. NULL.



Note

Extracts the Nth point from a linestring, using ST_Dump to extract the points.

- This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).
- This method implements the SQL/MM specification. SQL-MM 3: 7.2.5, 7.3.5
- This function supports 3d and will not drop the z-index.
- This method supports Circular Strings and Curves.



Note

2.0.0: PostGIS 2.0.0 implements OGC Simple Features Implementation Specification for SQL 1.1. 2.0.0 implements OGC Simple Features Implementation Specification (SQL/MM) 0-1. NULL. 2.3.0 implements OGC Simple Features Implementation Specification (-1) 0-1.

```
-- Extract all POINTs from a LINESTRING
SELECT ST_AsText(
  ST_PointN(
    column1,
    generate_series(1, ST_NPoints(column1))
  )
)
FROM ( VALUES ('LINESTRING(0 0, 1 1, 2 2)::geometry' ) AS foo;

st_astext
-----
POINT(0 0)
```


ST_LineString ST_CircularString

```
SELECT ST_AsText(ST_StartPoint('CIRCULARSTRING(5 2,-3 1.999999, -2 1, -4 2, 6 3)')::geometry ←
    );
    st_astext
-----
POINT(5 2)
```

ST_EndPoint, ST_PointN

7.4.40 ST_Summary

ST_Summary —

Synopsis

```
text ST_Summary(geometry g);
text ST_Summary(geography g);
```

Options:
 M: M
 Z: Z
 B: B
 G: G (G) G
 S: S

- M: M
- Z: Z
- B: B
- G: G (G) G
- S: S

- ✓ This method supports Circular Strings and Curves.
- ✓ This function supports Polyhedral surfaces.
- ✓ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

1.2.2

2.0.0

2.1.0

2.2.0 TIN (curve)

☒☒

```

=# SELECT ST_Summary(ST_GeomFromText('LINESTRING(0 0, 1 1)')) as geom,
         ST_Summary(ST_GeogFromText('POLYGON((0 0, 1 1, 1 2, 1 1, 0 0))')) geog;
-----+-----
geom          |          geog
-----+-----
LineString[B] with 2 points | Polygon[BGS] with 1 rings
                        | ring 0 has 5 points
                        |
                        |
(1 row)

=# SELECT ST_Summary(ST_GeogFromText('LINESTRING(0 0 1, 1 1 1)')) As geog_line,
         ST_Summary(ST_GeomFromText('SRID=4326;POLYGON((0 0 1, 1 1 2, 1 2 3, 1 1 1, 0 0 1)) ←
         ') As geom_poly;
;
         geog_line          |          geom_poly
-----+-----
LineString[ZBGS] with 2 points | Polygon[ZBS] with 1 rings
                        | : ring 0 has 5 points
                        | :
                        | :
(1 row)

```

☒☒

[PostGIS_DropBBox](#), [PostGIS_AddBBox](#), [ST_Force3DM](#), [ST_Force3DZ](#), [ST_Force2D](#), [geography](#)
[ST_IsValid](#), [ST_IsValidReason](#), [ST_IsValidDetail](#)

7.4.41 ST_X

ST_X — Returns the X coordinate of a Point.

Synopsis

float **ST_X**(geometry a_point);

☒☒

☒☒☒☒ X ☒☒☒☒☒☒☒☒. X ☒☒☒☒☒☒☒☒ NULL ☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



Note

To get the minimum and maximum X value of geometry coordinates use the functions [ST_XMin](#) and [ST_XMax](#).



This method implements the SQL/MM specification. SQL-MM 3: 6.1.3



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

☒☒

```
SELECT ST_X(ST_GeomFromEWKT('POINT(1 2 3 4)'));
  st_x
-----
      1
(1 row)

SELECT ST_Y(ST_Centroid(ST_GeomFromEWKT('LINESTRING(1 2 3 4, 1 1 1 1)')));
  st_y
-----
    1.5
(1 row)
```

☒☒

[ST_Centroid](#), [ST_GeomFromEWKT](#), [ST_M](#), [ST_XMax](#), [ST_XMin](#), [ST_Y](#), [ST_Z](#)

7.4.42 ST_Y

`ST_Y` — Returns the Y coordinate of a Point.

Synopsis

float **ST_Y**(geometry a_point);

☒☒

☒☒☒☒ Y ☒☒☒☒☒☒☒☒. Y ☒☒☒☒☒☒☒☒ NULL ☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



Note

To get the minimum and maximum Y value of geometry coordinates use the functions [ST_YMin](#) and [ST_YMax](#).



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).



This method implements the SQL/MM specification. SQL-MM 3: 6.1.4



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

☒☒

```
SELECT ST_Y(ST_GeomFromEWKT('POINT(1 2 3 4)'));
  st_y
-----
      2
(1 row)
```

```
SELECT ST_Y(ST_Centroid(ST_GeomFromEWKT('LINESTRING(1 2 3 4, 1 1 1 1)')));
 st_y
-----
 1.5
(1 row)
```

☒☒

[ST_Centroid](#), [ST_GeomFromEWKT](#), [ST_M](#), [ST_X](#), [ST_YMax](#), [ST_YMin](#), [ST_Z](#)

7.4.43 ST_Z

`ST_Z` — Returns the Z coordinate of a Point.

Synopsis

float `ST_Z`(geometry a_point);

☒☒

☒☒☒☒ Z ☒☒☒☒☒☒☒☒. Z ☒☒☒☒☒☒☒☒ NULL ☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



Note

To get the minimum and maximum Z value of geometry coordinates use the functions [ST_ZMin](#) and [ST_ZMax](#).



This method implements the SQL/MM specification.



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

☒☒

```
SELECT ST_Z(ST_GeomFromEWKT('POINT(1 2 3 4)'));
 st_z
-----
      3
(1 row)
```

☒☒

[ST_GeomFromEWKT](#), [ST_M](#), [ST_X](#), [ST_Y](#), [ST_ZMax](#), [ST_ZMin](#)

7.4.44 ST_Zmflag

ST_Zmflag — ST_Geometry

Synopsis

smallint **ST_Zmflag**(geometry geomA);

ST_Geometry

Values are: 0 = 2D, 1 = 3D-M, 2 = 3D-Z, 3 = 4D.



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



This method supports Circular Strings and Curves.

```
SELECT ST_Zmflag(ST_GeomFromEWKT('LINESTRING(1 2, 3 4)'));
st_zmflag
-----
          0

SELECT ST_Zmflag(ST_GeomFromEWKT('LINESTRINGM(1 2 3, 3 4 3)'));
st_zmflag
-----
          1

SELECT ST_Zmflag(ST_GeomFromEWKT('CIRCULARSTRING(1 2 3, 3 4 3, 5 6 3)'));
st_zmflag
-----
          2

SELECT ST_Zmflag(ST_GeomFromEWKT('POINT(1 2 3 4)'));
st_zmflag
-----
          3
```

[ST_CoordDim](#), [ST_NDims](#), [ST_Dimension](#)

7.4.45 ST_HasZ

ST_HasZ — Checks if a geometry has a Z dimension.

Synopsis

boolean **ST_HasZ**(geometry geom);



Checks if the input geometry has a Z dimension and returns a boolean value. If the geometry has a Z dimension, it returns true; otherwise, it returns false.

Geometry objects with a Z dimension typically represent three-dimensional (3D) geometries, while those without it are two-dimensional (2D) geometries.

This function is useful for determining if a geometry has elevation or height information.

Availability: 3.5.0



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



This function supports M coordinates.



```
SELECT ST_HasZ(ST_GeomFromText('POINT(1 2 3)'));
-- result
true
```

```
SELECT ST_HasZ(ST_GeomFromText('LINESTRING(0 0, 1 1)'));
-- result
false
```



[ST_Zmflag](#)

[ST_HasM](#)

7.4.46 ST_HasM

ST_HasM — Checks if a geometry has an M (measure) dimension.

Synopsis

boolean **ST_HasM**(geometry geom);



Checks if the input geometry has an M (measure) dimension and returns a boolean value. If the geometry has an M dimension, it returns true; otherwise, it returns false.

Geometry objects with an M dimension typically represent measurements or additional data associated with spatial features.

This function is useful for determining if a geometry includes measure information.

Availability: 3.5.0



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



This function supports M coordinates.

☒☒

[ST_RemovePoint](#), [ST_SetPoint](#)

7.5.2 ST_CollectionExtract

`ST_CollectionExtract` — Given a geometry collection, returns a multi-geometry containing only elements of a specified type.

Synopsis

geometry **ST_CollectionExtract**(geometry collection);

geometry **ST_CollectionExtract**(geometry collection, integer type);

☒☒

Given a geometry collection, returns a homogeneous multi-geometry.

If the *type* is not specified, returns a multi-geometry containing only geometries of the highest dimension. So polygons are preferred over lines, which are preferred over points.

If the *type* is specified, returns a multi-geometry containing only that type. If there are no sub-geometries of the right type, an EMPTY geometry is returned. Only points, lines and polygons are supported. The type numbers are:

- 1 == POINT
- 2 == LINESTRING
- 3 == POLYGON

For atomic geometry inputs, the geometry is returned unchanged if the input type matches the requested type. Otherwise, the result is an EMPTY geometry of the specified type. If required, these can be converted to multi-geometries using [ST_Multi](#).



Warning

MultiPolygon results are not checked for validity. If the polygon components are adjacent or overlapping the result will be invalid. (For example, this can occur when applying this function to an [ST_Split](#) result.) This situation can be checked with [ST_IsValid](#) and repaired with [ST_MakeValid](#).

1.5.0 ☒☒☒☒☒☒☒☒☒☒.



Note

Prior to 1.5.3 this function returned atomic inputs unchanged, no matter type. In 1.5.3 non-matching single geometries returned a NULL result. In 2.0.0 non-matching single geometries return an EMPTY result of the requested type.

**Warning**

This function does not ensure that the result is valid. In particular, a collection containing adjacent or overlapping Polygons will create an invalid MultiPolygon. This situation can be checked with [ST_IsValid](#) and repaired with [ST_MakeValid](#).

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

Single-element collection converted to an atomic geometry

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(POINT(0 0))'));

  st_astext
  -----
  POINT(0 0)
```

Nested single-element collection converted to an atomic geometry:

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(MULTIPOINT((0 0)))'));

  st_astext
  -----
  POINT(0 0)
```

Collection converted to a multi-geometry:

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(POINT(0 0),POINT(1 1))'));

  st_astext
  -----
  MULTIPOINT((0 0),(1 1))
```

Nested heterogeneous collection flattened to a GeometryCollection:

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION(POINT(0 0), GEOMETRYCOLLECTION ←
  ( LINESTRING(1 1, 2 2))')));

  st_astext
  -----
  GEOMETRYCOLLECTION(POINT(0 0),LINESTRING(1 1,2 2))
```

Collection of Polygons converted to an (invalid) MultiPolygon:

```
SELECT ST_AsText(ST_CollectionHomogenize('GEOMETRYCOLLECTION (POLYGON ((10 50, 50 50, 50 ←
  10, 10 10, 10 50)), POLYGON ((90 50, 90 10, 50 10, 50 50, 90 50))')));

  st_astext
  -----
  MULTIPOLYGON(((10 50,50 50,50 10,10 10,10 50)),((90 50,90 10,50 10,50 50,90 50)))
```

☒☒

[ST_CollectionExtract](#), [ST_Multi](#), [ST_IsValid](#), [ST_MakeValid](#)

7.5.4 ST_CurveToLine

ST_CurveToLine — Converts a geometry containing curves to a linear geometry.

Synopsis

geometry **ST_CurveToLine**(geometry curveGeom, float tolerance, integer tolerance_type, integer flags);

☒☒

Converts a CIRCULAR STRING to regular LINESTRING or CURVEPOLYGON to POLYGON or MULTISURFACE to MULTIPOLYGON. Useful for outputting to devices that can't support CIRCULARSTRING geometry types

Converts a given geometry to a linear geometry. Each curved geometry or segment is converted into a linear approximation using the given `tolerance` and options (32 segments per quadrant and no options by default).

The `tolerance_type` argument determines interpretation of the `tolerance` argument. It can take the following values:

- 0 (default): Tolerance is max segments per quadrant.
- 1: Tolerance is max-deviation of line from curve, in source units.
- 2: Tolerance is max-angle, in radians, between generating radii.

The `flags` argument is a bitfield. 0 by default. Supported bits are:

- 1: Symmetric (orientation independent) output.
- 2: Retain angle, avoids reducing angles (segment lengths) when producing symmetric output. Has no effect when Symmetric flag is off.

Availability: 1.3.0

Enhanced: 2.4.0 added support for max-deviation and max-angle tolerance, and for symmetric output.

Enhanced: 3.0.0 implemented a minimum number of segments per linearized arc to prevent topological collapse.

- ✔ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).
 - ✔ This method implements the SQL/MM specification. SQL-MM 3: 7.1.7
 - ✔ This function supports 3d and will not drop the z-index.
 - ✔ This method supports Circular Strings and Curves.
-

☒☒

```
SELECT ST_AsText(ST_CurveToLine(ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 150505,220227 150406)')));

--Result --
LINESTRING(220268 150415,220269.95064912 150416.539364228,220271.823415575 150418.17258804,220273.613787707 150419.895736857,
220275.317452352 150421.704659462,220276.930305234 150423.594998003,220278.448460847 150425.562198489,
220279.868261823 150427.60152176,220281.186287736 150429.708054909,220282.399363347 150431.876723113,
220283.50456625 150434.10230186,220284.499233914 150436.379429536,220285.380970099 150438.702620341,220286.147650624 150441.066277505,
220286.797428488 150443.464706771,220287.328738321 150445.892130112,220287.740300149 150448.342699654,
220288.031122486 150450.810511759,220288.200504713 150453.289621251,220288.248038775 150455.77405574,
220288.173610157 150458.257830005,220287.977398166 150460.734960415,220287.659875492 150463.199479347,
220287.221807076 150465.64544956,220286.664248262 150468.066978495,220285.988542259 150470.458232479,220285.196316903 150472.81345077,
220284.289480732 150475.126959442,220283.270218395 150477.39318505,220282.140985384 150479.606668057,
220280.90450212 150481.762075989,220279.5637474 150483.85421628,220278.12195122 150485.87804878,
220276.582586992 150487.828697901,220274.949363179 150489.701464356,220273.226214362 150491.491836488,
220271.417291757 150493.195501133,220269.526953216 150494.808354014,220267.559752731 150496.326509628,
220265.520429459 150497.746310603,220263.41389631 150499.064336517,220261.245228106 150500.277412127,
220259.019649359 150501.38261503,220256.742521683 150502.377282695,220254.419330878 150503.259018879,
220252.055673714 150504.025699404,220249.657244448 150504.675477269,220247.229821107 150505.206787101,
220244.779251566 150505.61834893,220242.311439461 150505.909171266,220239.832329968 150506.078553494,
220237.347895479 150506.126087555,220234.864121215 150506.051658938,220232.386990804 150505.855446946,
220229.922471872 150505.537924272,220227.47650166 150505.099855856,220225.054972724 150504.542297043,
220222.663718741 150503.86659104,220220.308500449 150503.074365683,
220217.994991777 150502.167529512,220215.72876617 150501.148267175,
220213.515283163 150500.019034164,220211.35987523 150498.7825509,
220209.267734939 150497.441796181,220207.243902439 150496,
220205.293253319 150494.460635772,220203.420486864 150492.82741196,220201.630114732 150491.104263143,
220199.926450087 150489.295340538,220198.313597205 150487.405001997,220196.795441592 150485.437801511,
220195.375640616 150483.39847824,220194.057614703 150481.291945091,220192.844539092 150479.123276887,220191.739336189 150476.89769814,
220190.744668525 150474.620570464,220189.86293234 150472.297379659,220189.096251815 150469.933722495,
220188.446473951 150467.535293229,220187.915164118 150465.107869888,220187.50360229 150462.657300346,
220187.212779953 150460.189488241,220187.043397726 150457.710378749,220186.995863664 150455.22594426,
220187.070292282 150452.742169995,220187.266504273 150450.265039585,220187.584026947 150447.800520653,
220188.022095363 150445.35455044,220188.579654177 150442.933021505,220189.25536018 150440.541767521,
```

```

220190.047585536 150438.18654923,220190.954421707 150435.873040558,220191.973684044 ←
  150433.60681495,
220193.102917055 150431.393331943,220194.339400319 150429.237924011,220195.680155039 ←
  150427.14578372,220197.12195122 150425.12195122,
220198.661315447 150423.171302099,220200.29453926 150421.298535644,220202.017688077 ←
  150419.508163512,220203.826610682 150417.804498867,
220205.716949223 150416.191645986,220207.684149708 150414.673490372,220209.72347298 ←
  150413.253689397,220211.830006129 150411.935663483,
220213.998674333 150410.722587873,220216.22425308 150409.61738497,220218.501380756 ←
  150408.622717305,220220.824571561 150407.740981121,
220223.188228725 150406.974300596,220225.586657991 150406.324522731,220227 150406)

--3d example
SELECT ST_AsEWKT(ST_CurveToLine(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 ←
  150505 2,220227 150406 3)')));
Output
-----
LINESTRING(220268 150415 1,220269.95064912 150416.539364228 1.0181172856673,
220271.823415575 150418.17258804 1.03623457133459,220273.613787707 150419.895736857 ←
  1.05435185700189,....AD INFINITUM ....
  220225.586657991 150406.324522731 1.32611114201132,220227 150406 3)

--use only 2 segments to approximate quarter circle
SELECT ST_AsText(ST_CurveToLine(ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 ←
  150505,220227 150406)'),2));
st_astext
-----
LINESTRING(220268 150415,220287.740300149 150448.342699654,220278.12195122 ←
  150485.87804878,
220244.779251566 150505.61834893,220207.243902439 150496,220187.50360229 150462.657300346,
220197.12195122 150425.12195122,220227 150406)

-- Ensure approximated line is no further than 20 units away from
-- original curve, and make the result direction-neutral
SELECT ST_AsText(ST_CurveToLine(
  'CIRCULARSTRING(0 0,100 -100,200 0) '::geometry,
  20, -- Tolerance
  1, -- Above is max distance between curve and line
  1 -- Symmetric flag
));
st_astext
-----
LINESTRING(0 0,50 -86.6025403784438,150 -86.6025403784439,200 -1.1331077795296e-13,200 0)

```

☒☒

ST_LineToCurve

7.5.5 ST_Scroll

ST_Scroll — Change start point of a closed LineString.

Synopsis

geometry **ST_Scroll**(geometry linestring, geometry point);

☒☒

Changes the start/end point of a closed LineString to the given vertex *point*.

Availability: 3.2.0



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



This function supports M coordinates.

☒☒

Make e closed line start at its 3rd vertex

```
SELECT ST_AsEWKT(ST_Scroll('SRID=4326;LINESTRING(0 0 0 1, 10 0 2 0, 5 5 4 2,0 0 0 1)', ' ←
    POINT(5 5 4 2)'));
```

```
st_asewkt
```

```
-----
```

```
SRID=4326;LINESTRING(5 5 4 2,0 0 0 1,10 0 2 0,5 5 4 2)
```

☒☒

ST_Normalize

7.5.6 ST_FlipCoordinates

ST_FlipCoordinates — Returns a version of a geometry with X and Y axis flipped.

Synopsis

geometry **ST_FlipCoordinates**(geometry geom);

☒☒

Returns a version of the given geometry with X and Y axis flipped. Useful for fixing geometries which contain coordinates expressed as latitude/longitude (Y,X).

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒.



This method supports Circular Strings and Curves.



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



This function supports M coordinates.



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
SELECT ST_AsEWKT(ST_FlipCoordinates(GeomFromEWKT('POINT(1 2)')));
   st_asewkt
-----
POINT(2 1)
```

☒☒

ST_SwapOrdinates

7.5.7 ST_Force2D

ST_Force2D — ☒☒☒“2 ☒☒☒☒” ☒☒☒☒☒☒.

Synopsis

geometry **ST_Force2D**(geometry geomA);

☒☒

☒☒☒“2 ☒☒☒☒” ☒☒☒☒☒☒☒☒☒☒☒ X ☒ Y ☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒ (OGC ☒☒☒☒ 2 ☒☒☒☒☒☒☒☒☒) OGC ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒ (polyhedral surface) ☒☒☒☒☒☒.

☒☒☒☒: 2.1.0 ☒☒☒☒, ☒ 2.0.x ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ ST_Force_2D ☒☒☒☒.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.



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

☒☒

```
SELECT ST_AsEWKT(ST_Force2D(ST_GeomFromEWKT('CIRCULARSTRING(1 1 2, 2 3 2, 4 5 2, 6 7 2, 5 6 2)')));
   st_asewkt
-----
CIRCULARSTRING(1 1,2 3,4 5,6 7,5 6)

SELECT ST_AsEWKT(ST_Force2D('POLYGON((0 0 2,0 5 2,5 0 2,0 0 2),(1 1 2,3 1 2,1 3 2,1 1 2))'));
   st_asewkt
-----
POLYGON((0 0,0 5,5 0,0 0),(1 1,3 1,1 3,1 1))
```


- ✔ This function supports 3d and will not drop the z-index.
- ✔ This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_AsText(
  ST_ForceCurve(
    'POLYGON((0 0 2, 5 0 2, 0 5 2, 0 0 2),(1 1 2, 1 3 2, 3 1 2, 1 1 2))'::geometry
  )
);
           st_astext
-----
CURVEPOLYGON Z ((0 0 2,5 0 2,0 5 2,0 0 2),(1 1 2,1 3 2,3 1 2,1 1 2))
(1 row)
```

☒☒

[ST_LineToCurve](#)

7.5.14 ST_ForcePolygonCCW

`ST_ForcePolygonCCW` — Orients all exterior rings counter-clockwise and all interior rings clockwise.

Synopsis

geometry **ST_ForcePolygonCCW** (geometry geom);

☒☒

Forces (Multi)Polygons to use a counter-clockwise orientation for their exterior ring, and a clockwise orientation for their interior rings. Non-polygonal geometries are returned unchanged.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

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

☒☒

[ST_ForcePolygonCW](#) , [ST_IsPolygonCCW](#) , [ST_IsPolygonCW](#)

7.5.15 ST_ForcePolygonCW

`ST_ForcePolygonCW` — Orients all exterior rings clockwise and all interior rings counter-clockwise.

Synopsis

geometry **ST_ForcePolygonCW** (geometry geom);

☒☒

Forces (Multi)Polygons to use a clockwise orientation for their exterior ring, and a counter-clockwise orientation for their interior rings. Non-polygonal geometries are returned unchanged.

2.2.0 ☒☒☒☒☒☒☒☒☒☒.

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

☒☒

ST_ForcePolygonCCW , **ST_IsPolygonCCW** , **ST_IsPolygonCW**

7.5.16 ST_ForceSFS

ST_ForceSFS — ☒☒☒ SFS 1.1 ☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_ForceSFS**(geometry geomA);
 geometry **ST_ForceSFS**(geometry geomA, text version);

☒☒

- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).
- ✔ This method supports Circular Strings and Curves.
- ✔ This function supports 3d and will not drop the z-index.

7.5.17 ST_ForceRHR

ST_ForceRHR — ☒☒☒☒☒☒☒☒☒☒☒☒☒ (orientation) ☒☒☒☒☒☒ (Right-Hand Rule) ☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_ForceRHR**(geometry g);

☒☒

Forces the orientation of the vertices in a polygon to follow a Right-Hand-Rule, in which the area that is bounded by the polygon is to the right of the boundary. In particular, the exterior ring is orientated in a clockwise direction and the interior rings in a counter-clockwise direction. This function is a synonym for [ST_ForcePolygonCW](#)

Note!

Note

The above definition of the Right-Hand-Rule conflicts with definitions used in other contexts. To avoid confusion, it is recommended to use [ST_ForcePolygonCW](#).

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒ (polyhedral surface) ☒☒☒☒☒☒☒.



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



This function supports Polyhedral surfaces.

☒☒

```
SELECT ST_AsEWKT(
  ST_ForceRHR(
    'POLYGON((0 0 2, 5 0 2, 0 5 2, 0 0 2),(1 1 2, 1 3 2, 3 1 2, 1 1 2))'
  )
);
```

	st_asewkt

POLYGON((0 0 2,0 5 2,5 0 2,0 0 2),(1 1 2,3 1 2,1 3 2,1 1 2))	
(1 row)	

☒☒

[ST_ForcePolygonCCW](#) , [ST_ForcePolygonCW](#) , [ST_IsPolygonCCW](#) , [ST_IsPolygonCW](#) , [ST_BuildArea](#), [ST_Polygonize](#), [ST_Reverse](#)

7.5.18 ST_LineExtend

[ST_LineExtend](#) — Returns a line extended forwards and backwards by specified distances.

Synopsis

geometry **ST_LineExtend**(geometry line, float distance_forward, float distance_backward=0.0);

☒☒

Returns a line extended forwards and backwards by adding new start (and end) points at the given distance(s). A distance of zero does not add a point. Only non-negative distances are allowed. The direction(s) of the added point(s) is determined by the first (and last) two distinct points of the line. Duplicate points are ignored.

Availability: 3.4.0

7.5.22 ST_Project

ST_Project — Returns a point projected from a start point by a distance and bearing (azimuth).

Synopsis

```
geometry ST_Project(geometry g1, float distance, float azimuth);
geometry ST_Project(geometry g1, geometry g2, float distance);
geography ST_Project(geography g1, float distance, float azimuth);
geography ST_Project(geography g1, geography g2, float distance);
```

☒☒

Returns a point projected from a point along a geodesic using a given distance and azimuth (bearing). This is known as the direct geodesic problem.

The two-point version uses the path from the first to the second point to implicitly define the azimuth and uses the distance as before.

The distance is given in meters. Negative values are supported.

The azimuth (also known as heading or bearing) is given in radians. It is measured clockwise from true north.

- North is azimuth zero (0 degrees)
- East is azimuth $\pi/2$ (90 degrees)
- South is azimuth π (180 degrees)
- West is azimuth $3\pi/2$ (270 degrees)

Negative azimuth values and values greater than 2π (360 degrees) are supported.

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Enhanced: 2.4.0 Allow negative distance and non-normalized azimuth.

Enhanced: 3.4.0 Allow geometry arguments and two-point form omitting azimuth.

Example: Projected point at 100,000 meters and bearing 45 degrees

```
SELECT ST_AsText(ST_Project('POINT(0 0)::geography, 100000, radians(45.0)));
-----
POINT(0.635231029125537 0.639472334729198)
```

☒☒

[ST_Azimuth](#), [ST_Distance](#), [PostgreSQL function radians\(\)](#)

7.5.23 ST_QuantizeCoordinates

ST_QuantizeCoordinates — Sets least significant bits of coordinates to zero

Synopsis

```
geometry ST_QuantizeCoordinates ( geometry g , int prec_x , int prec_y , int prec_z , int prec_m );
```

☒☒

`ST_QuantizeCoordinates` determines the number of bits (N) required to represent a coordinate value with a specified number of digits after the decimal point, and then sets all but the N most significant bits to zero. The resulting coordinate value will still round to the original value, but will have improved compressibility. This can result in a significant disk usage reduction provided that the geometry column is using a **compressible storage type**. The function allows specification of a different number of digits after the decimal point in each dimension; unspecified dimensions are assumed to have the precision of the x dimension. Negative digits are interpreted to refer digits to the left of the decimal point, (i.e., `prec_x=-2` will preserve coordinate values to the nearest 100.

The coordinates produced by `ST_QuantizeCoordinates` are independent of the geometry that contains those coordinates and the relative position of those coordinates within the geometry. As a result, existing topological relationships between geometries are unaffected by use of this function. The function may produce invalid geometry when it is called with a number of digits lower than the intrinsic precision of the geometry.

Availability: 2.5.0

Technical Background

PostGIS stores all coordinate values as double-precision floating point integers, which can reliably represent 15 significant digits. However, PostGIS may be used to manage data that intrinsically has fewer than 15 significant digits. An example is TIGER data, which is provided as geographic coordinates with six digits of precision after the decimal point (thus requiring only nine significant digits of longitude and eight significant digits of latitude.)

When 15 significant digits are available, there are many possible representations of a number with 9 significant digits. A double precision floating point number uses 52 explicit bits to represent the significand (mantissa) of the coordinate. Only 30 bits are needed to represent a mantissa with 9 significant digits, leaving 22 insignificant bits; we can set their value to anything we like and still end up with a number that rounds to our input value. For example, the value 100.123456 can be represented by the floating point numbers closest to 100.123456000000, 100.123456000001, and 100.123456432199. All are equally valid, in that `ST_AsText(geom, 6)` will return the same result with any of these inputs. As we can set these bits to any value, `ST_QuantizeCoordinates` sets the 22 insignificant bits to zero. For a long coordinate sequence this creates a pattern of blocks of consecutive zeros that is compressed by PostgreSQL more efficiently.



Note

Only the on-disk size of the geometry is potentially affected by `ST_QuantizeCoordinates`. `ST_MemSize`, which reports the in-memory usage of the geometry, will return the the same value regardless of the disk space used by a geometry.

☒☒

```
SELECT ST_AsText(ST_QuantizeCoordinates('POINT (100.123456 0)::geometry, 4));
st_astext
-----
POINT(100.123455047607 0)
```

```
WITH test AS (SELECT 'POINT (123.456789123456 123.456789123456)::geometry AS geom)
SELECT
  digits,
  encode(ST_QuantizeCoordinates(geom, digits), 'hex'),
  ST_AsText(ST_QuantizeCoordinates(geom, digits))
FROM test, generate_series(15, -15, -1) AS digits;
```

digits	encode	st_astext
15	010100000005f9a72083cdd5e405f9a72083cdd5e40	POINT(123.456789123456 123.456789123456) ↔
14	010100000005f9a72083cdd5e405f9a72083cdd5e40	POINT(123.456789123456 123.456789123456) ↔
13	010100000005f9a72083cdd5e405f9a72083cdd5e40	POINT(123.456789123456 123.456789123456) ↔
12	010100000005c9a72083cdd5e405c9a72083cdd5e40	POINT(123.456789123456 123.456789123456) ↔
11	01010000000409a72083cdd5e40409a72083cdd5e40	POINT(123.456789123456 123.456789123456) ↔
10	0101000000009a72083cdd5e40009a72083cdd5e40	POINT(123.456789123455 123.456789123455) ↔
9	0101000000009072083cdd5e40009072083cdd5e40	POINT(123.456789123418 123.456789123418) ↔
8	0101000000008072083cdd5e40008072083cdd5e40	POINT(123.45678912336 123.45678912336) ↔
7	0101000000000070083cdd5e40000070083cdd5e40	POINT(123.456789121032 123.456789121032) ↔
6	0101000000000040083cdd5e40000040083cdd5e40	POINT(123.456789076328 123.456789076328) ↔
5	01010000000000083cdd5e4000000083cdd5e40	POINT(123.456789016724 123.456789016724) ↔
4	01010000000000003cdd5e4000000003cdd5e40	POINT(123.456787109375 123.456787109375) ↔
3	010100000000000003cdd5e40000000003cdd5e40	POINT(123.456787109375 123.456787109375) ↔
2	01010000000000000038dd5e40000000038dd5e40	POINT(123.45654296875 123.45654296875) ↔
1	010100000000000000dd5e40000000000dd5e40	POINT(123.453125 123.453125) ↔
0	010100000000000000dc5e4000000000dc5e40	POINT(123.4375 123.4375) ↔
-1	010100000000000000c05e4000000000c05e40	POINT(123 123) ↔
-2	01010000000000000005e4000000000005e40	POINT(120 120) ↔
-3	0101000000000000000584000000000005840	POINT(96 96) ↔
-4	0101000000000000000584000000000005840	POINT(96 96) ↔
-5	0101000000000000000584000000000005840	POINT(96 96) ↔
-6	0101000000000000000584000000000005840	POINT(96 96) ↔
-7	0101000000000000000584000000000005840	POINT(96 96) ↔
-8	0101000000000000000584000000000005840	POINT(96 96) ↔
-9	0101000000000000000584000000000005840	POINT(96 96) ↔
-10	0101000000000000000584000000000005840	POINT(96 96) ↔
-11	0101000000000000000584000000000005840	POINT(96 96) ↔
-12	0101000000000000000584000000000005840	POINT(96 96) ↔
-13	0101000000000000000584000000000005840	POINT(96 96) ↔
-14	0101000000000000000584000000000005840	POINT(96 96) ↔
-15	0101000000000000000584000000000005840	POINT(96 96) ↔



ST_SnapToGrid

7.5.24 ST_RemovePoint

ST_RemovePoint — Remove a point from a linestring.

Synopsis

geometry **ST_RemovePoint**(geometry linestring, integer offset);

☒☒

Removes a point from a LineString, given its index (0-based). Useful for turning a closed line (ring) into an open linestring.

Enhanced: 3.2.0

1.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



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

☒☒

Guarantees no lines are closed by removing the end point of closed lines (rings). Assumes geom is of type LINESTRING

```
UPDATE sometable
  SET geom = ST_RemovePoint(geom, ST_NPoints(geom) - 1)
  FROM sometable
  WHERE ST_IsClosed(geom);
```

☒☒

[ST_AddPoint](#), [ST_NPoints](#), [ST_NumPoints](#)

7.5.25 ST_RemoveRepeatedPoints

ST_RemoveRepeatedPoints — Returns a version of a geometry with duplicate points removed.

Synopsis

geometry **ST_RemoveRepeatedPoints**(geometry geom, float8 tolerance);

☒☒

Returns a version of the given geometry with duplicate consecutive points removed. The function processes only (Multi)LineStrings, (Multi)Polygons and MultiPoints but it can be called with any kind of geometry. Elements of GeometryCollections are processed individually. The endpoints of LineStrings are preserved.

If the *tolerance* parameter is provided, vertices within the tolerance distance of one another are considered to be duplicates.

Enhanced: 3.2.0

2.2.0

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

```
SELECT ST_AsText( ST_RemoveRepeatedPoints( 'MULTIPOINT ((1 1), (2 2), (3 3), (2 2))' ));
-----
MULTIPOINT(1 1,2 2,3 3)
```

```
SELECT ST_AsText( ST_RemoveRepeatedPoints( 'LINESTRING (0 0, 0 0, 1 1, 0 0, 1 1, 2 2)' ));
-----
LINESTRING(0 0,1 1,0 0,1 1,2 2)
```

Example: Collection elements are processed individually.

```
SELECT ST_AsText( ST_RemoveRepeatedPoints( 'GEOMETRYCOLLECTION (LINESTRING (1 1, 2 2, 2 2, 3 3), POINT (4 4), POINT (4 4), POINT (5 5))' ));
-----
GEOMETRYCOLLECTION(LINESTRING(1 1,2 2,3 3),POINT(4 4),POINT(4 4),POINT(5 5))
```

Example: Repeated point removal with a distance tolerance.

```
SELECT ST_AsText( ST_RemoveRepeatedPoints( 'LINESTRING (0 0, 0 0, 1 1, 5 5, 1 1, 2 2)', 2) );
-----
LINESTRING(0 0,5 5,2 2)
```

[ST_Simplify](#)

7.5.26 ST_RemoveIrrelevantPointsForView

`ST_RemoveIrrelevantPointsForView` — Removes points that are irrelevant for rendering a specific rectangular view of a geometry.

Synopsis

geometry **ST_RemoveIrrelevantPointsForView**(geometry geom, box2d bounds);

Returns a **geometry** without points being irrelevant for rendering the geometry within a given rectangular view.

This function can be used to quickly preprocess geometries that should be rendered only within certain bounds.

Only geometries of type (MULTI)POLYGON and (MULTI)LINESTRING are evaluated. Other geometries keep unchanged.

In contrast to `ST_ClipByBox2D()` this function

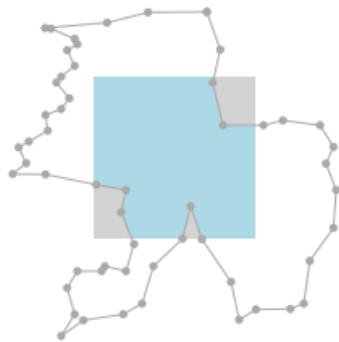
- sorts out points without computing new intersection points which avoids rounding errors and usually increases performance,
- returns a geometry with equal or similar point number,
- leads to the same rendering result within the specified view, and
- may introduce self-intersections which would make the resulting geometry invalid (see example below).



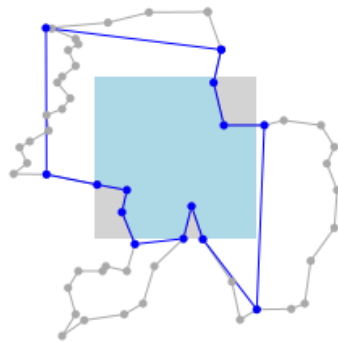
Warning

For polygons, this function does currently not ensure that the result is valid. This situation can be checked with `ST_IsValid` and repaired with `ST_MakeValid`.

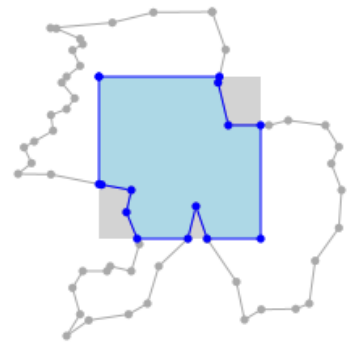
original
55 points



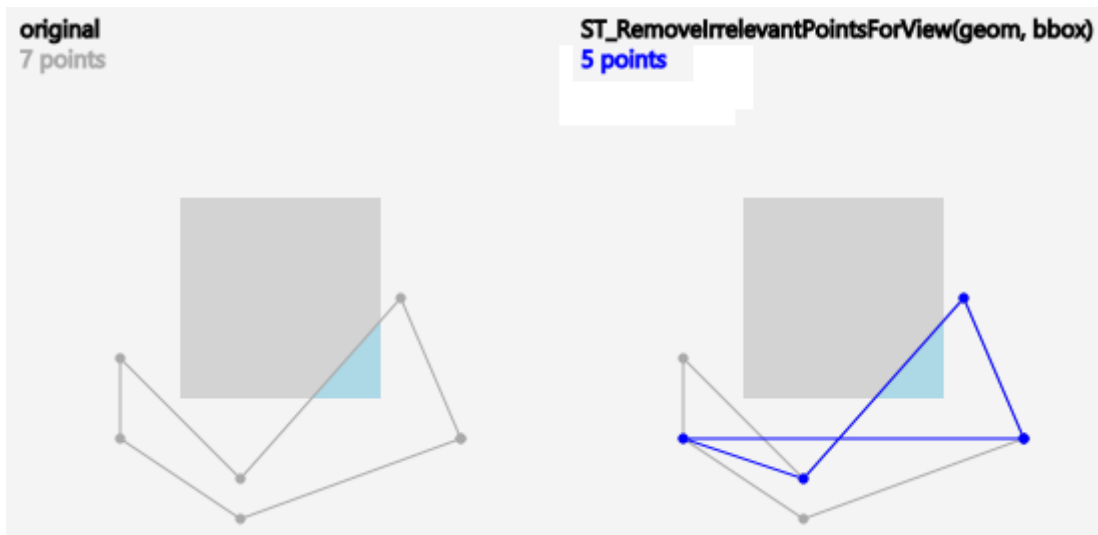
`ST_RemoveIrrelevantPointsForView(geom, bbox)`
15 points



`ST_ClipByBox2D(geom, bbox)`
15 points



Example: `ST_RemoveIrrelevantPointsForView()` applied to a polygon. Blue points remain, the rendering result (light-blue area) within the grey view box remains as well.



Example: Due to the fact that points are just sorted out and no new points are computed, the result of `ST_RemoveIrrelevantPointsForView()` may contain self-intersections.

Availability: 3.5.0

☒☒

```
SELECT ST_AsText(
    ST_RemoveIrrelevantPointsForView(
        ST_GeomFromText('MULTIPOLYGON(((10 10, 20 10, 30 10, 40 10, 20 20, ←
            10 20, 10 10)),((10 10, 20 10, 20 20, 10 20, 10 10)))'),
        ST_MakeEnvelope(12,12,18,18));

    st_astext
    -----
    MULTIPOLYGON(((10 10,40 10,20 20,10 20,10 10)),((10 10,20 10,20 20,10 ←
        20,10 10)))
```

```
SELECT ST_AsText(
    ST_RemoveIrrelevantPointsForView(
        ST_GeomFromText('MULTILINESTRING((0 0, 10 0,20 0,30 0), (0 15, 5 ←
            15, 10 15, 15 15, 20 15, 25 15, 30 15, 40 15), (13 13,15 15,17 ←
            17))'),
        ST_MakeEnvelope(12,12,18,18));

    st_astext
    -----
    MULTILINESTRING((10 15,15 15,20 15),(13 13,15 15,17 17))
```

```
SELECT ST_AsText(
    ST_RemoveIrrelevantPointsForView(
        ST_GeomFromText('LINESTRING(0 0, 10 0,20 0,30 0)'),
        ST_MakeEnvelope(12,12,18,18));

    st_astext
    -----
    LINESTRING EMPTY
```

☒☒

[ST_ClipByBox2D](#), [ST_Intersection](#)

7.5.27 ST_RemoveSmallParts

`ST_RemoveSmallParts` — Removes small parts (polygon rings or linestrings) of a geometry.

Synopsis

`geometry` **ST_RemoveSmallParts**(`geometry geom`, double precision `minSizeX`, double precision `minSizeY`);

☒☒

Returns a [geometry](#) without small parts (exterior or interior polygon rings, or linestrings).

This function can be used as preprocessing step for creating simplified maps, e. g. to remove small islands or holes.

It evaluates only geometries of type (MULTI)POLYGON and (MULTI)LINESTRING. Other geometries remain unchanged.

If *minSizeX* is greater than 0, parts are sorted out if their width is smaller than *minSizeX*.

If *minSizeY* is greater than 0, parts are sorted out if their height is smaller than *minSizeY*.

Both *minSizeX* and *minSizeY* are measured in coordinate system units of the geometry.

For polygon types, evaluation is done separately for each ring which can lead to one of the following results:

- the original geometry,
- a POLYGON with all rings with less vertices,
- a POLYGON with a reduced number of interior rings (having possibly less vertices),
- a POLYGON EMPTY, or
- a MULTIPOLYGON with a reduced number of polygons (having possibly less interior rings or vertices), or
- a MULTIPOLYGON EMPTY.

For linestring types, evaluation is done for each linestring which can lead to one of the following results:

- the original geometry,
- a LINESTRING with a reduced number of vertices,
- a LINESTRING EMPTY,
- a MULTILINESTRING with a reduced number of linestrings (having possibly less vertices), or
- a MULTILINESTRING EMPTY.

original
20 points, 4 parts



ST_RemoveSmallParts(geom, 30,30)
15 points, 3 parts



ST_RemoveSmallParts(geom, 50,50)
10 points, 2 parts




Example: ST_RemoveSmallParts() applied to a multi-polygon. Blue parts remain.

Availability: 3.5.0

1.1.0

2.3.0

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



```
--Change first point in line string from -1 3 to -1 1
SELECT ST_AsText(ST_SetPoint('LINESTRING(-1 2,-1 3)', 0, 'POINT(-1 1)'));
      st_astext
-----
LINESTRING(-1 1,-1 3)

---Change last point in a line string (lets play with 3d linestring this time)
SELECT ST_AsEWKT(ST_SetPoint(foo.geom, ST_NumPoints(foo.geom) - 1, ST_GeomFromEWKT('POINT ↵
(-1 1 3)'))))
FROM (SELECT ST_GeomFromEWKT('LINESTRING(-1 2 3,-1 3 4, 5 6 7)') As geom) As foo;
      st_asewkt
-----
LINESTRING(-1 2 3,-1 3 4,-1 1 3)

SELECT ST_AsText(ST_SetPoint(g, -3, p))
FROM ST_GeomFromText('LINESTRING(0 0, 1 1, 2 2, 3 3, 4 4)') AS g
      , ST_PointN(g,1) as p;
      st_astext
-----
LINESTRING(0 0,1 1,0 0,3 3,4 4)
```



[ST_AddPoint](#), [ST_NPoints](#), [ST_NumPoints](#), [ST_PointN](#), [ST_RemovePoint](#)

7.5.31 ST_ShiftLongitude

ST_ShiftLongitude — Shifts the longitude coordinates of a geometry between -180..180 and 0..360.

Synopsis

geometry **ST_ShiftLongitude**(geometry geom);



Reads every point/vertex in a geometry, and shifts its longitude coordinate from -180..0 to 180..360 and vice versa if between these ranges. This function is symmetrical so the result is a 0..360 representation of a -180..180 data and a -180..180 representation of a 0..360 data.



Note

This is only useful for data with coordinates in longitude/latitude; e.g. SRID 4326 (WGS 84 geographic)



Warning

1.3.4. This function will drop the z-index. 1.3.4. This function will drop the z-index.



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

2.0.0: (polyhedral surface) TIN.

2.2.0: "ST_Shift_Longitude".



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

```
--single point forward transformation
SELECT ST_AsText(ST_ShiftLongitude('SRID=4326;POINT(270 0)::geometry))

st_astext
-----
POINT(-90 0)

--single point reverse transformation
SELECT ST_AsText(ST_ShiftLongitude('SRID=4326;POINT(-90 0)::geometry))

st_astext
-----
POINT(270 0)

--for linestrings the functions affects only to the sufficient coordinates
SELECT ST_AsText(ST_ShiftLongitude('SRID=4326;LINESTRING(174 12, 182 13)::geometry))

st_astext
-----
LINESTRING(174 12, -178 13)
```

ST_WrapX

7.5.32 ST_WrapX

ST_WrapX — X.

Synopsis

geometry **ST_WrapX**(geometry geom, float8 wrap, float8 move);



Note

(ST_IsSimple).



Note

1.1.0 2 . 1.1.0 , , , .

1.0.0RC1 .

1.1.0 Z M .



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

```
--Snap your geometries to a precision grid of 10^-3
UPDATE mytable
  SET geom = ST_SnapToGrid(geom, 0.001);

SELECT ST_AsText(ST_SnapToGrid(
  ST_GeomFromText('LINESTRING(1.1115678 2.123, 4.111111 3.2374897,
    4.11112 3.23748667)'),
  0.001)
  );
      st_astext
-----
LINESTRING(1.112 2.123,4.111 3.237)
--Snap a 4d geometry
SELECT ST_AsEWKT(ST_SnapToGrid(
  ST_GeomFromEWKT('LINESTRING(-1.1115678 2.123 2.3456 1.11111,
    4.111111 3.2374897 3.1234 1.1111, -1.11111112 2.123 2.3456 1.111112)'),
  ST_GeomFromEWKT('POINT(1.12 2.22 3.2 4.4444)'),
  0.1, 0.1, 0.1, 0.01) );
      st_asewkt
-----
LINESTRING(-1.08 2.12 2.3 1.1144,4.12 3.22 3.1 1.1144,-1.08 2.12 2.3 1.1144)

--With a 4d geometry - the ST_SnapToGrid(geom,size) only touches x and y coords but keeps m
  and z the same
SELECT ST_AsEWKT(ST_SnapToGrid(ST_GeomFromEWKT('LINESTRING(-1.1115678 2.123 3 2.3456,
  4.111111 3.2374897 3.1234 1.1111)'),
  0.01) );
      st_asewkt
-----
LINESTRING(-1.11 2.12 3 2.3456,4.11 3.24 3.1234 1.1111)
```

[ST_Snap](#), [ST_AsEWKT](#), [ST_AsText](#), [ST_GeomFromText](#), [ST_GeomFromEWKT](#), [ST_Simplify](#)

7.5.34 ST_Snap

ST_Snap — 将几何体中的顶点和段对齐到另一个几何体的顶点。

Synopsis

geometry **ST_Snap**(geometry input, geometry reference, float tolerance);

返回

Snaps the vertices and segments of a geometry to another Geometry's vertices. A snap distance tolerance is used to control where snapping is performed. The result geometry is the input geometry with the vertices snapped. If no snapping occurs then the input geometry is returned unchanged.

返回的几何体是输入几何体，其顶点和段（如果适用）已对齐到参考几何体的顶点。如果未发生对齐，则返回输入几何体。

对齐距离用于控制在哪里进行对齐。结果几何体是输入几何体，其顶点和段（如果适用）已对齐到参考几何体的顶点。如果未发生对齐，则返回输入几何体。



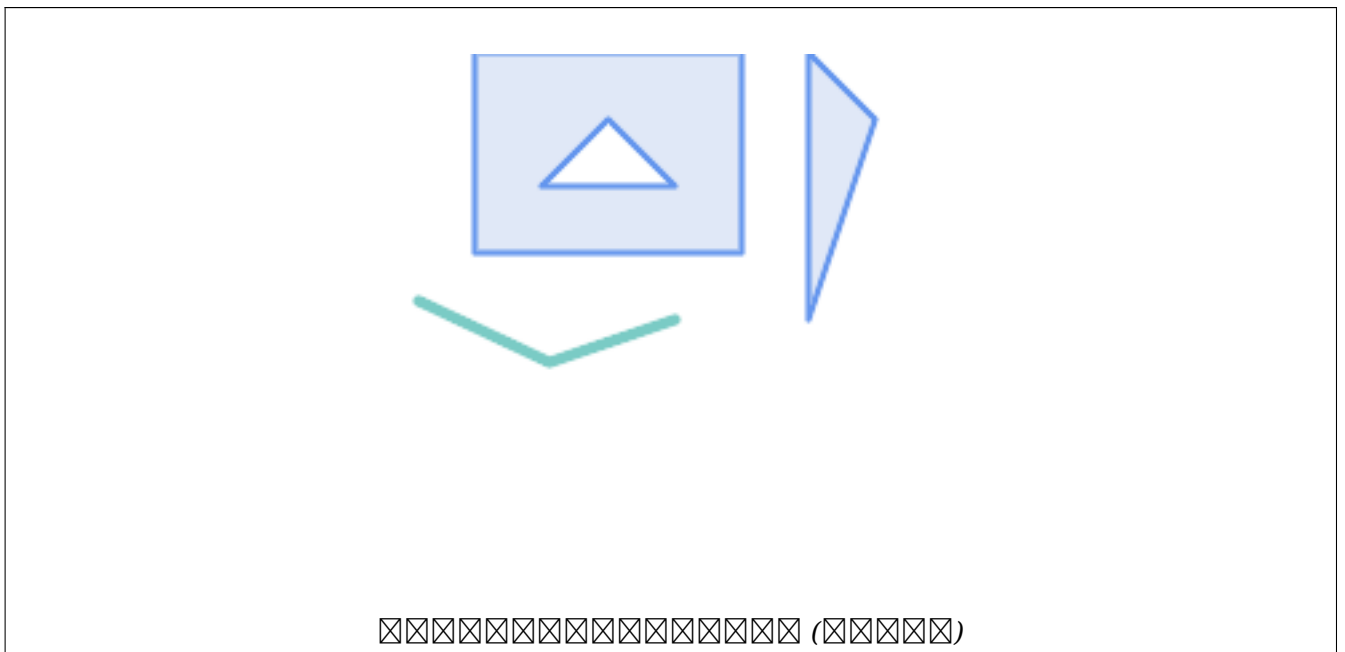
Note

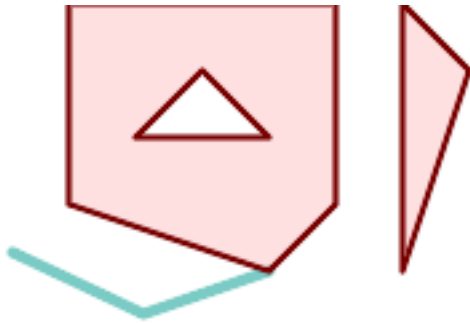
如果输入几何体不是简单多边形 (ST_IsSimple 为真) 或无效 (ST_IsValid 为假)，则返回空几何体。

GEOS 2.0.0 及以上版本。

2.0.0 及以上版本。

返回



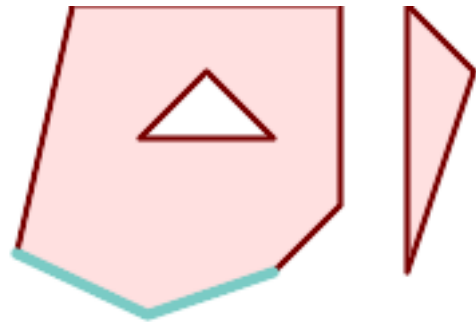


距离 1.01 将多边形和线对齐到最近的点。
 结果多边形如下所示。

```
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)))
```



距离 1.25 将多边形和线对齐到最近的点。
 结果多边形如下所示。

```
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)))
```


☒☒

Tests if an `ST_Geometry` value is well-formed and valid in 2D according to the OGC rules. For geometries with 3 and 4 dimensions, the validity is still only tested in 2 dimensions. For geometries that are invalid, a PostgreSQL NOTICE is emitted providing details of why it is not valid.

For the version with the `flags` parameter, supported values are documented in [ST_IsValidDetail](#). This version does not print a NOTICE explaining invalidity.

For more information on the definition of geometry validity, refer to [Section 4.4](#).

Note!

Note

SQL-MM defines the result of `ST_IsValid(NULL)` to be 0, while PostGIS returns NULL.

GEOS ☒☒☒☒☒

The version accepting flags is available starting with 2.0.0.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).



This method implements the SQL/MM specification. SQL-MM 3: 5.1.9

Note!

Note

Neither OGC-SFS nor SQL-MM specifications include a flag argument for `ST_IsValid`. The flag is a PostGIS extension.

☒☒

```
SELECT ST_IsValid(ST_GeomFromText('LINESTRING(0 0, 1 1)')) As good_line,
       ST_IsValid(ST_GeomFromText('POLYGON((0 0, 1 1, 1 2, 1 1, 0 0))')) As bad_poly
--results
NOTICE: Self-intersection at or near point 0 0
good_line | bad_poly
-----+-----
t         | f
```

☒☒

[ST_IsSimple](#), [ST_IsValidReason](#), [ST_IsValidDetail](#),

7.6.2 ST_IsValidDetail

`ST_IsValidDetail` — Returns a `valid_detail` row stating if a geometry is valid or if not a reason and a location.

Synopsis

`valid_detail` **ST_IsValidDetail**(geometry geom, integer flags);

☒☒

Returns a `valid_detail` row, containing a boolean (`valid`) stating if a geometry is valid, a varchar (`reason`) stating a reason why it is invalid and a geometry (`location`) pointing out where it is invalid. Useful to improve on the combination of `ST_IsValid` and `ST_IsValidReason` to generate a detailed report of invalid geometries.

The optional `flags` parameter is a bitfield. It can have the following values:

- 0: Use usual OGC SFS validity semantics.
- 1: Consider certain kinds of self-touching rings (inverted shells and exverted holes) as valid. This is also known as "the ESRI flag", since this is the validity model used by those tools. Note that this is invalid under the OGC model.

GEOS ☒☒☒☒☒

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
--First 3 Rejects from a successful quintuplet experiment
SELECT gid, reason(ST_IsValidDetail(geom)), ST_AsText(location(ST_IsValidDetail(geom))) as ←
      location
FROM
(SELECT ST_MakePolygon(ST_ExteriorRing(e.buff), array_agg(f.line)) As geom, gid
FROM (SELECT ST_Buffer(ST_Point(x1*10,y1), z1) As buff, x1*10 + y1*100 + z1*1000 As gid
      FROM generate_series(-4,6) x1
      CROSS JOIN generate_series(2,5) y1
      CROSS JOIN generate_series(1,8) z1
      WHERE x1
> y1*0.5 AND z1 < x1*y1) As e
      INNER JOIN (SELECT ST_Translate(ST_ExteriorRing(ST_Buffer(ST_Point(x1*10,y1), z1)), ←
      y1*1, z1*2) As line
      FROM generate_series(-3,6) x1
      CROSS JOIN generate_series(2,5) y1
      CROSS JOIN generate_series(1,10) z1
      WHERE x1
> y1*0.75 AND z1 < x1*y1) As f
ON (ST_Area(e.buff)
> 78 AND ST_Contains(e.buff, f.line))
GROUP BY gid, e.buff) As quintuplet_experiment
WHERE ST_IsValid(geom) = false
ORDER BY gid
LIMIT 3;
```

gid	reason	location
5330	Self-intersection	POINT(32 5)
5340	Self-intersection	POINT(42 5)
5350	Self-intersection	POINT(52 5)

```
--simple example
SELECT * FROM ST_IsValidDetail('LINESTRING(220227 150406,2220227 150407,222020 150410)');
```

valid	reason	location
t		

☒☒

[ST_IsValid](#), [ST_IsValidReason](#)

7.6.3 ST_IsValidReason

`ST_IsValidReason` — Returns text stating if a geometry is valid, or a reason for invalidity.

Synopsis

```
text ST_IsValidReason(geometry geomA);
text ST_IsValidReason(geometry geomA, integer flags);
```

☒☒

Returns text stating if a geometry is valid, or if invalid a reason why.

Useful in combination with [ST_IsValid](#) to generate a detailed report of invalid geometries and reasons.

Allowed flags are documented in [ST_IsValidDetail](#).

GEOS ☒☒☒☒☒

Availability: 1.4

Availability: 2.0 version taking flags.

☒☒

```
-- invalid bow-tie polygon
SELECT ST_IsValidReason(
  'POLYGON ((100 200, 100 100, 200 200,
    200 100, 100 200))'::geometry) as validity_info;
validity_info
-----
Self-intersection[150 150]
```

```
--First 3 Rejects from a successful quintuplet experiment
SELECT gid, ST_IsValidReason(geom) as validity_info
FROM
(SELECT ST_MakePolygon(ST_ExteriorRing(e.buff), array_agg(f.line)) As geom, gid
FROM (SELECT ST_Buffer(ST_Point(x1*10,y1), z1) As buff, x1*10 + y1*100 + z1*1000 As gid
      FROM generate_series(-4,6) x1
      CROSS JOIN generate_series(2,5) y1
      CROSS JOIN generate_series(1,8) z1
      WHERE x1
> y1*0.5 AND z1 < x1*y1) As e
      INNER JOIN (SELECT ST_Translate(ST_ExteriorRing(ST_Buffer(ST_Point(x1*10,y1), z1)), ←
        y1*1, z1*2) As line
      FROM generate_series(-3,6) x1
      CROSS JOIN generate_series(2,5) y1
      CROSS JOIN generate_series(1,10) z1
      WHERE x1
> y1*0.75 AND z1 < x1*y1) As f
ON (ST_Area(e.buff)
> 78 AND ST_Contains(e.buff, f.line))
```

```

GROUP BY gid, e.buff) As quintuplet_experiment
WHERE ST_IsValid(geom) = false
ORDER BY gid
LIMIT 3;

gid |      validity_info
-----+-----
5330 | Self-intersection [32 5]
5340 | Self-intersection [42 5]
5350 | Self-intersection [52 5]

--simple example
SELECT ST_IsValidReason('LINESTRING(220227 150406,2220227 150407,222020 150410)');

st_isvalidreason
-----
Valid Geometry

```

☒☒

[ST_IsValid, ST_Summary](#)

7.6.4 ST_MakeValid

ST_MakeValid — Attempts to make an invalid geometry valid without losing vertices.

Synopsis

```

geometry ST_MakeValid(geometry input);
geometry ST_MakeValid(geometry input, text params);

```

☒☒

The function attempts to create a valid representation of a given invalid geometry without losing any of the input vertices. Valid geometries are returned unchanged.

Supported inputs are: POINTS, MULTIPOINTS, LINESTRINGS, MULTILINESTRINGS, POLYGONS, MULTIPOLYGONS and GEOMETRYCOLLECTIONS containing any mix of them.

In case of full or partial dimensional collapses, the output geometry may be a collection of lower-to-equal dimension geometries, or a geometry of lower dimension.

Single polygons may become multi-geometries in case of self-intersections.

The params argument can be used to supply an options string to select the method to use for building valid geometry. The options string is in the format "method=linework|structure keepcollapsed=true|false". If no "params" argument is provided, the "linework" algorithm will be used as the default.

The "method" key has two values.

- "linework" is the original algorithm, and builds valid geometries by first extracting all lines, nodding that linework together, then building a value output from the linework.
- "structure" is an algorithm that distinguishes between interior and exterior rings, building new geometry by unioning exterior rings, and then differencing all interior rings.

The "keepcollapsed" key is only valid for the "structure" algorithm, and takes a value of "true" or "false". When set to "false", geometry components that collapse to a lower dimensionality, for example a one-point linestring would be dropped.

GEOS 

2.0.0 .

Enhanced: 2.0.1, speed improvements

Enhanced: 2.1.0, added support for GEOMETRYCOLLECTION and MULTIPOINT.

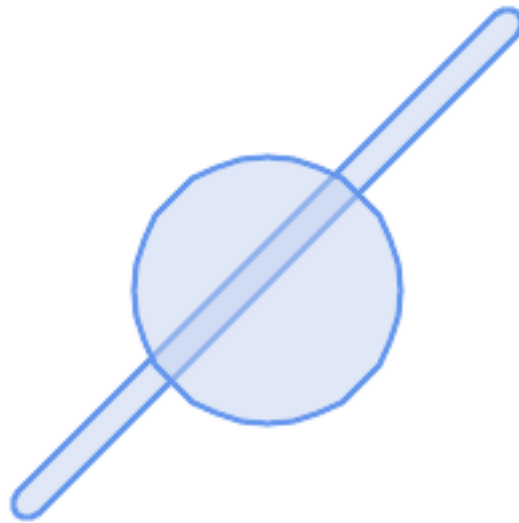
Enhanced: 3.1.0, added removal of Coordinates with NaN values.

Enhanced: 3.2.0, added algorithm options, 'linework' and 'structure' which requires GEOS >= 3.10.0.

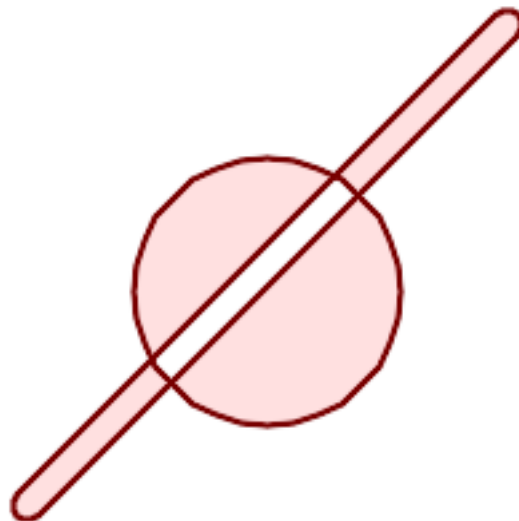


This function supports 3d and will not drop the z-index.

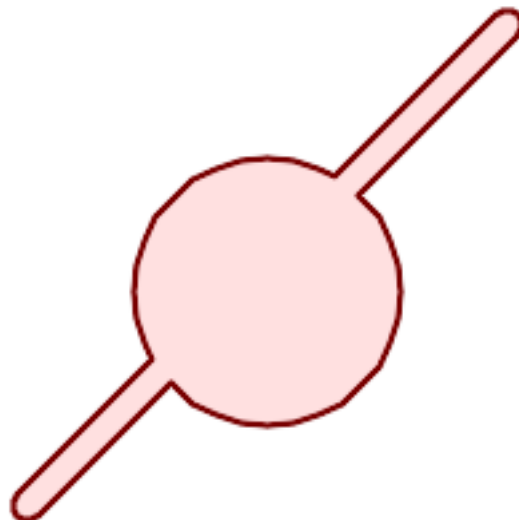




before_geom: MULTIPOLYGON of 2 overlapping polygons

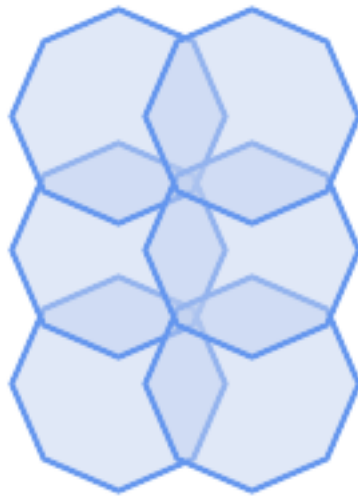


after_geom: MULTIPOLYGON of 4 non-overlapping polygons

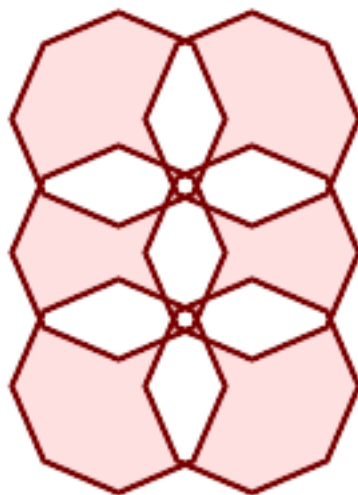


after_geom_structure: MULTIPOLYGON of 1 non-overlapping polygon

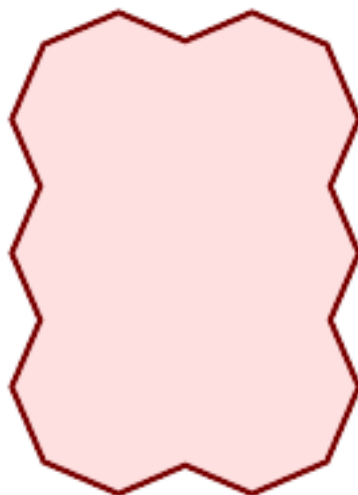
```
SELECT f.geom AS before_geom, ST_MakeValid(f.geom) AS after_geom, ST_MakeValid(f.geom, ↵
    'method=structure') AS after_geom_structure
FROM (SELECT 'MULTIPOLYGON(((186 194,187 194,188 195,189 195,190 195,
```

before_geom: MULTIPOLYGON of 6 overlapping polygons



after_geom: MULTIPOLYGON of 14 Non-overlapping polygons



after_geom_structure: MULTIPOLYGON of 1 Non-overlapping polygon

```
SELECT c.geom AS before_geom,
       ST_MakeValid(c.geom) AS after_geom,
       ST_MakeValid(c.geom, 'method=structure') AS after_geom_structure
FROM (SELECT 'MULTIPOLYGON(((91 50.79 22.51 10.23 22.11 50.23 78.51 90.79 78.91 ↵
```

☒☒

```
SELECT ST_AsText(ST_MakeValid(
  'LINESTRING(0 0, 0 0)',
  'method=structure keepcollapsed=true'
));
```

```
st_astext
-----
POINT(0 0)
```

```
SELECT ST_AsText(ST_MakeValid(
  'LINESTRING(0 0, 0 0)',
  'method=structure keepcollapsed=false'
));
```

```
st_astext
-----
LINESTRING EMPTY
```

☒☒

[ST_IsValid](#), [ST_Collect](#), [ST_CollectionExtract](#)

7.7 Spatial Reference System Functions

7.7.1 ST_InverseTransformPipeline

`ST_InverseTransformPipeline` — Return a new geometry with coordinates transformed to a different spatial reference system using the inverse of a defined coordinate transformation pipeline.

Synopsis

geometry **ST_InverseTransformPipeline**(geometry geom, text pipeline, integer to_srid);

☒☒

Return a new geometry with coordinates transformed to a different spatial reference system using a defined coordinate transformation pipeline to go in the inverse direction.

Refer to [ST_TransformPipeline](#) for details on writing a transformation pipeline.

Availability: 3.4.0

The SRID of the input geometry is ignored, and the SRID of the output geometry will be set to zero unless a value is provided via the optional `to_srid` parameter. When using [ST_TransformPipeline](#) the pipeline is executed in a forward direction. Using `ST_InverseTransformPipeline()` the pipeline is executed in the inverse direction.

Transforms using pipelines are a specialised version of [ST_Transform](#). In most cases `ST_Transform` will choose the correct operations to convert between coordinate systems, and should be preferred.

☒☒

Change WGS 84 long lat to UTM 31N using the EPSG:16031 conversion

```
-- Inverse direction
SELECT ST_AsText(ST_InverseTransformPipeline('POINT(426857.9877165967 5427937.523342293)':: ←
  geometry,
  'urn:ogc:def:coordinateOperation:EPSG::16031')) AS wgs_geom;

          wgs_geom
-----
POINT(2 48.99999999999999)
(1 row)
```

GDA2020 example.

```
-- using ST_Transform with automatic selection of a conversion pipeline.
SELECT ST_AsText(ST_Transform('SRID=4939;POINT(143.0 -37.0)'::geometry, 7844)) AS ←
  gda2020_auto;

          gda2020_auto
-----
POINT(143.00000635638918 -36.999986706128176)
(1 row)
```

☒☒

[ST_Transform](#), [ST_TransformPipeline](#)

7.7.2 ST_SetSRID

ST_SetSRID — Set the SRID on a geometry.

Synopsis

geometry **ST_SetSRID**(geometry geom, integer srid);

☒☒

Sets the SRID on a geometry to a particular integer value. Useful in constructing bounding boxes for queries.



Note

This function does not transform the geometry coordinates in any way - it simply sets the meta data defining the spatial reference system the geometry is assumed to be in. Use [ST_Transform](#) if you want to transform the geometry into a new projection.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).



This method supports Circular Strings and Curves.

☒☒

-- Mark a point as WGS 84 long lat --

```
SELECT ST_SetSRID(ST_Point(-123.365556, 48.428611),4326) As wgs84long_lat;
-- the ewkt representation (wrap with ST_AsEWKT) -
SRID=4326;POINT(-123.365556 48.428611)
```

-- Mark a point as WGS 84 long lat and then transform to web mercator (Spherical Mercator) --

```
SELECT ST_Transform(ST_SetSRID(ST_Point(-123.365556, 48.428611),4326),3785) As spere_merc;
-- the ewkt representation (wrap with ST_AsEWKT) -
SRID=3785;POINT(-13732990.8753491 6178458.96425423)
```

☒☒

Section [4.5](#), [ST_SRID](#), [ST_Transform](#), [UpdateGeometrySRID](#)

7.7.3 ST_SRID

ST_SRID — Returns the spatial reference identifier for a geometry.

Synopsis

integer **ST_SRID**(geometry g1);

☒☒

Returns the spatial reference identifier for the ST_Geometry as defined in spatial_ref_sys table. Section [4.5](#)



Note

spatial_ref_sys table is a table that catalogs all spatial reference systems known to PostGIS and is used for transformations from one spatial reference system to another. So verifying you have the right spatial reference system identifier is important if you plan to ever transform your geometries.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.1](#)



This method implements the SQL/MM specification. SQL-MM 3: 5.1.5



This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_SRID(ST_GeomFromText('POINT(-71.1043 42.315)',4326));
-- result
4326
```

☒☒

Section 4.5, [ST_SetSRID](#), [ST_Transform](#), [ST_SRID](#), [ST_SRID](#)

7.7.4 ST_Transform

`ST_Transform` — Return a new geometry with coordinates transformed to a different spatial reference system.

Synopsis

```
geometry ST_Transform(geometry g1, integer srid);
geometry ST_Transform(geometry geom, text to_proj);
geometry ST_Transform(geometry geom, text from_proj, text to_proj);
geometry ST_Transform(geometry geom, text from_proj, integer to_srid);
```

☒☒

Returns a new geometry with its coordinates transformed to a different spatial reference system. The destination spatial reference `to_srid` may be identified by a valid SRID integer parameter (i.e. it must exist in the `spatial_ref_sys` table). Alternatively, a spatial reference defined as a PROJ.4 string can be used for `to_proj` and/or `from_proj`, however these methods are not optimized. If the destination spatial reference system is expressed with a PROJ.4 string instead of an SRID, the SRID of the output geometry will be set to zero. With the exception of functions with `from_proj`, input geometries must have a defined SRID.

`ST_Transform` is often confused with [ST_SetSRID](#). `ST_Transform` actually changes the coordinates of a geometry from one spatial reference system to another, while `ST_SetSRID()` simply changes the SRID identifier of the geometry.

`ST_Transform` automatically selects a suitable conversion pipeline given the source and target spatial reference systems. To use a specific conversion method, use [ST_TransformPipeline](#).



Note

Requires PostGIS be compiled with PROJ support. Use [PostGIS_Full_Version](#) to confirm you have PROJ support compiled in.



Note

If using more than one transformation, it is useful to have a functional index on the commonly used transformations to take advantage of index usage.



Note

1.3.4 [ST_Transform](#) (curve) [ST_Transform](#). 1.3.4 [ST_Transform](#).

☒☒☒☒: 2.0.0 [ST_Transform](#) (polyhedral surface) [ST_Transform](#).

Enhanced: 2.3.0 support for direct PROJ.4 text was introduced.

- ☑ This method implements the SQL/MM specification. SQL-MM 3: 5.1.6
- ☑ This method supports Circular Strings and Curves.
- ☑ This function supports Polyhedral surfaces.

☒☒

Change Massachusetts state plane US feet geometry to WGS 84 long lat

```
SELECT ST_AsText(ST_Transform(ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,
743265 2967450,743265.625 2967416,743238 2967416))',2249),4326)) As wgs_geom;

wgs_geom
-----
POLYGON((-71.1776848522251 42.3902896512902,-71.1776843766326 42.3903829478009,
-71.1775844305465 42.3903826677917,-71.1775825927231 42.3902893647987,-71.177684
8522251 42.3902896512902));
(1 row)

--3D Circular String example
SELECT ST_AsEWKT(ST_Transform(ST_GeomFromEWKT('SRID=2249;CIRCULARSTRING(743238 2967416 ↵
1,743238 2967450 2,743265 2967450 3,743265.625 2967416 3,743238 2967416 4)'),4326));

st_asewkt
-----
SRID=4326;CIRCULARSTRING(-71.1776848522251 42.3902896512902 1,-71.1776843766326 ↵
42.3903829478009 2,
-71.1775844305465 42.3903826677917 3,
-71.1775825927231 42.3902893647987 3,-71.1776848522251 42.3902896512902 4)
```

Example of creating a partial functional index. For tables where you are not sure all the geometries will be filled in, its best to use a partial index that leaves out null geometries which will both conserve space and make your index smaller and more efficient.

```
CREATE INDEX idx_geom_26986_parcel
ON parcels
USING gist
(ST_Transform(geom, 26986))
WHERE geom IS NOT NULL;
```

Examples of using PROJ.4 text to transform with custom spatial references.

```
-- Find intersection of two polygons near the North pole, using a custom Gnomonic projection
-- See http://boundlessgeo.com/2012/02/flattening-the-peel/
WITH data AS (
  SELECT
    ST_GeomFromText('POLYGON((170 50,170 72,-130 72,-130 50,170 50))', 4326) AS p1,
    ST_GeomFromText('POLYGON((-170 68,-170 90,-141 90,-141 68,-170 68))', 4326) AS p2,
    '+proj=gnom +ellps=WGS84 +lat_0=70 +lon_0=-160 +no_defs'::text AS gnom
)
SELECT ST_AsText(
  ST_Transform(
    ST_Intersection(ST_Transform(p1, gnom), ST_Transform(p2, gnom)),
    gnom, 4326))
FROM data;

st_astext
-----
```

```
POLYGON((-170 74.053793645338, -141 73.4268621378904, -141 68, -170 68, -170 74.053793645338) ↵
)
```

Configuring transformation behavior

Sometimes coordinate transformation involving a grid-shift can fail, for example if PROJ.4 has not been built with grid-shift files or the coordinate does not lie within the range for which the grid shift is defined. By default, PostGIS will throw an error if a grid shift file is not present, but this behavior can be configured on a per-SRID basis either by testing different `to_proj` values of PROJ.4 text, or altering the `proj4text` value within the `spatial_ref_sys` table.

For example, the `proj4text` parameter `+datum=NAD87` is a shorthand form for the following `+nadgrids` parameter:

```
+nadgrids=@conus,@alaska,@ntv2_0.gsb,@ntv1_can.dat
```

The `@` prefix means no error is reported if the files are not present, but if the end of the list is reached with no file having been appropriate (ie. found and overlapping) then an error is issued.

If, conversely, you wanted to ensure that at least the standard files were present, but that if all files were scanned without a hit a null transformation is applied you could use:

```
+nadgrids=@conus,@alaska,@ntv2_0.gsb,@ntv1_can.dat,null
```

The null grid shift file is a valid grid shift file covering the whole world and applying no shift. So for a complete example, if you wanted to alter PostGIS so that transformations to SRID 4267 that didn't lie within the correct range did not throw an ERROR, you would use the following:

```
UPDATE spatial_ref_sys SET proj4text = '+proj=longlat +ellps=clrk66 +nadgrids=@conus, ↵
@alaska,@ntv2_0.gsb,@ntv1_can.dat,null +no_defs' WHERE srid = 4267;
```

☒☒

Section [4.5](#), [ST_SetSRID](#), [ST_SRID](#), [UpdateGeometrySRID](#), [ST_TransformPipeline](#)

7.7.5 ST_TransformPipeline

`ST_TransformPipeline` — Return a new geometry with coordinates transformed to a different spatial reference system using a defined coordinate transformation pipeline.

Synopsis

```
geometry ST_TransformPipeline(geometry g1, text pipeline, integer to_srid);
```

☒☒

Return a new geometry with coordinates transformed to a different spatial reference system using a defined coordinate transformation pipeline.

Transformation pipelines are defined using any of the following string formats:

- `urn:ogc:def:coordinateOperation:AUTHORITY::CODE`. Note that a simple `EPSG:CODE` string does not uniquely identify a coordinate operation: the same EPSG code can be used for a CRS definition.

- A PROJ pipeline string of the form: `+proj=pipeline . . .`. Automatic axis normalisation will not be applied, and if necessary the caller will need to add an additional pipeline step, or remove axis swap steps.
- Concatenated operations of the form: `urn:ogc:def:coordinateOperation,coordinateOperation:EPSG:`

Availability: 3.4.0

The SRID of the input geometry is ignored, and the SRID of the output geometry will be set to zero unless a value is provided via the optional `to_srid` parameter. When using `ST_TransformPipeline()` the pipeline is executed in a forward direction. Using `ST_InverseTransformPipeline` the pipeline is executed in the inverse direction.

Transforms using pipelines are a specialised version of `ST_Transform`. In most cases `ST_Transform` will choose the correct operations to convert between coordinate systems, and should be preferred.

☒☒

Change WGS 84 long lat to UTM 31N using the EPSG:16031 conversion

```
-- Forward direction
SELECT ST_AsText(ST_TransformPipeline('SRID=4326;POINT(2 49)::geometry,
  'urn:ogc:def:coordinateOperation:EPSG::16031')) AS utm_geom;

          utm_geom
-----
POINT(426857.9877165967 5427937.523342293)
(1 row)

-- Inverse direction
SELECT ST_AsText(ST_InverseTransformPipeline('POINT(426857.9877165967 5427937.523342293):: ←
  geometry,
  'urn:ogc:def:coordinateOperation:EPSG::16031')) AS wgs_geom;

          wgs_geom
-----
POINT(2 48.99999999999999)
(1 row)
```

GDA2020 example.

```
-- using ST_Transform with automatic selection of a conversion pipeline.
SELECT ST_AsText(ST_Transform('SRID=4939;POINT(143.0 -37.0)::geometry, 7844)) AS ←
  gda2020_auto;

          gda2020_auto
-----
POINT(143.00000635638918 -36.999986706128176)
(1 row)

-- using a defined conversion (EPSG:8447)
SELECT ST_AsText(ST_TransformPipeline('SRID=4939;POINT(143.0 -37.0)::geometry,
  'urn:ogc:def:coordinateOperation:EPSG::8447')) AS gda2020_code;

          gda2020_code
-----
POINT(143.0000063280214 -36.999986718287545)
(1 row)

-- using a PROJ pipeline definition matching EPSG:8447, as returned from
-- 'projinfo -s EPSG:4939 -t EPSG:7844'.
```

```
-- NOTE: any 'axiswap' steps must be removed.
SELECT ST_AsText(ST_TransformPipeline('SRID=4939;POINT(143.0 -37.0)>::geometry,
'+proj=pipeline
+step +proj=unitconvert +xy_in=deg +xy_out=rad
+step +proj=hgridshift +grids=au_icsm_GDA94_GDA2020_conformal_and_distortion.tif
+step +proj=unitconvert +xy_in=rad +xy_out=deg')) AS gda2020_pipeline;

                gda2020_pipeline
-----
POINT(143.0000063280214 -36.999986718287545)
(1 row)
```

☒☒

[ST_Transform](#), [ST_InverseTransformPipeline](#)

7.7.6 postgis_srs_codes

`postgis_srs_codes` — Return the list of SRS codes associated with the given authority.

Synopsis

setof text **postgis_srs_codes**(text auth_name);

☒☒

Returns a set of all auth_srid for the given auth_name.

Availability: 3.4.0

Proj version 6+

☒☒

List the first ten codes associated with the EPSG authority.

```
SELECT * FROM postgis_srs_codes('EPSG') LIMIT 10;
```

```
postgis_srs_codes
-----
2000
20004
20005
20006
20007
20008
20009
2001
20010
20011
```

☒☒

[postgis_srs](#), [postgis_srs_all](#), [postgis_srs_search](#)

7.7.7 postgis_srs

postgis_srs — Return a metadata record for the requested authority and srid.

Synopsis

setof record **postgis_srs**(text auth_name, text auth_srid);

☒☒

Returns a metadata record for the requested auth_srid for the given auth_name. The record will have the auth_name, auth_srid, sname, srtext, proj4text, and the corners of the area of usage, point_sw and point_ne.

Availability: 3.4.0

Proj version 6+

☒☒

Get the metadata for EPSG:3005.

```
SELECT * FROM postgis_srs('EPSG', '3005');
```

```

auth_name | EPSG
auth_srid | 3005
sname     | NAD83 / BC Albers
srtext    | PROJCS["NAD83 / BC Albers", ... ]
proj4text | +proj=aea +lat_0=45 +lon_0=-126 +lat_1=50 +lat_2=58.5 +x_0=1000000 +y_0=0 +
        datum=NAD83 +units=m +no_defs +type=crs
point_sw  | 0101000020E6100000E17A14AE476161C00000000000204840
point_ne  | 0101000020E610000085EB51B81E855CC0E17A14AE47014E40

```

☒☒

[postgis_srs_codes](#), [postgis_srs_all](#), [postgis_srs_search](#)

7.7.8 postgis_srs_all

postgis_srs_all — Return metadata records for every spatial reference system in the underlying Proj database.

Synopsis

setof record **postgis_srs_all**(void);

☒☒

Returns a set of all metadata records in the underlying Proj database. The records will have the auth_name, auth_srid, sname, srtext, proj4text, and the corners of the area of usage, point_sw and point_ne.

Availability: 3.4.0

Proj version 6+

☒☒

Get the first 10 metadata records from the Proj database.

```
SELECT auth_name, auth_srid, sname FROM postgis_srs_all() LIMIT 10;
```

auth_name	auth_srid	sname
EPSG	2000	Anguilla 1957 / British West Indies Grid
EPSG	20004	Pulkovo 1995 / Gauss-Kruger zone 4
EPSG	20005	Pulkovo 1995 / Gauss-Kruger zone 5
EPSG	20006	Pulkovo 1995 / Gauss-Kruger zone 6
EPSG	20007	Pulkovo 1995 / Gauss-Kruger zone 7
EPSG	20008	Pulkovo 1995 / Gauss-Kruger zone 8
EPSG	20009	Pulkovo 1995 / Gauss-Kruger zone 9
EPSG	2001	Antigua 1943 / British West Indies Grid
EPSG	20010	Pulkovo 1995 / Gauss-Kruger zone 10
EPSG	20011	Pulkovo 1995 / Gauss-Kruger zone 11

☒☒

[postgis_srs_codes](#), [postgis_srs](#), [postgis_srs_search](#)

7.7.9 postgis_srs_search

`postgis_srs_search` — Return metadata records for projected coordinate systems that have areas of useage that fully contain the bounds parameter.

Synopsis

setof record **postgis_srs_search**(geometry bounds, text auth_name=EPSG);

☒☒

Return a set of metadata records for projected coordinate systems that have areas of useage that fully contain the bounds parameter. Each record will have the `auth_name`, `auth_srid`, `sname`, `srtxt`, `proj4text`, and the corners of the area of usage, `point_sw` and `point_ne`.

The search only looks for projected coordinate systems, and is intended for users to explore the possible systems that work for the extent of their data.

Availability: 3.4.0

Proj version 6+

☒☒

Search for projected coordinate systems in Louisiana.

```
SELECT auth_name, auth_srid, sname,
       ST_AsText(point_sw) AS point_sw,
       ST_AsText(point_ne) AS point_ne
FROM postgis_srs_search('SRID=4326;LINESTRING(-90 30, -91 31)')
LIMIT 3;
```


 This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2](#)

GEOS

1.1.0

[ST_BuildArea](#), [ST_BdMPolyFromText](#)

7.8.1.2 ST_BdMPolyFromText

ST_BdMPolyFromText — WKT

Synopsis

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

WKT



Note

WKT. [ST_BdPolyFromText](#), [ST_BuildArea\(\)](#)

 This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2](#)

GEOS

1.1.0

[ST_BuildArea](#), [ST_BdPolyFromText](#)

7.8.1.3 ST_GeogFromText

ST_GeogFromText — WKT (GEOGRAPHY)

Synopsis

geography **ST_GeogFromText**(text EWKT);

☒☒

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

OGC 3.2.6.2 - SRID (conformance suite).

WKT (GEOMETRYCOLLECTION) null.



Note

WKT, SRID. ST_GeomFromText.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2](#)



This method implements the SQL/MM specification.

☒☒

```
SELECT ST_GeomCollFromText('GEOMETRYCOLLECTION(POINT(1 2),LINESTRING(1 2, 3 4))');
```

☒☒

[ST_GeomFromText](#), [ST_SRID](#)

7.8.1.6 ST_GeomFromEWKT

ST_GeomFromEWKT — EWKT(Extended Well-Known Text) ST_Geometry.

Synopsis

geometry **ST_GeomFromEWKT**(text EWKT);

☒☒

OGC EWKT(Extended Well-Known Text) PostGIS ST_Geometry.



Note

EWKT OGC, SRID PostGIS.

2.0.0 (polyhedral surface) TIN.



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



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```

SELECT ST_GeomFromEWKT('SRID=4269;LINESTRING(-71.160281 42.258729,-71.160837 ↵
  42.259113,-71.161144 42.25932)');
SELECT ST_GeomFromEWKT('SRID=4269;MULTILINESTRING((-71.160281 42.258729,-71.160837 ↵
  42.259113,-71.161144 42.25932)');

SELECT ST_GeomFromEWKT('SRID=4269;POINT(-71.064544 42.28787)');

SELECT ST_GeomFromEWKT('SRID=4269;POLYGON((-71.1776585052917 ↵
  42.3902909739571,-71.1776820268866 42.3903701743239,
-71.1776063012595 42.3903825660754,-71.1775826583081 42.3903033653531,-71.1776585052917 ↵
  42.3902909739571)))');

SELECT ST_GeomFromEWKT('SRID=4269;MULTIPOLYGON((( -71.1031880899493 42.3152774590236,
-71.1031627617667 42.3152960829043,-71.102923838298 42.3149156848307,
-71.1023097974109 42.3151969047397,-71.1019285062273 42.3147384934248,
-71.102505233663 42.3144722937587,-71.10277487471 42.3141658254797,
-71.103113945163 42.3142739188902,-71.10324876416 42.31402489987,
-71.1033002961013 42.3140393340215,-71.1033488797549 42.3139495090772,
-71.103396240451 42.3138632439557,-71.1041521907712 42.3141153348029,
-71.1041411411543 42.3141545014533,-71.1041287795912 42.3142114839058,
-71.1041188134329 42.3142693656241,-71.1041112482575 42.3143272556118,
-71.1041072845732 42.3143851580048,-71.1041057218871 42.3144430686681,
-71.1041065602059 42.3145009876017,-71.1041097995362 42.3145589148055,
-71.1041166403905 42.3146168544148,-71.1041258822717 42.3146748022936,
-71.1041375307579 42.3147318674446,-71.1041492906949 42.3147711126569,
-71.1041598612795 42.314808571739,-71.1042515013869 42.3151287620809,
-71.1041173835118 42.3150739481917,-71.1040809891419 42.3151344119048,
-71.1040438678912 42.3151191367447,-71.1040194562988 42.3151832057859,
-71.1038734225584 42.3151140942995,-71.1038446938243 42.3151006300338,
-71.1038315271889 42.315094347535,-71.1037393329282 42.315054824985,
-71.1035447555574 42.3152608696313,-71.1033436658644 42.3151648370544,
-71.1032580383161 42.3152269126061,-71.103223066939 42.3152517403219,
-71.1031880899493 42.3152774590236)),
((-71.1043632495873 42.315113108546,-71.1043583974082 42.3151211109857,
-71.1043443253471 42.3150676015829,-71.1043850704575 42.3150793250568,-71.1043632495873 ↵
  42.315113108546)))');

```

--3d circular string

```
SELECT ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)');
```

--Polyhedral Surface example

```

SELECT ST_GeomFromEWKT('POLYHEDRALSURFACE(
  ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
  ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
  ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
  ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
  ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
  ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1))
)');

```

☒☒

ST_AsEWKT, ST_GeomFromText

7.8.1.7 ST_GeomFromMARC21

ST_GeomFromMARC21 — Takes MARC21/XML geographic data as input and returns a PostGIS geometry object.

Synopsis

geometry **ST_GeomFromMARC21** (text marcxml);

☒☒

This function creates a PostGIS geometry from a MARC21/XML record, which can contain a POINT or a POLYGON. In case of multiple geographic data entries in the same MARC21/XML record, a MULTIPOINT or MULTIPOLYGON will be returned. If the record contains mixed geometry types, a GEOMETRYCOLLECTION will be returned. It returns NULL if the MARC21/XML record does not contain any geographic data (datafield:034).

LOC MARC21/XML versions supported:

- [MARC21/XML 1.1](#)

Availability: 3.3.0, requires libxml2 2.6+



Note

The MARC21/XML Coded Cartographic Mathematical Data currently does not provide any means to describe the Spatial Reference System of the encoded coordinates, so this function will always return a geometry with SRID 0.



Note

Returned POLYGON geometries will always be clockwise oriented.

☒☒

Converting MARC21/XML geographic data containing a single POINT encoded as hddd.ddddd

```
SELECT
  ST_AsText(
    ST_GeomFromMARC21('
      <record xmlns="http://www.loc.gov/MARC21/slim">
        <leader
>00000nz a2200000nc 4500</leader>
        <controlfield tag="001"
>040277569</controlfield>
          <datafield tag="034" ind1=" " ind2=" ">
            <subfield code="d"
>W004.500000</subfield>
              <subfield code="e"
>W004.500000</subfield>
                <subfield code="f"
>N054.250000</subfield>
                  <subfield code="g"
```

```

>N054.250000</subfield>
                                </datafield>
                                </record>
>' ));

      st_astext
-----
POINT(-4.5 54.25)
(1 row)

```

Converting MARC21/XML geographic data containing a single POLYGON encoded as hdddmmss

```

      SELECT
      ST_AsText(
        ST_GeomFromMARC21('
          <record xmlns="http://www.loc.gov/MARC21/slim">
            <leader
>01062cem a2200241 a 4500</leader>
            <controlfield tag="001"
> 84696781 </controlfield>
            <datafield tag="034" ind1="1" ind2=" " >
              <subfield code="a"
>a</subfield>
              <subfield code="b"
>50000</subfield>
              <subfield code="d"
>E0130600</subfield>
              <subfield code="e"
>E0133100</subfield>
              <subfield code="f"
>N0523900</subfield>
              <subfield code="g"
>N0522300</subfield>
            </datafield>
          </record>
        >' ));

      st_astext
-----
POLYGON((13.1 52.65,13.516666666666667 52.65,13.516666666666667 ←
          52.38333333333333,13.1 52.38333333333333,13.1 52.65))
(1 row)

```

Converting MARC21/XML geographic data containing a POLYGON and a POINT:

```

      SELECT
      ST_AsText(
        ST_GeomFromMARC21('
          <record xmlns="http://www.loc.gov/MARC21/slim">
            <datafield tag="034" ind1="1" ind2=" " >
              <subfield code="a"
>a</subfield>
              <subfield code="b"
>50000</subfield>
              <subfield code="d"

```

```

>E0130600</subfield>
<subfield code="e"
>E0133100</subfield>
<subfield code="f"
>N0523900</subfield>
<subfield code="g"
>N0522300</subfield>
</datafield>
<datafield tag="034" ind1=" " ind2=" ">
<subfield code="d"
>W004.500000</subfield>
<subfield code="e"
>W004.500000</subfield>
<subfield code="f"
>N054.250000</subfield>
<subfield code="g"
>N054.250000</subfield>
</datafield>
</record
>');

```

st_astext ←

```

GEOMETRYCOLLECTION(POLYGON((13.1 52.65,13.516666666666667 ←
52.65,13.516666666666667 52.38333333333333,13.1 52.38333333333333,13.1 ←
52.65)),POINT(-4.5 54.25))
(1 row)

```

☒☒

ST_AsMARC21

7.8.1.8 ST_GeometryFromText

ST_GeometryFromText — WKT(Well-Known Text) ☒☒☒☒☒☒ ST_Geometry ☒☒☒☒☒☒☒. ☒☒☒☒☒ ST_GeomFromText ☒☒☒☒☒☒☒☒☒.

Synopsis

```

geometry ST_GeometryFromText(text WKT);
geometry ST_GeometryFromText(text WKT, integer srid);

```

☒☒

- ✔ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).
- ✔ This method implements the SQL/MM specification. SQL-MM 3: 5.1.40

☒☒

ST_GeomFromText

7.8.1.9 ST_GeomFromText

ST_GeomFromText — WKT ST_Geometry

Synopsis

```
geometry ST_GeomFromText(text WKT);
geometry ST_GeomFromText(text WKT, integer srid);
```

OGC WKT(Well-Known Text) PostGIS ST_Geometry

Note ST_GeomFromText 2, SRID (SRID=0). SRID SRID.

- This method implements the OGC Simple Features Implementation Specification for SQL 1.1. 3.2.6.2 - SRID (conformance suite).
- This method implements the SQL/MM specification. SQL-MM 3: 5.1.40
- This method supports Circular Strings and Curves.

Note While not OGC-compliant, ST_MakePoint is faster than ST_GeomFromText and ST_PointFromText. It is also easier to use for numeric coordinate values. ST_Point is another option similar in speed to ST_MakePoint and is OGC-compliant, but doesn't support anything but 2D points.

Warning PostGIS 2.0.0 ST_GeomFromText('GEOMETRYCOLLECTION(EMPTY)') PostGIS 2.0.0, SQL/MM ST_GeomFromText('GEOMETRYCOLLECTION EMPTY')

```
SELECT ST_GeomFromText('LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144 42.25932)');
SELECT ST_GeomFromText('LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144 42.25932)',4269);
SELECT ST_GeomFromText('MULTILINESTRING((-71.160281 42.258729,-71.160837 42.259113,-71.161144 42.25932))');
SELECT ST_GeomFromText('POINT(-71.064544 42.28787)');
SELECT ST_GeomFromText('POLYGON((-71.1776585052917 42.3902909739571,-71.1776820268866 42.3903701743239,
```




Note

ST_GeomFromText, ST_GeomFromText. ST_GeomFromText.



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



This method implements the SQL/MM specification. SQL-MM 3: 7.2.8

```
SELECT ST_LineFromText('LINESTRING(1 2, 3 4)') AS aline, ST_LineFromText('POINT(1 2)') AS null_return;
aline | null_return
-----|-----
01020000000200000000000000000000F ... | t
```

ST_GeomFromText

7.8.1.11 ST_MLineFromText

ST_MLineFromText — WKT ST_MultiLineString.

Synopsis

geometry ST_MLineFromText(text WKT, integer srid);
geometry ST_MLineFromText(text WKT);

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

OGC 3.2.6.2 - SRID (conformance suite).

WKT null.



Note

WKT, ST_GeomFromText.



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



This method implements the SQL/MM specification. SQL-MM 3: 9.4.4

☒☒

```
SELECT ST_MLineFromText('MULTILINESTRING((1 2, 3 4), (4 5, 6 7))');
```

☒☒

ST_GeomFromText

7.8.1.12 ST_MPointFromText

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

Synopsis

```
geometry ST_MPointFromText(text WKT, integer srid);
geometry ST_MPointFromText(text WKT);
```

☒☒

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

OGC 3.2.6.2 - SRID (conformance suite).

WKT null.



Note

WKT, SRID. ST_GeomFromText.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1.3.2.6.2](#)



This method implements the SQL/MM specification. SQL-MM 3: 9.2.4

☒☒

```
SELECT ST_MPointFromText('MULTIPOINT((1 2),(3 4))');
SELECT ST_MPointFromText('MULTIPOINT((-70.9590 42.1180),(-70.9611 42.1223))', 4326);
```

☒☒

ST_GeomFromText

7.8.1.13 ST_MPolyFromText

ST_MPolyFromText — Makes a MultiPolygon Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.

Synopsis

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

Makes a MultiPolygon from WKT with the given SRID. If SRID is not given, it defaults to 0.
 OGC 3.2.6.2 - SRID (conformance suite).
 WKT.



Note

WKT, ST_GeomFromText.

- This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2](#)
- This method implements the SQL/MM specification. SQL-MM 3: 9.6.4

```
SELECT ST_MPolyFromText('MULTIPOLYGON(((0 0 1,20 0 1,20 20 1,0 20 1,0 0 1),(5 5 3,5 7 3,7 7 ←
3,7 5 3,5 5 3)))');
SELECT ST_MPolyFromText('MULTIPOLYGON((( -70.916 42.1002, -70.9468 42.0946, -70.9765 ←
42.0872, -70.9754 42.0875, -70.9749 42.0879, -70.9752 42.0881, -70.9754 42.0891, -70.9758 ←
42.0894, -70.9759 42.0897, -70.9759 42.0899, -70.9754 42.0902, -70.9756 42.0906, -70.9753 ←
42.0907, -70.9753 42.0917, -70.9757 42.0924, -70.9755 42.0928, -70.9755 42.0942, -70.9751 ←
42.0948, -70.9755 42.0953, -70.9751 42.0958, -70.9751 42.0962, -70.9759 42.0983, -70.9767 ←
42.0987, -70.9768 42.0991, -70.9771 42.0997, -70.9771 42.1003, -70.9768 42.1005, -70.977 ←
42.1011, -70.9766 42.1019, -70.9768 42.1026, -70.9769 42.1033, -70.9775 42.1042, -70.9773 ←
42.1043, -70.9776 42.1043, -70.9778 42.1048, -70.9773 42.1058, -70.9774 42.1061, -70.9779 ←
42.1065, -70.9782 42.1078, -70.9788 42.1085, -70.9798 42.1087, -70.9806 42.109, -70.9807 ←
42.1093, -70.9806 42.1099, -70.9809 42.1109, -70.9808 42.1112, -70.9798 42.1116, -70.9792 ←
42.1127, -70.979 42.1129, -70.9787 42.1134, -70.979 42.1139, -70.9791 42.1141, -70.9987 ←
42.1116, -71.0022 42.1273,
-70.9408 42.1513, -70.9315 42.1165, -70.916 42.1002)))', 4326);
```

ST_GeomFromText, ST_SRID

7.8.1.14 ST_PointFromText

ST_PointFromText — SRID WKT. SRID, 0.

Synopsis

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

☒☒

Constructs a PostGIS ST_Geometry point object from the OGC Well-Known text representation. If SRID is not given, it defaults to unknown (currently 0). If geometry is not a WKT point representation, returns null. If completely invalid WKT, then throws an error.



Note

ST_PointFromText `geometry` 2 `geometry`, `integer` SRID `geometry`
`geometry`. `integer` SRID `geometry`. `integer` SRID `geometry`
`geometry` ST_Geometry `geometry`. `integer` SRID `geometry`.



Note

`geometry` WKT `geometry`, `integer`. `geometry`
`geometry` ST_GeomFromText `geometry`. `integer` OGC
`geometry`, `integer` ST_MakePoint `geometry` ST_Point `geometry`.



This method implements the **OGC Simple Features Implementation Specification for SQL 1.1**. ☒
 ☒ 3.2.6.2 - `integer` SRID `geometry` (conformance suite) `geometry`.



This method implements the SQL/MM specification. SQL-MM 3: 6.1.8

☒☒

```
SELECT ST_PointFromText('POINT(-71.064544 42.28787)');
SELECT ST_PointFromText('POINT(-71.064544 42.28787)', 4326);
```

☒☒

ST_GeomFromText, ST_MakePoint, ST_Point, ST_SRID

7.8.1.15 ST_PolygonFromText

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

Synopsis

```
geometry ST_PolygonFromText(text WKT);
geometry ST_PolygonFromText(text WKT, integer srid);
```

☒☒

Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0. Returns null if WKT is not a polygon.

OGC ☒☒ 3.2.6.2 - `integer` SRID `geometry` (conformance suite) `geometry`.



Note

WKT POLYGON((-71.1776585052917 42.3902909739571, -71.1776820268866 42.3903701743239, -71.1776063012595 42.3903825660754, -71.1775826583081 42.3903033653531, -71.1776585052917 42.3902909739571)); ST_GeomFromText

✓ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2](#)

✓ This method implements the SQL/MM specification. SQL-MM 3: 8.3.6

☒

```
SELECT ST_PolygonFromText('POLYGON((-71.1776585052917 42.3902909739571, -71.1776820268866 ↵
42.3903701743239,
-71.1776063012595 42.3903825660754, -71.1775826583081 42.3903033653531, -71.1776585052917 ↵
42.3902909739571))');
st_polygonfromtext
-----
010300000001000000050000006...

SELECT ST_PolygonFromText('POINT(1 2)') IS NULL as point_is_notpoly;
point_is_not_poly
-----
t
```

☒

ST_GeomFromText

7.8.1.16 ST_WKTTToSQL

ST_WKTTToSQL — WKT(Well-Known Text) ☒ ST_Geometry ☒. ST_GeomFromText

Synopsis

geometry **ST_WKTTToSQL**(text WKT);

☒

✓ This method implements the SQL/MM specification. SQL-MM 3: 5.1.34

☒

ST_GeomFromText

7.8.2 Well-Known Binary (WKB)

7.8.2.1 ST_GeogFromWKB

ST_GeogFromWKB — WKB EWKB(WKB) ST_Geometry.

Synopsis

geometry ST_GeogFromWKB(bytea wkb);

ST_GeogFromWKB WKB PostGIS WKB ST_Geometry. SQL (Geometry Factory).

SRID, 4326(WGS84) ST_Geometry.



This method supports Circular Strings and Curves.

```
--Although bytea rep contains single \, these need to be escaped when inserting into a
table
SELECT ST_AsText(
ST_GeogFromWKB(E'\001\002\000\000\000\002\000\000\000\037\205\353Q
\270~\300\323Mb\020X\231C@\020X9\264\310~\300)\217\302\365\230
C@')
);
-----
st_astext
-----
LINESTRING(-113.98 39.198, -113.981 39.195)
(1 row)
```

[ST_GeogFromText](#), [ST_AsBinary](#)

7.8.2.2 ST_GeomFromEWKB

ST_GeomFromEWKB — EWKB(Extended Well-Known Binary) ST_Geometry.

Synopsis

geometry ST_GeomFromEWKB(bytea EWKB);

7.8.2.3 ST_GeomFromWKB


ST_GeomFromWKB — WKB(Well-Known Binary) SRID.

Synopsis

geometry **ST_GeomFromWKB**(bytea geom);
 geometry **ST_GeomFromWKB**(bytea geom, integer srid);

ST_GeomFromWKB WKB SRID(SRID ID) SRID . SRID SQL SRID (Geometry Factory) SRID . SRID ST_WKBToSQL SRID .

SRID SRID , SRID 0(unknown) SRID .

 This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s3.2.7.2](#) - SRID SRID (conformance suite) SRID .

 This method implements the SQL/MM specification. SQL-MM 3: 5.1.41

 This method supports Circular Strings and Curves.

```
--Although bytea rep contains single \, these need to be escaped when inserting into a table
-- unless standard_conforming_strings is set to on.
SELECT ST_AsEWKT(
ST_GeomFromWKB(E'\\001\\002\\000\\000\\000\\002\\000\\000\\000\\0037\\205\\3530
\\270~\\300\\323Mb\\020X\\231C@\\020X9\\264\\310~\\300)\\217\\302\\365\\230
C@',4326)
);
          st_asewkt
-----
SRID=4326;LINESTRING(-113.98 39.198,-113.981 39.195)
(1 row)

SELECT
  ST_AsText(
    ST_GeomFromWKB(
      ST_AsEWKB('POINT(2 5)::geometry)
    )
  );
  st_astext
-----
POINT(2 5)
(1 row)
```

[ST_WKBToSQL](#), [ST_AsBinary](#), [ST_GeomFromEWKB](#)

7.8.2.4 ST_LineFromWKB

ST_LineFromWKB — SRID WKB LINESRING.

Synopsis

geometry **ST_LineFromWKB**(bytea WKB);
 geometry **ST_LineFromWKB**(bytea WKB, integer srid);

ST_LineFromWKB WKB SRID(SRID ID) - LINESRING - SQL (Geometry Factory). SRID 0. bytea, NULL.



Note

OGC 3.2.6.2 - SRID (conformance suite).



Note

LINESRING, ST_GeomFromWKB. ST_GeomFromWKB.

✔ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s3.2.6.2](#)

✔ This method implements the SQL/MM specification. SQL-MM 3: 7.2.9

```
SELECT ST_LineFromWKB(ST_AsBinary(ST_GeomFromText('LINESRING(1 2, 3 4)'))) AS aline,
       ST_LineFromWKB(ST_AsBinary(ST_GeomFromText('POINT(1 2)'))) IS NULL AS null_return;
aline | null_return
-----|-----
01020000000200000000000000000000F ... | t
```

[ST_GeomFromWKB](#), [ST_LinestringFromWKB](#)

7.8.2.5 ST_LinestringFromWKB

ST_LinestringFromWKB — SRID WKB.

Synopsis

geometry **ST_LineStringFromWKB**(bytea WKB);
 geometry **ST_LineStringFromWKB**(bytea WKB, integer srid);

ST_LineStringFromWKB WKB SRID(ID) - , LINESTRING - . SQL (Geometry Factory) .

SRID , 0 . bytea LINESTRING , NULL .



Note

OGC 3.2.6.2 - SRID (conformance suite) .



Note

LINESTRING , **ST_GeomFromWKB** . **ST_GeomFromWKB** , LINESTRING .



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1 s3.2.6.2](#)



This method implements the SQL/MM specification. SQL-MM 3: 7.2.9

```
SELECT
  ST_LineStringFromWKB(
    ST_AsBinary(ST_GeomFromText('LINESTRING(1 2, 3 4)'))
  ) AS aline,
  ST_LineStringFromWKB(
    ST_AsBinary(ST_GeomFromText('POINT(1 2)'))
  ) IS NULL AS null_return;
aline | null_return
-----|-----
01020000000200000000000000000000F ... | t
```


[ST_GeomFromWKB](#), [ST_LineFromWKB](#)

7.8.2.6 ST_PointFromWKB

ST_PointFromWKB — SRID WKB .

Synopsis

geometry **ST_WKBToSQL**(bytea WKB);

 This method implements the SQL/MM specification. SQL-MM 3: 5.1.36

ST_GeomFromWKB

7.8.3 Other Formats

7.8.3.1 ST_Box2dFromGeoHash

ST_Box2dFromGeoHash — GeoHash BOX2D

Synopsis

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

GeoHash BOX2D

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

precision, ST_Box2dFromGeoHash GeoHash BOX2D

2.1.0

```
SELECT ST_Box2dFromGeoHash('9qqj7nmxcggy4d0dbxqz0');
           st_geomfromgeohash
-----
BOX(-115.172816 36.114646,-115.172816 36.114646)

SELECT ST_Box2dFromGeoHash('9qqj7nmxcggy4d0dbxqz0', 0);
           st_box2dfromgeohash
-----
BOX(-180 -90,180 90)

SELECT ST_Box2dFromGeoHash('9qqj7nmxcggy4d0dbxqz0', 10);
           st_box2dfromgeohash
-----
BOX(-115.17282128334 36.1146408319473,-115.172810554504 36.1146461963654)
```


7.8.3.3 ST_GeomFromGML

ST_GeomFromGML — GML PostGIS.

Synopsis

```
geometry ST_GeomFromGML(text geomgml);
geometry ST_GeomFromGML(text geomgml, integer srid);
```

OGC GML PostGIS ST_Geometry.

ST_GeomFromGML GML (geometry fragment). GML

OGC GML:

- GML 3.2.1
- GML 3.1.1 SF-2 (GML 3.1.0 3.0.0)
- GML 2.1.2

OGC GML: <http://www.opengeospatial.org/standards/gml>

1.5. LibXML2 1.6.

: 2.0.0 (polyhedral surface) TIN.

: 2.0.0 SRID.

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

✔ This function supports Polyhedral surfaces.

✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

GML (MultiGeometry) 2D 3D. PostGIS Z ST_GeomFromGML 2D.

GML SRS. PostGIS, ST_GeomFromGML SRS. GML srsName,.

ST_GeomFromGML GML. GML XLink.



Note

ST_GeomFromGML SQL/MM.

☒☒: **srsName** ☒☒☒☒☒☒☒

```
SELECT ST_GeomFromGML($$
  <gml:LineString xmlns:gml="http://www.opengis.net/gml"
    srsName="EPSG:4269">
    <gml:coordinates>
      -71.16028,42.258729 -71.160837,42.259112 -71.161143,42.25932
    </gml:coordinates>
  </gml:LineString>
$$);
```

☒☒: **XLink** ☒☒

```
SELECT ST_GeomFromGML($$
  <gml:LineString xmlns:gml="http://www.opengis.net/gml"
    xmlns:xlink="http://www.w3.org/1999/xlink"
    srsName="urn:ogc:def:crs:EPSG::4269">
    <gml:pointProperty>
      <gml:Point gml:id="p1"
        ><gml:pos
          >42.258729 -71.16028</gml:pos
        ></gml:Point>
      </gml:pointProperty>
      <gml:pos
        >42.259112 -71.160837</gml:pos>
      <gml:pointProperty>
        <gml:Point xlink:type="simple" xlink:href="#p1"/>
      </gml:pointProperty>
    </gml:LineString>
$$);
```

☒☒: ☒☒☒☒☒☒

```
SELECT ST_AsEWKT(ST_GeomFromGML('
  <gml:PolyhedralSurface xmlns:gml="http://www.opengis.net/gml">
  <gml:polygonPatches>
    <gml:PolygonPatch>
      <gml:exterior>
        <gml:LinearRing
          ><gml:posList srsDimension="3"
            >0 0 0 0 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</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</gml:posList
              ></gml:LinearRing>
            </gml:exterior>
          </gml:PolygonPatch>
        </gml:PolygonPatch>
      </gml:polygonPatches>
    </gml:PolyhedralSurface>
  ');
```

```

>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 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:polygons>
</gml:PolyhedralSurface
>');

-- result --
POLYHEDRALSURFACE(((0 0 0,0 0 1,0 1 1,0 1 0,0 0 0)),
((0 0 0,0 1 0,1 1 0,1 0 0,0 0 0)),
((0 0 0,1 0 0,1 0 1,0 0 1,0 0 0)),
((1 1 0,1 1 1,1 0 1,1 0 0,1 1 0)),
((0 1 0,0 1 1,1 1 1,1 1 0,0 1 0)),
((0 0 1,1 0 1,1 1 1,0 1 1,0 0 1)))

```

☒☒

Section [2.2.3](#), [ST_AsGML](#), [ST_GMLToSQL](#)

7.8.3.4 ST_GeomFromGeoJSON

ST_GeomFromGeoJSON — GeoJSON ☒☒☒☒☒☒☒ PostGIS ☒☒☒☒☒☒☒☒☒.

Synopsis

```

geometry ST_GeomFromGeoJSON(text geomjson);
geometry ST_GeomFromGeoJSON(json geomjson);
geometry ST_GeomFromGeoJSON(jsonb geomjson);

```

¶¶

GeoJSON ¶¶¶¶¶¶ PostGIS ¶¶¶¶¶¶¶¶¶¶.

ST_GeomFromGML ¶ JSON ¶¶¶¶ (geometry fragment) ¶¶¶¶¶¶¶¶¶¶. ¶¶¶ JSON ¶¶¶¶ ¶¶¶¶¶¶¶¶¶¶¶¶¶¶.

Enhanced: 3.0.0 parsed geometry defaults to SRID=4326 if not specified otherwise.

Enhanced: 2.5.0 can now accept json and jsonb as inputs.

2.0.0 ¶¶¶¶¶¶¶¶¶¶¶¶. JSON-C 0.9 ¶¶¶¶¶¶¶¶¶¶¶¶.



Note

JSON-C ¶¶¶¶¶¶¶¶¶¶¶¶, ¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶. JSON-C ¶¶¶¶¶¶ ¶¶¶¶¶¶, "--with-jsondir=/path/to/json-c" ¶¶¶¶¶¶¶¶¶¶¶¶. ¶¶¶¶¶¶ Section 2.2.3 ¶¶¶¶ ¶¶¶¶.



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

¶¶

```
SELECT ST_AsText(ST_GeomFromGeoJSON('{"type":"Point","coordinates":[-48.23456,20.12345]}')) ←
    As wkt;
wkt
-----
POINT(-48.23456 20.12345)
```

```
-- a 3D linestring
SELECT ST_AsText(ST_GeomFromGeoJSON('{"type":"LineString","coordinates ←
    ":[1,2,3],[4,5,6],[7,8,9]}')) As wkt;
wkt
-----
LINESTRING(1 2,4 5,7 8)
```

¶¶

[ST_AsText](#), [ST_AsGeoJSON](#), Section 2.2.3

7.8.3.5 ST_GeomFromKML

ST_GeomFromKML — ¶¶¶ KML ¶¶¶¶¶¶¶¶ PostGIS ¶¶¶¶¶¶¶¶¶¶.

Synopsis

geometry **ST_GeomFromKML**(text geomkml);

¶¶

OGC KML ¶¶¶¶¶¶ PostGIS ST_Geometry ¶¶¶¶¶¶¶¶.

ST_GeomFromKML ¶ KML ¶¶¶¶ (geometry fragment) ¶¶¶¶¶¶¶¶¶¶. ¶¶¶ KML ¶¶¶¶¶¶
¶¶¶¶¶¶¶¶¶¶¶¶¶¶.

¶¶¶¶ OGC KML ¶¶¶¶¶¶¶¶¶¶:

- KML 2.2.0 ¶¶¶¶¶¶

OGC KML ¶¶: <http://www.opengespatial.org/standards/kml>

Availability: 1.5, requires libxml2 2.6+



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



Note

ST_GeomFromKML ¶¶¶ SQL/MM ¶¶¶¶¶¶¶¶¶¶¶¶¶¶.

¶¶: **srsName** ¶¶¶¶¶¶¶¶

```
SELECT ST_GeomFromKML($$
  <LineString>
    <coordinates>
>-71.1663,42.2614
    -71.1667,42.2616</coordinates>
  </LineString>
$$);
```

¶¶

Section [2.2.3, ST_AsKML](#)

7.8.3.6 ST_GeomFromTWKB

ST_GeomFromTWKB — TWKB("Tiny Well-Known Binary") ¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶.

Synopsis

geometry **ST_GeomFromTWKB**(bytea twkb);

¶¶

ST_GeomFromTWKB ¶¶¶ TWKB("Tiny Well-Known Binary") ¶¶¶¶¶¶ (WKB) ¶¶¶¶¶¶¶¶¶¶¶¶¶¶
¶¶¶¶¶¶¶¶¶¶.


```

SELECT ST_AsText(ST_PointFromGeoHash('9qqj7nmxcgyy4d0dbxqz0'));
           st_astext
-----
POINT(-115.172816 36.114646)

SELECT ST_AsText(ST_PointFromGeoHash('9qqj7nmxcgyy4d0dbxqz0', 4));
           st_astext
-----
POINT(-115.13671875 36.123046875)

SELECT ST_AsText(ST_PointFromGeoHash('9qqj7nmxcgyy4d0dbxqz0', 10));
           st_astext
-----
POINT(-115.172815918922 36.1146435141563)

```

☒☒

[ST_GeoHash](#), [ST_Box2dFromGeoHash](#), [ST_GeomFromGeoHash](#)

7.8.3.10 ST_FromFlatGeobufToTable

`ST_FromFlatGeobufToTable` — Creates a table based on the structure of FlatGeobuf data.

Synopsis

`void` **ST_FromFlatGeobufToTable**(text schemaname, text tablename, bytea FlatGeobuf input data);

☒☒

Creates a table based on the structure of FlatGeobuf data. (<http://flatgeobuf.org>).

schema Schema name.

table Table name.

data Input FlatGeobuf data.

Availability: 3.2.0

7.8.3.11 ST_FromFlatGeobuf

`ST_FromFlatGeobuf` — Reads FlatGeobuf data.

Synopsis

setof anyelement **ST_FromFlatGeobuf**(anyelement Table reference, bytea FlatGeobuf input data);

☒☒

Reads FlatGeobuf data (<http://flatgeobuf.org>). NOTE: PostgreSQL bytea cannot exceed 1GB.

tabletype reference to a table type.

data input FlatGeobuf data.

Availability: 3.2.0

7.9 Geometry Output

7.9.1 Well-Known Text (WKT)

7.9.1.1 ST_AsEWKT

`ST_AsEWKT` — WKT(Well-Known Text) SRID

Synopsis

```
text ST_AsEWKT(geometry g1);
text ST_AsEWKT(geometry g1, integer maxdecimaldigits=15);
text ST_AsEWKT(geography g1);
text ST_AsEWKT(geography g1, integer maxdecimaldigits=15);
```

Returns the Well-Known Text representation of the geometry prefixed with the SRID. The optional *maxdecimaldigits* argument may be used to reduce the maximum number of decimal digits after floating point used in output (defaults to 15).

To perform the inverse conversion of EWKT representation to PostGIS geometry use [ST_GeomFromEWKT](#).



Warning

Using the *maxdecimaldigits* parameter can cause output geometry to become invalid. To avoid this use [ST_ReducePrecision](#) with a suitable gridsize first.



Note

The WKT spec does not include the SRID. To get the OGC WKT format use [ST_AsText](#).



Warning

WKT format does not maintain precision so to prevent floating truncation, use [ST_AsBinary](#) or [ST_AsEWKB](#) format for transport.

Enhanced: 3.1.0 support for optional precision parameter.

2.0.0, TIN.



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



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).


```

<script type="text/javascript" src="http://maps.googleapis.com/maps/api/js?libraries= ↵
  geometry"
></script>
<script type="text/javascript">
  flightPath = new google.maps.Polyline({
    path: google.maps.geometry.encoding.decodePath("$encodedFlightPath ↵
    "),
    map: map,
    strokeColor: '#0000CC',
    strokeOpacity: 1.0,
    strokeWeight: 4
  });
</script>

```

☒☒

[ST_LineFromEncodedPolyline](#), [ST_Segmentize](#)

7.9.3.2 ST_AsFlatGeobuf

ST_AsFlatGeobuf — Return a FlatGeobuf representation of a set of rows.

Synopsis

```

bytea ST_AsFlatGeobuf(anelement set row);
bytea ST_AsFlatGeobuf(anelement row, bool index);
bytea ST_AsFlatGeobuf(anelement row, bool index, text geom_name);

```

☒☒

Return a FlatGeobuf representation (<http://flatgeobuf.org>) of a set of rows corresponding to a FeatureCollection. NOTE: PostgreSQL bytea cannot exceed 1GB.

row row data with at least a geometry column.

index toggle spatial index creation. Default is false.

geom_name is the name of the geometry column in the row data. If NULL it will default to the first found geometry column.

Availability: 3.2.0

7.9.3.3 ST_AsGeobuf

ST_AsGeobuf — Return a Geobuf representation of a set of rows.

Synopsis

```

bytea ST_AsGeobuf(anelement set row);
bytea ST_AsGeobuf(anelement row, text geom_name);

```

☒☒

Return a Geobuf representation (<https://github.com/mapbox/geobuf>) of a set of rows corresponding to a FeatureCollection. Every input geometry is analyzed to determine maximum precision for optimal storage. Note that Geobuf in its current form cannot be streamed so the full output will be assembled in memory.

row row data with at least a geometry column.

geom_name is the name of the geometry column in the row data. If NULL it will default to the first found geometry column.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
SELECT encode(ST_AsGeobuf(q, 'geom'), 'base64')
  FROM (SELECT ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))') AS geom) AS q;
 st_asgeobuf
-----
GAAiEAo0CgwIBBoIAAAAAgIAAAE=
```

7.9.3.4 ST_AsGeoJSON

ST_AsGeoJSON — Return a geometry or feature in GeoJSON format.

Synopsis

```
text ST_AsGeoJSON(record feature, text geom_column="", integer maxdecimaldigits=9, boolean
pretty_bool=false, text id_column="");
text ST_AsGeoJSON(geometry geom, integer maxdecimaldigits=9, integer options=8);
text ST_AsGeoJSON(geography geog, integer maxdecimaldigits=9, integer options=0);
```

☒☒

Returns a geometry as a GeoJSON "geometry" object, or a row as a GeoJSON "feature" object.

The resulting GeoJSON geometry and feature representations conform with the [GeoJSON specifications RFC 7946](#), except when the parsed geometries are referenced with a CRS other than WGS84 longitude and latitude ([EPSG:4326](#), [urn:ogc:def:crs:OGC::CRS84](#)); the GeoJSON geometry object will then have a short CRS SRID identifier attached by default. 2D and 3D Geometries are both supported. GeoJSON only supports SFS 1.1 geometry types (no curve support for example).

The geom_column parameter is used to distinguish between multiple geometry columns. If omitted, the first geometry column in the record will be determined. Conversely, passing the parameter will save column type lookups.

The maxdecimaldigits argument may be used to reduce the maximum number of decimal places used in output (defaults to 9). If you are using EPSG:4326 and are outputting the geometry only for display, maxdecimaldigits=6 can be a good choice for many maps.



Warning

Using the *maxdecimaldigits* parameter can cause output geometry to become invalid. To avoid this use [ST_ReducePrecision](#) with a suitable gridsize first.


```
{ "type": "FeatureCollection", "features": [ { "type": "Feature", "geometry": { "type": "Point", "coordinates": [1,1] }, "id": 1, "properties": { "name": "one" } }, { "type": "Feature", "geometry": { "type": "Point", "coordinates": [2,2] }, "id": 2, "properties": { "name": "two" } }, { "type": "Feature", "geometry": { "type": "Point", "coordinates": [3,3] }, "id": 3, "properties": { "name": "three" } } ] }
```

Generate a Feature:

```
SELECT ST_AsGeoJSON(t.*, id_column =
> 'id')
FROM (VALUES (1, 'one', 'POINT(1 1)::geometry)) AS t(id, name, geom);
```

```
st_asgeojson
```

```
{ "type": "Feature", "geometry": { "type": "Point", "coordinates": [1,1] }, "id": 1, "properties": { "name": "one" } }
```

Don't forget to transform your data to WGS84 longitude, latitude to conform with the GeoJSON specification:

```
SELECT ST_AsGeoJSON(ST_Transform(geom,4326)) from fe_edges limit 1;
```

```
st_asgeojson
```

```
{ "type": "MultiLineString", "coordinates": [ [ [ [-89.734634999999997, 31.492072000000000], [-89.734959999999997, 31.492237999999997] ] ] ] }
```

3D geometries are supported:

```
SELECT ST_AsGeoJSON('LINESTRING(1 2 3, 4 5 6)');
```

```
{ "type": "LineString", "coordinates": [ [ [1,2,3], [4,5,6] ] ] }
```

☒☒

[ST_GeomFromGeoJSON](#), [ST_ForcePolygonCCW](#), [ST_Transform](#)

7.9.3.5 ST_AsGML

ST_AsGML — ☒☒☒ GML 2 ☒☒ GML 3 ☒☒☒☒☒☒☒☒☒☒.

Synopsis

```
text ST_AsGML(geometry geom, integer maxdecimaldigits=15, integer options=0);
text ST_AsGML(geography geog, integer maxdecimaldigits=15, integer options=0, text nprefix=null, text id=null);
text ST_AsGML(integer version, geometry geom, integer maxdecimaldigits=15, integer options=0, text nprefix=null, text id=null);
text ST_AsGML(integer version, geography geog, integer maxdecimaldigits=15, integer options=0, text nprefix=null, text id=null);
```


☒☒: ☒☒ 2

```
SELECT ST_AsGML(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));
      st_asgml
-----
      <gml:Polygon srsName="EPSG:4326"
><gml:outerBoundaryIs
><gml:LinearRing
><gml:coordinates
>0,0 0,1 1,1 1,0 0,0</gml:coordinates
></gml:LinearRing
></gml:outerBoundaryIs
></gml:Polygon>
```

☒☒: ☒☒ 3

```
-- Flip coordinates and output extended EPSG (16 | 1)--
SELECT ST_AsGML(3, ST_GeomFromText('POINT(5.234234233242 6.34534534534)',4326), 5, 17);
      st_asgml
-----
      <gml:Point srsName="urn:ogc:def:crs:EPSG::4326"
><gml:pos
>6.34535 5.23423</gml:pos
></gml:Point>
```

```
-- Output the envelope (32) --
SELECT ST_AsGML(3, ST_GeomFromText('LINESTRING(1 2, 3 4, 10 20)',4326), 5, 32);
      st_asgml
-----
      <gml:Envelope srsName="EPSG:4326">
        <gml:lowerCorner
>1 2</gml:lowerCorner>
        <gml:upperCorner
>10 20</gml:upperCorner>
      </gml:Envelope>
```

```
-- Output the envelope (32) , reverse (lat lon instead of lon lat) (16), long srs (1)= 32 | ↔
16 | 1 = 49 --
SELECT ST_AsGML(3, ST_GeomFromText('LINESTRING(1 2, 3 4, 10 20)',4326), 5, 49);
      st_asgml
-----
      <gml:Envelope srsName="urn:ogc:def:crs:EPSG::4326">
        <gml:lowerCorner
>2 1</gml:lowerCorner>
        <gml:upperCorner
>20 10</gml:upperCorner>
      </gml:Envelope>
```

```
-- Polyhedral Example --
SELECT ST_AsGML(3, ST_GeomFromEWKT('POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0) ↔
),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )''));
      st_asgml
```

```

-----
<gml:PolyhedralSurface>
<gml:polygonPatches>
  <gml:PolygonPatch>
    <gml:exterior>
      <gml:LinearRing>
        <gml:posList srsDimension="3"
>0 0 0 0 0 1 0 1 1 0 1 0 0 0 0 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 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 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 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 0</gml:posList>
                </gml:LinearRing>
              </gml:exterior>
            </gml:PolygonPatch>
            <gml:PolygonPatch>
              <gml:exterior>
                <gml:LinearRing>
                  <gml:posList srsDimension="3"
>0 0 1 1 0 1 1 1 1 0 1 1 0 0 1</gml:posList>
                  </gml:LinearRing>
                </gml:exterior>
              </gml:PolygonPatch>
            </gml:polygonPatches>
          </gml:PolyhedralSurface>

```

☒☒

[ST_GeomFromGML](#)

7.9.3.6 ST_AsKML

ST_AsKML — GML 2 GML 3

Synopsis

text ST_AsKML(geometry geom, integer maxdecimaldigits=15, text nprefix=NULL);
text ST_AsKML(geography geog, integer maxdecimaldigits=15, text nprefix=NULL);

KML(Keyhole Markup Language) . . . (15), 2 . . .



Warning

Using the *maxdecimaldigits* parameter can cause output geometry to become invalid. To avoid this use **ST_ReducePrecision** with a suitable gridsize first.



Note

PostGIS Proj . . . Proj . . . **PostGIS_Full_Version** . . .



Note

1.2.2 . . . 1.3.2 . . .



Note

: 2.0.0



Note

Changed: 3.0.0 - Removed the "versioned" variant signature



Note

ST_AsKML SRID . . .



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



This function returns a MARC21/XML record with **Coded Cartographic Mathematical Data** representing the bounding box of a given geometry. The format parameter allows to encode the coordinates in subfields \$d,\$e,\$f and \$g in all formats supported by the MARC21/XML standard. Valid formats are:

- cardinal direction, degrees, minutes and seconds (default): hdddmmss
- decimal degrees with cardinal direction: hddd.ddddd
- decimal degrees without cardinal direction: ddd.ddddd
- decimal minutes with cardinal direction: hdddmm.mmmm
- decimal minutes without cardinal direction: dddmm.mmmm
- decimal seconds with cardinal direction: hdddmmss.sss

The decimal sign may be also a comma, e.g. hdddmm,mmm.

The precision of decimal formats can be limited by the number of characters after the decimal sign, e.g. hdddmm.mm for decimal minutes with a precision of two decimals.

This function ignores the Z and M dimensions.

LOC MARC21/XML versions supported:

- **MARC21/XML 1.1**

Availability: 3.3.0



Note

This function does not support non lon/lat geometries, as they are not supported by the MARC21/XML standard (Coded Cartographic Mathematical Data).



Note

The MARC21/XML Standard does not provide any means to annotate the spatial reference system for Coded Cartographic Mathematical Data, which means that this information will be lost after conversion to MARC21/XML.



Converting a POINT to MARC21/XML formatted as hdddmmss (default)

```
SELECT ST_AsMARC21('SRID=4326;POINT(-4.504289 54.253312)')::geometry);

          st_asmarc21
-----
<record xmlns="http://www.loc.gov/MARC21/slim">
  <datafield tag="034" ind1="1" ind2=" ">
    <subfield code="a"
>a</subfield>
    <subfield code="d"
>W0043015</subfield>
    <subfield code="e"
```

```

>W0043015</subfield>
      <subfield code="f"
>N0541512</subfield>
      <subfield code="g"
>N0541512</subfield>
      </datafield>
</record>

```

Converting a POLYGON to MARC21/XML formatted in decimal degrees

```

SELECT ST_AsMARC21('SRID=4326;POLYGON((-4.5792388916015625 ↔
54.18172660239091,-4.56756591796875 ↔
54.196993557130355,-4.546623229980469 ↔
54.18313300502024,-4.5792388916015625 54.18172660239091))'::geometry,' ↔
hddd.dddd');

<record xmlns="http://www.loc.gov/MARC21/slim">
  <datafield tag="034" ind1="1" ind2=" ">
    <subfield code="a"
>a</subfield>
    <subfield code="d"
>W004.5792</subfield>
    <subfield code="e"
>W004.5466</subfield>
    <subfield code="f"
>N054.1970</subfield>
    <subfield code="g"
>N054.1817</subfield>
  </datafield>
</record>

```

Converting a GEOMETRYCOLLECTION to MARC21/XML formatted in decimal minutes. The geometries order in the MARC21/XML output correspond to their order in the collection.

```

SELECT ST_AsMARC21('SRID=4326;GEOMETRYCOLLECTION(POLYGON((13.1 ↔
52.65,13.516666666666667 52.65,13.516666666666667 52.38333333333333,13.1 ↔
52.38333333333333,13.1 52.65)),POINT(-4.5 54.25))'::geometry,'hdddmm. ↔
mmmm');

          st_asmarc21
-----
<record xmlns="http://www.loc.gov/MARC21/slim">
  <datafield tag="034" ind1="1" ind2=" ">
    <subfield code="a"
>a</subfield>
    <subfield code="d"
>E01307.0000</subfield>
    <subfield code="e"
>E01331.0000</subfield>
    <subfield code="f"
>N05240.0000</subfield>
    <subfield code="g"

```

```

>N05224.0000</subfield>
      </datafield>
      <datafield tag="034" ind1="1" ind2=" " >
        <subfield code="a"
>a</subfield>
          <subfield code="d"
>W00430.0000</subfield>
            <subfield code="e"
>W00430.0000</subfield>
              <subfield code="f"
>N05415.0000</subfield>
                <subfield code="g"
>N05415.0000</subfield>
          </datafield>
</record>

```

☒☒

ST_GeomFromMARC21

7.9.3.9 ST_AsMVTGeom

ST_AsMVTGeom — Transforms a geometry into the coordinate space of a MVT tile.

Synopsis

geometry **ST_AsMVTGeom**(geometry geom, box2d bounds, integer extent=4096, integer buffer=256, boolean clip_geom=true);

☒☒

Transforms a geometry into the coordinate space of a MVT ([Mapbox Vector Tile](#)) tile, clipping it to the tile bounds if required. The geometry must be in the coordinate system of the target map (using [ST_Transform](#) if needed). Commonly this is [Web Mercator](#) (SRID:3857).

The function attempts to preserve geometry validity, and corrects it if needed. This may cause the result geometry to collapse to a lower dimension.

The rectangular bounds of the tile in the target map coordinate space must be provided, so the geometry can be transformed, and clipped if required. The bounds can be generated using [ST_TileEnvelope](#).

This function is used to convert geometry into the tile coordinate space required by [ST_AsMVT](#).

geom is the geometry to transform, in the coordinate system of the target map.

bounds is the rectangular bounds of the tile in map coordinate space, with no buffer.

extent is the tile extent size in tile coordinate space as defined by the [MVT specification](#). Defaults to 4096.

buffer is the buffer size in tile coordinate space for geometry clipping. Defaults to 256.

clip_geom is a boolean to control if geometries are clipped or encoded as-is. Defaults to true.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

**Note**

From 3.0, Wagyu can be chosen at configure time to clip and validate MVT polygons. This library is faster and produces more correct results than the GEOS default, but it might drop small polygons.



```
SELECT ST_AsText(ST_AsMVTGeom(
  ST_GeomFromText('POLYGON ((0 0, 10 0, 10 5, 0 -5, 0 0))'),
  ST_MakeBox2D(ST_Point(0, 0), ST_Point(4096, 4096)),
  4096, 0, false));
           st_astext
-----
MULTIPOLYGON(((5 4096,10 4091,10 4096,5 4096)),((5 4096,0 4101,0 4096,5 4096)))
```

Canonical example for a Web Mercator tile using a computed tile bounds to query and clip geometry.

```
SELECT ST_AsMVTGeom(
  ST_Transform( geom, 3857 ),
  ST_TileEnvelope(12, 513, 412), extent =
> 4096, buffer =
> 64) AS geom
FROM data
WHERE geom && ST_TileEnvelope(12, 513, 412, margin =
> (64.0 / 4096))
```



[ST_AsMVT](#), [ST_TileEnvelope](#), [PostGIS_Wagyu_Version](#)

7.9.3.10 ST_AsMVT

ST_AsMVT — Aggregate function returning a MVT representation of a set of rows.

Synopsis

```
bytea ST_AsMVT(anyelement set row);
bytea ST_AsMVT(anyelement row, text name);
bytea ST_AsMVT(anyelement row, text name, integer extent);
bytea ST_AsMVT(anyelement row, text name, integer extent, text geom_name);
bytea ST_AsMVT(anyelement row, text name, integer extent, text geom_name, text feature_id_name);
```



An aggregate function which returns a binary [Mapbox Vector Tile](#) representation of a set of rows corresponding to a tile layer. The rows must contain a geometry column which will be encoded as a feature geometry. The geometry must be in tile coordinate space and valid as per the [MVT specification](#). [ST_AsMVTGeom](#) can be used to transform geometry into tile coordinate space. Other row columns are encoded as feature attributes.

The **Mapbox Vector Tile** format can store features with varying sets of attributes. To use this capability supply a JSONB column in the row data containing Json objects one level deep. The keys and values in the JSONB values will be encoded as feature attributes.

Tiles with multiple layers can be created by concatenating multiple calls to this function using `||` or `STRING_AGG`.



Important

Do not call with a `GEOMETRYCOLLECTION` as an element in the row. However you can use `ST_AsMVTGeom` to prepare a geometry collection for inclusion.

row row data with at least a geometry column.

name is the name of the layer. Default is the string "default".

extent is the tile extent in screen space as defined by the specification. Default is 4096.

geom_name is the name of the geometry column in the row data. Default is the first geometry column. Note that PostgreSQL by default automatically **folds unquoted identifiers to lower case**, which means that unless the geometry column is quoted, e.g. "MyMVTGeom", this parameter must be provided as lowercase.

feature_id_name is the name of the Feature ID column in the row data. If NULL or negative the Feature ID is not set. The first column matching name and valid type (smallint, integer, bigint) will be used as Feature ID, and any subsequent column will be added as a property. JSON properties are not supported.

Enhanced: 3.0 - added support for Feature ID.

Enhanced: 2.5.0 - added support parallel query.

2.2.0

```
WITH mvtgeom AS
(
  SELECT ST_AsMVTGeom(geom, ST_TileEnvelope(12, 513, 412), extent =
> 4096, buffer =
> 64) AS geom, name, description
  FROM points_of_interest
  WHERE geom && ST_TileEnvelope(12, 513, 412, margin =
> (64.0 / 4096))
)
SELECT ST_AsMVT(mvtgeom.*)
FROM mvtgeom;
```

[ST_AsMVTGeom](#), [ST_TileEnvelope](#)

7.9.3.11 ST_AsSVG

`ST_AsSVG` — Returns SVG path data for a geometry.

Synopsis

```
text ST_AsSVG(geometry geom, integer rel=0, integer maxdecimaldigits=15);
text ST_AsSVG(geography geog, integer rel=0, integer maxdecimaldigits=15);
```

SVG

SVG (Scalar Vector Graphics) is a vector graphics format. It uses relative move (relative move) and absolute move (absolute move) commands. The 'rel' argument (0 or 1) controls the use of relative or absolute coordinates. The 'maxdecimaldigits' argument (0 to 15) controls the number of decimal digits. The 'cx/cy' argument (0 or 1) controls the use of cx/cy or x/y coordinates. The '","' and '";' arguments control the use of comma or semicolon as a separator.

For working with PostGIS SVG graphics, checkout [pg_svg](#) library which provides plpgsql functions for working with outputs from ST_AsSVG.

Enhanced: 3.4.0 to support all curve types

Changes: 2.0.0 (default arg) and (named arg) added.



Note

1.2.2 and 1.4.0 <http://www.w3.org/TR/SVG-paths.html#PathDataBNF> L



This method supports Circular Strings and Curves.

SVG

```
SELECT ST_AsSVG('POLYGON((0 0,0 1,1 1,0 0))'::geometry);
```

```
st_assvg
```

```
-----
```

```
M 0 0 L 0 -1 1 -1 1 0 Z
```

Circular string

```
SELECT ST_AsSVG( ST_GeomFromText('CIRCULARSTRING(-2 0,0 2,2 0,0 2,2 4)') );
```

```
st_assvg
```

```
-----
```

```
M -2 0 A 2 2 0 0 1 2 0 A 2 2 0 0 1 2 -4
```

Multi-curve

```
SELECT ST_AsSVG('MULTICURVE((5 5,3 5,3 3,0 3),
  CIRCULARSTRING(0 0,2 1,2 2))'::geometry, 0, 0);
```

```
st_assvg
```

```
-----
```

```
M 5 -5 L 3 -5 3 -3 0 -3 M 0 0 A 2 2 0 0 0 2 -2
```

Multi-surface

```
SELECT ST_AsSVG('MULTISURFACE(
  CURVEPOLYGON(CIRCULARSTRING(-2 0,-1 -1,0 0,1 -1,2 0,0 2,-2 0),
    (-1 0,0 0.5,1 0,0 1,-1 0)),
  ((7 8,10 10,6 14,4 11,7 8))'::geometry, 0, 2);
```

st_assvg

```

-----
M -2 0 A 1 1 0 0 0 0 0 A 1 1 0 0 0 2 0 A 2 2 0 0 0 -2 0 Z
M -1 0 L 0 -0.5 1 0 0 -1 -1 0 Z
M 7 -8 L 10 -10 6 -14 4 -11 Z

```

7.9.3.12 ST_AsTWKB

ST_AsTWKB — TWKB(Tiny Well-Known Binary).

Synopsis

bytea **ST_AsTWKB**(geometry geom, integer prec=0, integer prec_z=0, integer prec_m=0, boolean with_sizes=false, boolean with_boxes=false);

bytea **ST_AsTWKB**(geometry[] geom, bigint[] ids, integer prec=0, integer prec_z=0, integer prec_m=0, boolean with_sizes=false, boolean with_boxes=false);

TWKB(Tiny Well-Known Binary). TWKB .

. ., .

. . TWKB .

. TWKB . array_agg .



Note <https://github.com/TWKB/Specification>, <https://github.com/TWKB/twkb.js>

Enhanced: 2.4.0 memory and speed improvements.

2.2.0 .

```

SELECT ST_AsTWKB('LINESTRING(1 1,5 5)')::geometry);
          st_astwkb
-----
\x02000202020808

```

TWKB , "array_agg()" TWKB .

PostGIS	2D X3D	3D X3D
POINT		
(MULTI) POLYGON, POLYHEDRALSURFACE	X3D (markup)	IndexedFaceSet (faceset)
TIN	TriangleSet2D	IndexedTriangleSet



Note

2 ...

Lots of advancements happening in 3D space particularly with X3D Integration with HTML5

Free Wrl ... http://freewrl.sourceforge.net/ ... FreeWRL_Launcher

Also check out PostGIS minimalist X3D viewer that utilizes this function and x3dDom html/js open source toolkit.

2.0.0 ISO-IEC-19776-1.2-X3DEncodings-XML

2.2.0 (x/y, z) ...

- ✔ 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).

FreeWrl X3D ...

```

SELECT '<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE X3D PUBLIC "ISO//Web3D//DTD X3D 3.0//EN" "http://www.web3d.org/specifications/x3d
-3.0.dtd">
<X3D>
  <Scene>
    <Transform>
      <Shape>
        <Appearance>
          <Material emissiveColor='0 0 1' />
        </Appearance>
      </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>
```

PostGIS buildings

Copy and paste the output of this query to [x3d scene viewer](#) and click Show

```
SELECT string_agg('<Shape
>' || ST_AsX3D(ST_Extrude(geom, 0,0, i*0.5)) ||
  '<Appearance>
    <Material diffuseColor="' || (0.01*i)::text || ' 0.8 0.2" specularColor="' || ←
    (0.05*i)::text || ' 0 0.5"/>
  </Appearance>
</Shape
>', '')
FROM ST_Subdivide(ST_Letters('PostGIS'),20) WITH ORDINALITY AS f(geom,i);
```



Buildings formed by subdividing PostGIS and extrusion

☒☒: ☒☒☒☒☒☒ 6 ☒☒ 3 ☒☒☒☒☒☒☒☒☒

```
SELECT ST_AsX3D(
ST_Translate(
  ST_Force_3d(
    ST_Buffer(ST_Point(10,10),5, 'quad_segs=2')), 0,0,
    3)
,6) As x3dfrag;
```

```
x3dfrag
-----
<IndexedFaceSet coordIndex="0 1 2 3 4 5 6 7">
  <Coordinate point="15 10 3 13.535534 6.464466 3 10 5 3 6.464466 6.464466 3 5 10 3  ←
    6.464466 13.535534 3 10 15 3 13.535534 13.535534 3 " />
</IndexedFaceSet>
```

TIN

```
SELECT ST_AsX3D(ST_GeomFromEWKT('TIN (((
    0 0 0,
    0 0 1,
    0 1 0,
    0 0 0
  )), ((
    0 0 0,
    0 1 0,
    1 1 0,
    0 0 0
  ))
)')) As x3dfrag;

x3dfrag
-----
<IndexedTriangleSet index='0 1 2 3 4 5'
><Coordinate point='0 0 0 0 1 0 1 0 0 0 0 0 1 0 1 1 0' /></IndexedTriangleSet>
```

MULTILINESTRING (MULTILINESTRING)

```
SELECT ST_AsX3D(
  ST_GeomFromEWKT('MULTILINESTRING((20 0 10,16 -12 10,0 -16 10,-12 -12  ←
    10,-20 0 10,-12 16 10,0 24 10,16 16 10,20 0 10),
  (12 0 10,8 8 10,0 12 10,-8 8 10,-8 0 10,-8 -4 10,0 -8 10,8 -4 10,12 0 10)))')
) As x3dfrag;

x3dfrag
-----
<IndexedLineSet coordIndex='0 1 2 3 4 5 6 7 0 -1 8 9 10 11 12 13 14 15 8'>
  <Coordinate point='20 0 10 16 -12 10 0 -16 10 -12 -12 10 -20 0 10 -12 16 10 0 24 10 16  ←
    16 10 12 0 10 8 8 10 0 12 10 -8 8 10 -8 0 10 -8 -4 10 0 -8 10 8 -4 10 ' />
</IndexedLineSet>
```

7.9.3.14 ST_GeoHash

ST_GeoHash — GeoHash

Synopsis

text **ST_GeoHash**(geometry geom, integer maxchars=full_precision_of_point);

☒☒

Computes a **GeoHash** representation of a geometry. A GeoHash encodes a geographic Point into a text form that is sortable and searchable based on prefixing. A shorter GeoHash is a less precise representation of a point. It can be thought of as a box that contains the point.

Non-point geometry values with non-zero extent can also be mapped to GeoHash codes. The precision of the code depends on the geographic extent of the geometry.

If `maxchars` is not specified, the returned GeoHash code is for the smallest cell containing the input geometry. Points return a GeoHash with 20 characters of precision (about enough to hold the full double precision of the input). Other geometric types may return a GeoHash with less precision, depending on the extent of the geometry. Larger geometries are represented with less precision, smaller ones with more precision. The box determined by the GeoHash code always contains the input feature.

If `maxchars` is specified the returned GeoHash code has at most that many characters. It maps to a (possibly) lower precision representation of the input geometry. For non-points, the starting point of the calculation is the center of the bounding box of the geometry.

1.4.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



Note

ST_GeoHash requires input geometry to be in geographic (lon/lat) coordinates.



This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_GeoHash( ST_Point(-126,48) );
```

```
      st_geohash
```

```
-----  
c0w3hf1s70w3hf1s70w3
```

```
SELECT ST_GeoHash( ST_Point(-126,48), 5);
```

```
      st_geohash
```

```
-----  
c0w3h
```

```
-- This line contains the point, so the GeoHash is a prefix of the point code
```

```
SELECT ST_GeoHash('LINESTRING(-126 48, -126.1 48.1)::geometry);
```

```
      st_geohash
```

```
-----  
c0w3
```

☒☒

ST_GeomFromGeoHash, ST_PointFromGeoHash, ST_Box2dFromGeoHash

7.10 **&&** (operator)

7.10.1 Bounding Box Operators

7.10.1.1 &&

&& — A 2D geometry B 2D geometry TRUE.

Synopsis

boolean **&&**(geometry A , geometry B);
 boolean **&&**(geography A , geography B);

&& A 2D geometry B 2D geometry TRUE.



Note

(operand) geometry.

2.0.0 (polyhedral surface) geometry.

1.5.0 geometry.

This method supports Circular Strings and Curves.

This function supports Polyhedral surfaces.

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 && tbl2.column2 AS overlaps
FROM ( VALUES
      (1, 'LINESTRING(0 0, 3 3)::geometry),
      (2, 'LINESTRING(0 1, 0 5)::geometry)) AS tbl1,
( VALUES
      (3, 'LINESTRING(1 2, 4 6)::geometry)) AS tbl2;
```

column1	column1	overlaps
1	3	t
2	3	f

(2 rows)

ST_Intersects, **ST_Extent**, **|&>**, **&>**, **&<|**, **&<**, **~**, **@**

7.10.1.2 **&&(geometry,box2df)**

&&(geometry,box2df) — Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).

Synopsis

boolean **&&**(geometry A , box2df B);

☒☒

The **&&** operator returns TRUE if the cached 2D bounding box of geometry A intersects the 2D bounding box B, using float precision. This means that if B is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)



Note

This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.

☒☒

```
SELECT ST_Point(1,1) && ST_MakeBox2D(ST_Point(0,0), ST_Point(2,2)) AS overlaps;
```

```
overlaps
-----
t
(1 row)
```

☒☒

&&(box2df,geometry), **&&**(box2df,box2df), **~**(geometry,box2df), **~**(box2df,geometry), **~**(box2df,box2df), **@**(geometry,box2df), **@**(box2df,geometry), **@**(box2df,box2df)

7.10.1.3 **&&**(box2df,geometry)

&&(box2df,geometry) — Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.

Synopsis

boolean **&&**(box2df A , geometry B);

☒☒

The && operator returns TRUE if the 2D bounding box A intersects the cached 2D bounding box of geometry B, using float precision. This means that if A is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

**Note**

This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.

☒☒

```
SELECT ST_MakeBox2D(ST_Point(0,0), ST_Point(2,2)) && ST_Point(1,1) AS overlaps;
```

```
overlaps
-----
t
(1 row)
```

☒☒

&&(geometry,box2df), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,geometry), ~(box2df,box2df),
@(geometry,box2df), @(box2df,geometry), @(box2df,box2df)

7.10.1.4 &&(box2df,box2df)

&&(box2df,box2df) — Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.

Synopsis

boolean **&&**(box2df A , box2df B);

☒☒

The && operator returns TRUE if two 2D bounding boxes A and B intersect each other, using float precision. This means that if A (or B) is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

**Note**

This operator is intended to be used internally by BRIN indexes, more than by users.

3

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 &&& tbl2.column2 AS overlaps_3d,
      tbl1.column2 && tbl2.column2 AS overlaps_2d
FROM ( VALUES
      (1, 'LINESTRING Z(0 0 1, 3 3 2)::geometry),
      (2, 'LINESTRING Z(1 2 0, 0 5 -1)::geometry)) AS tbl1,
( VALUES
      (3, 'LINESTRING Z(1 2 1, 4 6 1)::geometry)) AS tbl2;
```

column1	column1	overlaps_3d	overlaps_2d
1	3	t	t
2	3	f	t

3DM

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 &&& tbl2.column2 AS overlaps_3zm,
      tbl1.column2 && tbl2.column2 AS overlaps_2d
FROM ( VALUES
      (1, 'LINESTRING M(0 0 1, 3 3 2)::geometry),
      (2, 'LINESTRING M(1 2 0, 0 5 -1)::geometry)) AS tbl1,
( VALUES
      (3, 'LINESTRING M(1 2 1, 4 6 1)::geometry)) AS tbl2;
```

column1	column1	overlaps_3zm	overlaps_2d
1	3	t	t
2	3	f	t

&&

7.10.1.6 &&&(geometry,gidx)

&&&(geometry,gidx) — Returns TRUE if a geometry’s (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).

Synopsis

boolean **&&&**(geometry A , gidx B);

The **&&&** operator returns TRUE if the cached n-D bounding box of geometry A intersects the n-D bounding box B, using float precision. This means that if B is a (double precision) box3d, it will be internally converted to a float precision 3D bounding box (GIDX)

**Note**

This operator is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).



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



```
SELECT ST_MakePoint(1,1,1) &&& ST_3DMakeBox(ST_MakePoint(0,0,0), ST_MakePoint(2,2,2)) AS ←
    overlaps;
```

```
overlaps
-----
t
(1 row)
```



&&&(gidx,geometry), &&&(gidx,gidx)

7.10.1.7 &&&(gidx,geometry)

&&&(gidx,geometry) — Returns TRUE if a n-D float precision bounding box (GIDX) intersects a geometry's (cached) n-D bounding box.

Synopsis

boolean **&&&**(gidx A , geometry B);







The **&&&** operator returns TRUE if the n-D bounding box A intersects the cached n-D bounding box of geometry B, using float precision. This means that if A is a (double precision) box3d, it will be internally converted to a float precision 3D bounding box (GIDX)

**Note**

This operator is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

-  This method supports Circular Strings and Curves.
-  This function supports Polyhedral surfaces.
-  This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).
-  This function supports 3d and will not drop the z-index.

☒☒

```
SELECT ST_3DMakeBox(ST_MakePoint(0,0,0), ST_MakePoint(2,2,2)) &&& ST_MakePoint(1,1,1) AS overlaps; ↵
```

```
overlaps
-----
t
(1 row)
```

☒☒

&&&(geometry,gidx), &&&(gidx,gidx)

7.10.1.8 &&&(gidx,gidx)

&&&(gidx,gidx) — Returns TRUE if two n-D float precision bounding boxes (GIDX) intersect each other.

Synopsis

boolean **&&&**(gidx A , gidx B);

☒☒





The &&& operator returns TRUE if two n-D bounding boxes A and B intersect each other, using float precision. This means that if A (or B) is a (double precision) box3d, it will be internally converted to a float precision 3D bounding box (GIDX)



Note

This operator is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.

-  This method supports Circular Strings and Curves.
-  This function supports Polyhedral surfaces.
-  This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).
-  This function supports 3d and will not drop the z-index.

Synopsis

boolean **&>**(geometry A , geometry B);

&> returns true if geometry A intersects geometry B, false otherwise. TRUE if both are NULL.



Note

(operand) must be a geometry.

```
SELECT tbl1.column1, tbl2.column1, tbl1.column2 &
> tbl2.column2 AS overright
FROM
  ( VALUES
    (1, 'LINESTRING(1 2, 4 6)::geometry) AS tbl1,
  ( VALUES
    (2, 'LINESTRING(0 0, 3 3)::geometry),
    (3, 'LINESTRING(0 1, 0 5)::geometry),
    (4, 'LINESTRING(6 0, 6 1)::geometry) AS tbl2;
```

column1	column1	overright
1	2	t
1	3	t
1	4	f

(3 rows)

&&, **|&>**, **&<**, **&<**

7.10.1.12 <<

<< — A contains B, TRUE if both are NULL.

Synopsis

boolean **<<**(geometry A , geometry B);

<< returns true if geometry A contains geometry B, false otherwise. TRUE if both are NULL.



Note

(operand) must be a geometry.


```

1 | 3 | f
1 | 4 | f
(3 rows)

```

☒☒

<<, >>, |>>

7.10.1.14 =

= — Returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B.

Synopsis

```

boolean =( geometry A , geometry B );
boolean =( geography A , geography B );

```

☒☒

The = operator returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B. PostgreSQL uses the =, <, and > operators defined for geometries to perform internal orderings and comparison of geometries (ie. in a GROUP BY or ORDER BY clause).



Note

Only geometry/geography that are exactly equal in all respects, with the same coordinates, in the same order, are considered equal by this operator. For "spatial equality", that ignores things like coordinate order, and can detect features that cover the same spatial area with different representations, use [ST_OrderingEquals](#) or [ST_Equals](#)



Caution

This operand will NOT make use of any indexes that may be available on the geometries. For an index assisted exact equality test, combine = with &&.

Changed: 2.4.0, in prior versions this was bounding box equality not a geometric equality. If you need bounding box equality, use `~=` instead.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.

☒☒


```

-----+-----+-----
      1 |      2 | t
      1 |      3 | f
      1 |      4 | t
(3 rows)
    
```

☒☒

~, &&

7.10.1.17 @(geometry,box2df)

@(geometry,box2df) — Returns TRUE if a geometry’s 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).

Synopsis

boolean @(geometry A , box2df B);

☒☒

The @ operator returns TRUE if the A geometry’s 2D bounding box is contained the 2D bounding box B, using float precision. This means that if B is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)



Note

This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.

☒☒

```

SELECT ST_Buffer(ST_GeomFromText('POINT(2 2)'), 1) @ ST_MakeBox2D(ST_Point(0,0), ST_Point(
      (5,5)) AS is_contained;
    
```

```

is_contained
-----
t
(1 row)
    
```

☒☒

&&(geometry,box2df), &&(box2df,geometry), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,geometry), ~(box2df,box2df), @(box2df,geometry), @(box2df,box2df)

7.10.1.18 @(box2df,geometry)

@(box2df,geometry) — Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.

Synopsis

```
boolean @( box2df A , geometry B );
```

☒☒

The @ operator returns TRUE if the 2D bounding box A is contained into the B geometry's 2D bounding box, using float precision. This means that if B is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)

**Note**

This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.

☒☒

```
SELECT ST_MakeBox2D(ST_Point(2,2), ST_Point(3,3)) @ ST_Buffer(ST_GeomFromText('POINT(1 1)') ←
, 10) AS is_contained;
```

```
is_contained
-----
t
(1 row)
```

☒☒

&&(geometry,box2df), &&(box2df,geometry), &&(box2df,box2df), ~(geometry,box2df), ~(box2df,geometry),
~(box2df,box2df), @(geometry,box2df), @(box2df,box2df)

7.10.1.19 @(box2df,box2df)

@(box2df,box2df) — Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.

Synopsis

```
boolean @( box2df A , box2df B );
```


7.10.1.23 ~(**geometry,box2df**)

~(**geometry,box2df**) — Returns TRUE if a geometry's 2D bonding box contains a 2D float precision bounding box (GIDX).

Synopsis

boolean ~(geometry A , box2df B);

☒☒

The ~ operator returns TRUE if the 2D bounding box of a geometry A contains the 2D bounding box B, using float precision. This means that if B is a (double precision) box2d, it will be internally converted to a float precision 2D bounding box (BOX2DF)



Note

This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.

☒☒

```
SELECT ST_Buffer(ST_GeomFromText('POINT(1 1)'), 10) ~ ST_MakeBox2D(ST_Point(0,0), ST_Point(↵
(2,2)) AS contains;
```

```
contains
-----
t
(1 row)
```

☒☒

&&(geometry,box2df), &&(box2df,geometry), &&(box2df,box2df), ~(box2df,geometry), ~(box2df,box2df), @ (geometry,box2df), @ (box2df,geometry), @ (box2df,box2df)

7.10.1.24 ~(**box2df,geometry**)

~(**box2df,geometry**) — Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bonding box.

Synopsis

boolean ~(box2df A , geometry B);

☒☒

The `~` operator returns TRUE if the 2D bounding box A contains the B geometry's bounding box, using float precision. This means that if A is a (double precision) `box2d`, it will be internally converted to a float precision 2D bounding box (BOX2DF)

**Note**

This operand is intended to be used internally by BRIN indexes, more than by users.

Availability: 2.3.0 support for Block Range INdexes (BRIN) was introduced. Requires PostgreSQL 9.5+.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.

☒☒

```
SELECT ST_MakeBox2D(ST_Point(0,0), ST_Point(5,5)) ~ ST_Buffer(ST_GeomFromText('POINT(2 2)') ←
, 1) AS contains;
```

```
contains
-----
t
(1 row)
```

☒☒

[&&\(geometry,box2df\)](#), [&&\(box2df,geometry\)](#), [&&\(box2df,box2df\)](#), [~\(geometry,box2df\)](#), [~\(box2df,box2df\)](#), [@\(geometry,box2df\)](#), [@\(box2df,geometry\)](#), [@\(box2df,box2df\)](#)

7.10.1.25 ~ (box2df,box2df)

`~(box2df,box2df)` — Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).

Synopsis

```
boolean ~( box2df A , box2df B );
```

☒☒

The `~` operator returns TRUE if the 2D bounding box A contains the 2D bounding box B, using float precision. This means that if A is a (double precision) `box2d`, it will be internally converted to a float precision 2D bounding box (BOX2DF)

**Note**

This operand is intended to be used internally by BRIN indexes, more than by users.

☒☒

<->

7.11 Spatial Relationships

7.11.1 Topological Relationships

7.11.1.1 ST_3DIntersects

ST_3DIntersects — Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)

Synopsis

boolean **ST_3DIntersects**(geometry geomA , geometry geomB);

☒☒

Overlaps, Touches, Within all imply spatial intersection. If any of the aforementioned returns true, then the geometries also spatially intersect. Disjoint implies false for spatial intersection.



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.



Note

Because of floating robustness failures, geometries don't always intersect as you'd expect them to after geometric processing. For example the closest point on a linestring to a geometry may not lie on the linestring. For these kind of issues where a distance of a centimeter you want to just consider as intersecting, use [ST_3DDWithin](#).

Changed: 3.0.0 SFCGAL backend removed, GEOS backend supports TINs.

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



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



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).



This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1

SQL

```
SELECT ST_3DIntersects(pt, line), ST_Intersects(pt, line)
FROM (SELECT 'POINT(0 0 2)::geometry As pt, 'LINESTRING (0 0 1, 0 2 3)::geometry As
      line) As foo;
st_3dintersects | st_intersects
-----+-----
f                | t
(1 row)
```

TIN Examples

```
SELECT ST_3DIntersects('TIN(((0 0 0,1 0 0,0 1 0,0 0 0)))::geometry, 'POINT(.1 .1 0)::
      geometry);
st_3dintersects
-----
t
```

SQL

[ST_3DDWithin](#), [ST_Intersects](#)

7.11.1.2 ST_Contains

ST_Contains — Tests if every point of B lies in A, and their interiors have a point in common

Synopsis

boolean **ST_Contains**(geometry geomA, geometry geomB);

SQL

Returns TRUE if geometry A contains geometry B. A contains B if and only if all points of B lie inside (i.e. in the interior or boundary of) A (or equivalently, no points of B lie in the exterior of A), and the interiors of A and B have at least one point in common.

In mathematical terms: $ST_Contains(A, B) \Leftrightarrow (A \sqsupseteq B = B) \wedge (Int(A) \sqcap Int(B) \neq \emptyset)$

The contains relationship is reflexive: every geometry contains itself. (In contrast, in the [ST_ContainsProperly](#) predicate a geometry does *not* properly contain itself.) The relationship is antisymmetric: if $ST_Contains(A, B) = true$ and $ST_Contains(B, A) = true$, then the two geometries must be topologically equal ($ST_Equals(A, B) = true$).

ST_Contains is the converse of [ST_Within](#). So, $ST_Contains(A, B) = ST_Within(B, A)$.



Note

Because the interiors must have a common point, a subtlety of the definition is that polygons and lines do *not* contain lines and points lying fully in their boundary. For further details see [Subtleties of OGC Covers, Contains, Within](#). The [ST_Covers](#) predicate provides a more inclusive relationship.



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_Contains`.

GEOS ☒☒☒☒☒

Enhanced: 2.3.0 Enhancement to PIP short-circuit extended to support MultiPoints with few points. Prior versions only supported point in polygon.



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION



Important

Do not use this function with invalid geometries. You will get unexpected results.

NOTE: this is the "allowable" version that returns a boolean, not an integer.



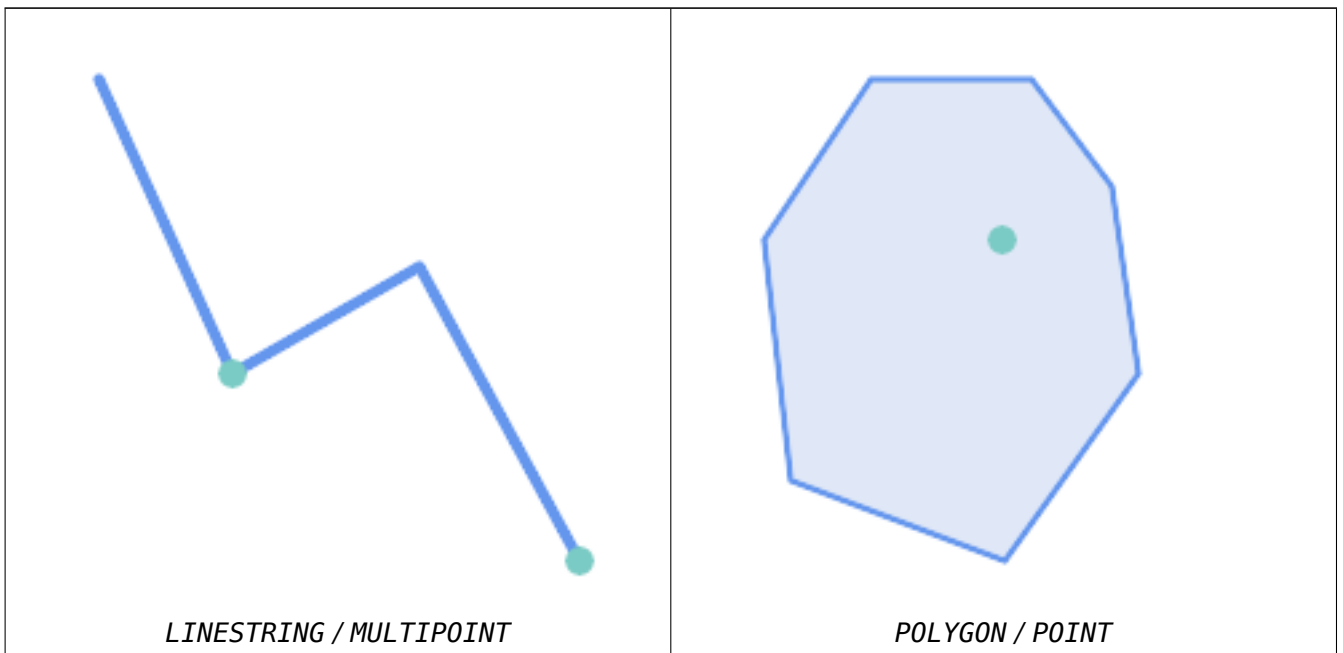
This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3](#) - same as `within(geometry B, geometry A)`

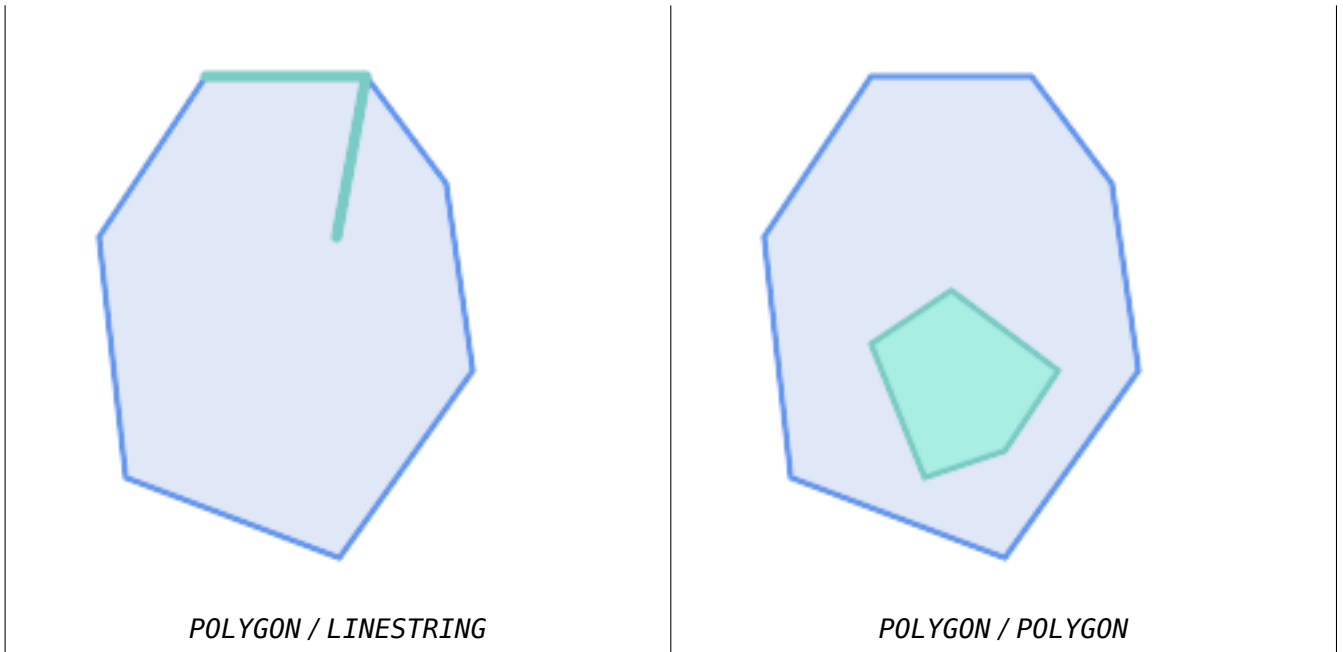


This method implements the SQL/MM specification. SQL-MM 3: 5.1.31

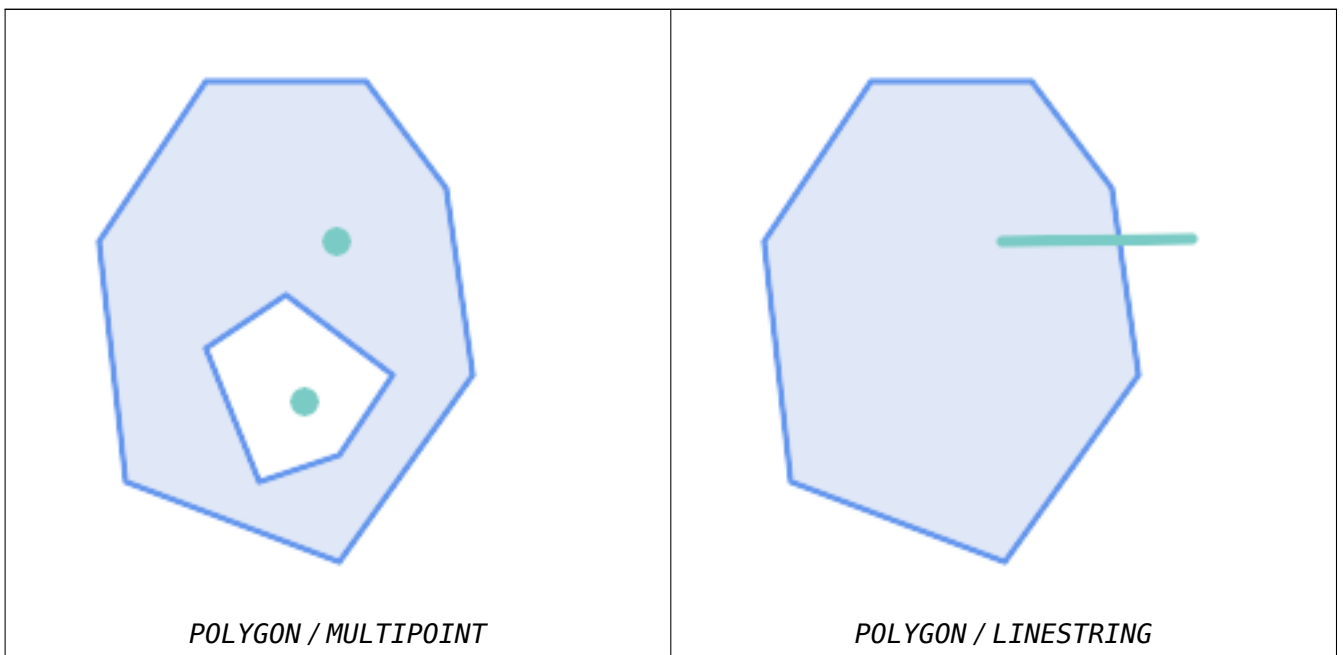
☒☒

`ST_Contains` returns TRUE in the following situations:

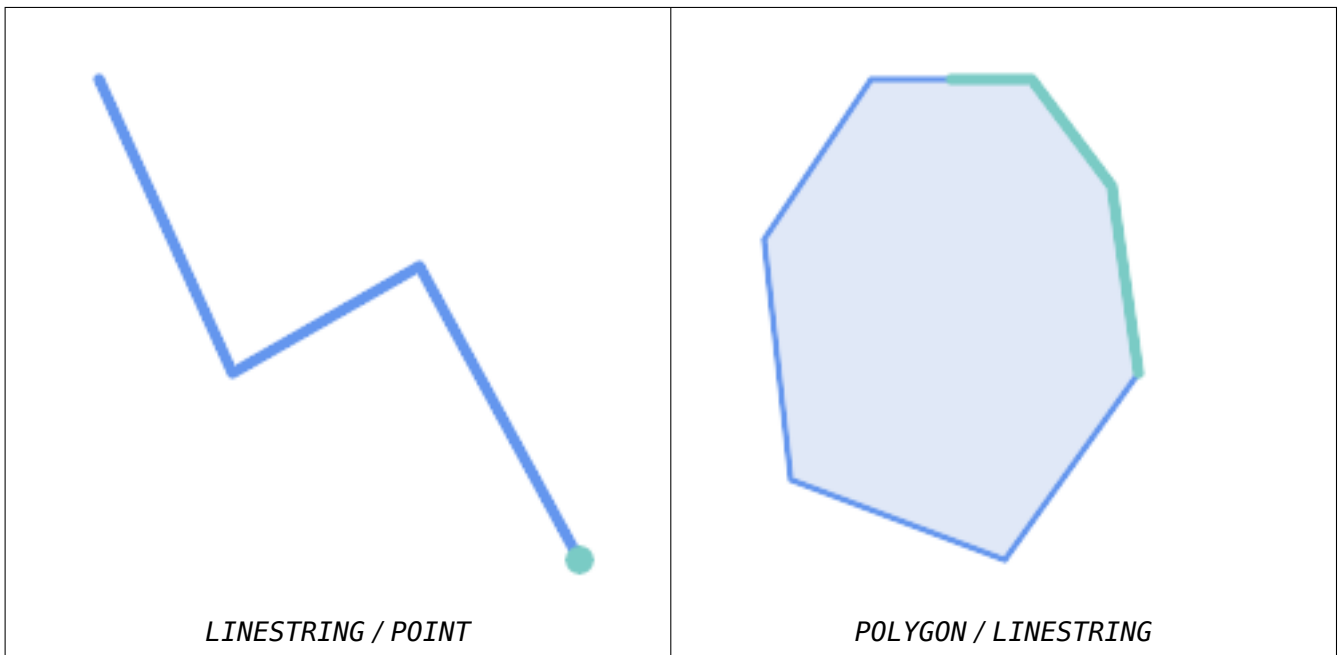




ST_Contains returns FALSE in the following situations:



Due to the interior intersection condition ST_Contains returns FALSE in the following situations (whereas ST_Covers returns TRUE):



```
-- A circle within a circle
SELECT ST_Contains(smallc, bigc) As smallcontainsbig,
       ST_Contains(bigc,smallc) As bigcontainssmall,
       ST_Contains(bigc, ST_Union(smallc, bigc)) as bigcontainsunion,
       ST_Equals(bigc, ST_Union(smallc, bigc)) as bigisunion,
       ST_Covers(bigc, ST_ExteriorRing(bigc)) As bigcoversexterior,
       ST_Contains(bigc, ST_ExteriorRing(bigc)) As bigcontainsexterior
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 2)'), 10) As smallc,
         ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As bigc) As foo;

-- Result
smallcontainsbig | bigcontainssmall | bigcontainsunion | bigisunion | bigcoversexterior | bigcontainsexterior |
-----+-----+-----+-----+-----+-----+
f                | t                | t                | t          | t                | f                |

-- Example demonstrating difference between contains and contains properly
SELECT ST_GeometryType(geomA) As geomtype, ST_Contains(geomA,geomA) AS acontainsa,
       ST_ContainsProperly(geomA, geomA) AS acontainspropa,
       ST_Contains(geomA, ST_Boundary(geomA)) As acontainsba, ST_ContainsProperly(geomA,
       ST_Boundary(geomA)) As acontainspropba
FROM (VALUES ( ST_Buffer(ST_Point(1,1), 5,1) ),
            ( ST_MakeLine(ST_Point(1,1), ST_Point(-1,-1) ) ),
            ( ST_Point(1,1) )
      ) As foo(geomA);

geomtype | acontainsa | acontainspropa | acontainsba | acontainspropba
-----+-----+-----+-----+-----+
ST_Polygon | t         | f             | f           | f
ST_LineString | t        | f             | f           | f
ST_Point | t         | t             | f           | f
```

☒☒

[ST_Boundary](#), [ST_ContainsProperly](#), [ST_Covers](#), [ST_CoveredBy](#), [ST_Equals](#), [ST_Within](#)

7.11.1.3 ST_ContainsProperly

`ST_ContainsProperly` — Tests if every point of B lies in the interior of A

Synopsis

boolean **ST_ContainsProperly**(geometry geomA, geometry geomB);

☒☒

Returns true if every point of B lies in the interior of A (or equivalently, no point of B lies in the the boundary or exterior of A).

In mathematical terms: $ST_ContainsProperly(A, B) \Leftrightarrow Int(A) \supset B = B$

A contains B properly if the DE-9IM Intersection Matrix for the two geometries matches [T**FF*FF*]

A does not properly contain itself, but does contain itself.

A use for this predicate is computing the intersections of a set of geometries with a large polygonal geometry. Since intersection is a fairly slow operation, it can be more efficient to use `containsProperly` to filter out test geometries which lie fully inside the area. In these cases the intersection is known a priori to be exactly the original test geometry.



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_ContainsProperly`.



Note

The advantage of this predicate over `ST_Contains` and `ST_Intersects` is that it can be computed more efficiently, with no need to compute topology at individual points.

GEOS ☒☒☒☒☒

1.4.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION



Important

Do not use this function with invalid geometries. You will get unexpected results.

ST_CoveredBy is the converse of **ST_Covers**. So, ST_CoveredBy(A,B) = ST_Covers(B,A).

Generally this function should be used instead of **ST_Within**, since it has a simpler definition which does not have the quirk that "boundaries are not within their geometry".



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_CoveredBy`.



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION



Important

Do not use this function with invalid geometries. You will get unexpected results.

GEOS

1.2.2

NOTE: this is the "allowable" version that returns a boolean, not an integer.

Not an OGC standard, but Oracle has it too.

```
--a circle coveredby a circle
SELECT ST_CoveredBy(smallc,smallc) As smallinsmall,
       ST_CoveredBy(smallc, bigc) As smallcoveredbybig,
       ST_CoveredBy(ST_ExteriorRing(bigc), bigc) As exteriorcoveredbybig,
       ST_Within(ST_ExteriorRing(bigc),bigc) As exeriorwithinbig
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 2)'), 10) As smallc,
          ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As bigc) As foo;
--Result
smallinsmall | smallcoveredbybig | exteriorcoveredbybig | exeriorwithinbig
-----+-----+-----+-----
t           | t                 | t                 | f
(1 row)
```

ST_Contains, ST_Covers, ST_ExteriorRing, ST_Within

7.11.1.5 ST_Covers

ST_Covers — Tests if every point of B lies in A


```
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)
```

Geography Example

```
-- a point with a 300 meter buffer compared to a point, a point and its 10 meter buffer
SELECT ST_Covers(geog_poly, geog_pt) As poly_covers_pt,
        ST_Covers(ST_Buffer(geog_pt,10), geog_pt) As buff_10m_covers_cent
FROM (SELECT ST_Buffer(ST_GeogFromText('SRID=4326;POINT(-99.327 31.4821)'), 300) As ↵
        geog_poly,
        ST_GeogFromText('SRID=4326;POINT(-99.33 31.483)') As geog_pt ) As foo;

poly_covers_pt | buff_10m_covers_cent
-----+-----
f               | t
```



ST_Contains, ST_CoveredBy, ST_Within

7.11.1.6 ST_Crosses

ST_Crosses — Tests if two geometries have some, but not all, interior points in common

Synopsis

boolean **ST_Crosses**(geometry g1, geometry g2);



Compares two geometry objects and returns true if their intersection "spatially crosses"; that is, the geometries have some, but not all interior points in common. The intersection of the interiors of the geometries must be non-empty and must have dimension less than the maximum dimension of the two input geometries, and the intersection of the two geometries must not equal either geometry. Otherwise, it returns false. The crosses relation is symmetric and irreflexive.

In mathematical terms: $ST_Crosses(A, B) \Leftrightarrow (dim(Int(A) \cap Int(B)) < \max(dim(Int(A)), dim(Int(B))) \wedge (A \cap B \neq A) \wedge (A \cap B \neq B)$

Geometries cross if their DE-9IM Intersection Matrix matches:

- T*T***** for Point/Line, Point/Area, and Line/Area situations
- T*****T** for Line/Point, Area/Point, and Area/Line situations
- 0***** for Line/Line situations
- the result is false for Point/Point and Area/Area situations



Note

The OpenGIS Simple Features Specification defines this predicate only for Point/Line, Point/Area, Line/Line, and Line/Area situations. JTS / GEOS extends the definition to apply to Line/Point, Area/Point and Area/Line situations as well. This makes the relation symmetric.



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION



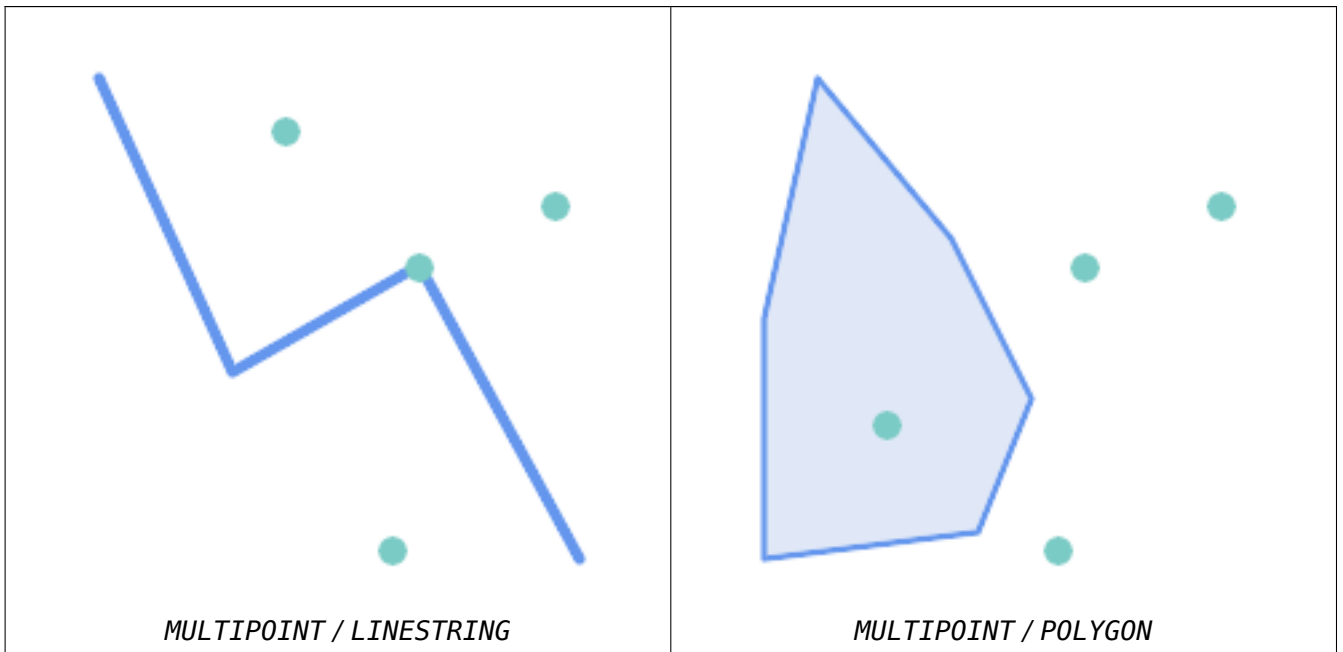
This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.13.3](#)

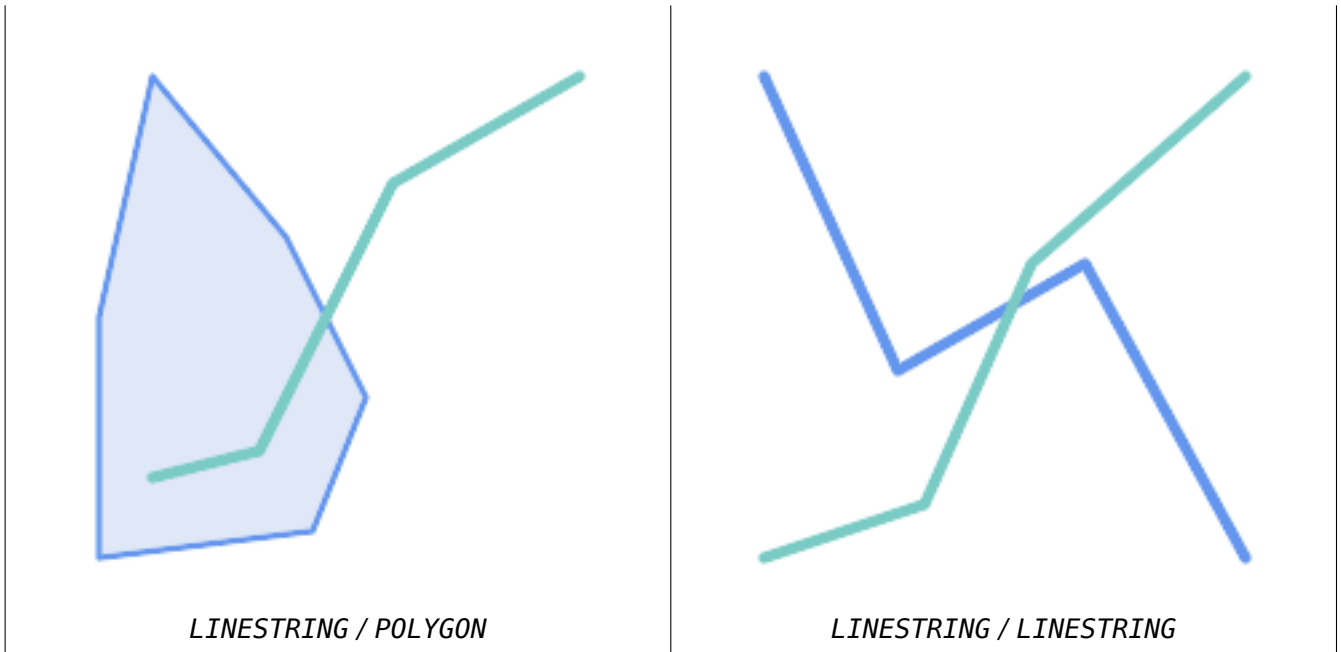


This method implements the SQL/MM specification. SQL-MM 3: 5.1.29



The following situations all return true.





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, 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 similar to:

```
SELECT roads.id
FROM roads, highways
WHERE ST_Crosses(roads.geom, highways.geom);
```

☒☒

ST_Contains, ST_Overlaps

7.11.1.7 ST_Disjoint

ST_Disjoint — Tests if two geometries have no points in common

Synopsis

boolean **ST_Disjoint**(geometry A , geometry B);

 ☒☒

Returns `true` if two geometries are disjoint. Geometries are disjoint if they have no point in common. If any other spatial relationship is true for a pair of geometries, they are not disjoint. Disjoint implies that `ST_Intersects` is false.

In mathematical terms: $ST_Disjoint(A, B) \Leftrightarrow A \cap B = \emptyset$



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION

 GEOS ☒☒☒☒☒



Note

This function call does not use indexes. A negated `ST_Intersects` predicate can be used as a more performant alternative that uses indexes: `ST_Disjoint(A,B) = NOT ST_Intersects(A,B)`



Note

NOTE: this is the "allowable" version that returns a boolean, not an integer.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 //s2.1.13.3 - a.Relate\(b, 'FF*FF****'\)](#)



This method implements the SQL/MM specification. SQL-MM 3: 5.1.26

☒☒

```
SELECT ST_Disjoint('POINT(0 0)::geometry, 'LINESTRING ( 2 0, 0 2 ) '::geometry);
st_disjoint
-----
t
(1 row)
SELECT ST_Disjoint('POINT(0 0)::geometry, 'LINESTRING ( 0 0, 0 2 ) '::geometry);
st_disjoint
-----
f
(1 row)
```

☒☒

`ST_Intersects`

7.11.1.8 `ST_Equals`

`ST_Equals` — Tests if two geometries include the same set of points

Synopsis

boolean **ST_Equals**(geometry A, geometry B);

☒☒

Returns true if the given geometries are "topologically equal". Use this for a 'better' answer than '='. Topological equality means that the geometries have the same dimension, and their point-sets occupy the same space. This means that the order of vertices may be different in topologically equal geometries. To verify the order of points is consistent use **ST_OrderingEquals** (it must be noted **ST_OrderingEquals** is a little more stringent than simply verifying order of points are the same).

In mathematical terms: $ST_Equals(A, B) \Leftrightarrow A = B$

The following relation holds: $ST_Equals(A, B) \Leftrightarrow ST_Within(A,B) \wedge ST_Within(B,A)$



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION



This method implements the **OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2**



This method implements the SQL/MM specification. SQL-MM 3: 5.1.24

Changed: 2.2.0 Returns true even for invalid geometries if they are binary equal

☒☒

```
SELECT ST_Equals(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
  ST_GeomFromText('LINESTRING(0 0, 5 5, 10 10)'));
 st_equals
-----
t
(1 row)
```

```
SELECT ST_Equals(ST_Reverse(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
  ST_GeomFromText('LINESTRING(0 0, 5 5, 10 10)'));
 st_equals
-----
t
(1 row)
```

☒☒

ST_IsValid, **ST_OrderingEquals**, **ST_Reverse**, **ST_Within**

7.11.1.9 ST_Intersects

ST_Intersects — Tests if two geometries intersect (they have at least one point in common)

Synopsis

```
boolean ST_Intersects( geometry geomA , geometry geomB );
boolean ST_Intersects( geography geogA , geography geogB );
```

☒☒

Returns true if two geometries intersect. Geometries intersect if they have any point in common. For geography, a distance tolerance of 0.00001 meters is used (so points that are very close are considered to intersect).

In mathematical terms: $ST_Intersects(A, B) \Leftrightarrow A \cap B \neq \emptyset$

Geometries intersect if their DE-9IM Intersection Matrix matches one of:

- T*****
- *T*****
- ***T*****
- ****T*****

Spatial intersection is implied by all the other spatial relationship tests, except **ST_Disjoint**, which tests that geometries do NOT intersect.

Note!

Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.

Changed: 3.0.0 SFCGAL version removed and native support for 2D TINs added.

Enhanced: 2.5.0 Supports GEOMETRYCOLLECTION.

Enhanced: 2.3.0 Enhancement to PIP short-circuit extended to support MultiPoints with few points. Prior versions only supported point in polygon.

Performed by the GEOS module (for geometry), geography is native

Availability: 1.5 support for geography was introduced.

Note!

Note

For geography, this function has a distance tolerance of about 0.00001 meters and uses the sphere rather than spheroid calculation.

Note!

Note

NOTE: this is the "allowable" version that returns a boolean, not an integer.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 //s2.1.13.3 - ST_Intersects\(g1, g2 \) --> Not \(ST_Disjoint\(g1, g2 \)\)](#)



This method implements the SQL/MM specification. SQL-MM 3: 5.1.27



This method supports Circular Strings and Curves.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```

SELECT ST_Intersects('POINT(0 0)::geometry, 'LINESTRING ( 2 0, 0 2 ) '::geometry);
  st_intersects
-----
 f
(1 row)
SELECT ST_Intersects('POINT(0 0)::geometry, 'LINESTRING ( 0 0, 0 2 ) '::geometry);
  st_intersects
-----
 t
(1 row)

-- Look up in table. Make sure table has a GiST index on geometry column for faster lookup.
SELECT id, name FROM cities WHERE ST_Intersects(geom, 'SRID=4326;POLYGON((28 53,27.707  ←
  52.293,27 52,26.293 52.293,26 53,26.293 53.707,27 54,27.707 53.707,28 53))');
 id | name
----+-----
  2 | Minsk
(1 row)

```

☒☒☒☒☒

```

SELECT ST_Intersects(
  'SRID=4326;LINESTRING(-43.23456 72.4567,-43.23456 72.4568) '::geography,
  'SRID=4326;POINT(-43.23456 72.4567772) '::geography
);

  st_intersects
-----
 t

```

☒☒

&&, [ST_3DIntersects](#), [ST_Disjoint](#)

7.11.1.10 ST_LineCrossingDirection

`ST_LineCrossingDirection` — Returns a number indicating the crossing behavior of two `LineStrings`

Synopsis

integer **ST_LineCrossingDirection**(geometry linestringA, geometry linestringB);

☒☒

Given two linestrings returns an integer between -3 and 3 indicating what kind of crossing behavior exists between them. 0 indicates no crossing. This is only supported for `LINESTRINGS`.

The crossing number has the following meaning:

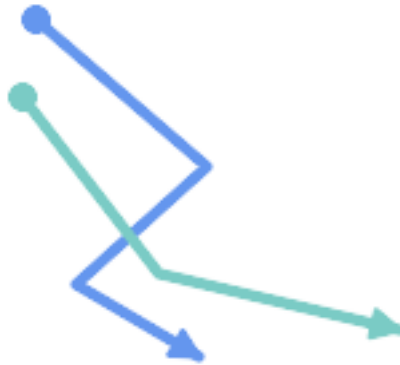
- 0: LINE NO CROSS
- -1: LINE CROSS LEFT

- 1: LINE CROSS RIGHT
- -2: LINE MULTICROSS END LEFT
- 2: LINE MULTICROSS END RIGHT
- -3: LINE MULTICROSS END SAME FIRST LEFT
- 3: LINE MULTICROSS END SAME FIRST RIGHT

Availability: 1.4

☒☒

Example: LINE CROSS LEFT and LINE CROSS RIGHT

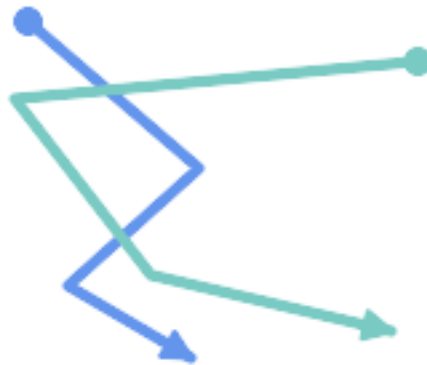


Blue: Line A; Green: Line B

```
SELECT ST_LineCrossingDirection(lineA, lineB) As A_cross_B,
       ST_LineCrossingDirection(lineB, lineA) As B_cross_A
FROM (SELECT
      ST_GeomFromText('LINESTRING(25 169,89 114,40 70,86 43)') As lineA,
      ST_GeomFromText('LINESTRING (20 140, 71 74, 161 53)') As lineB
    ) As foo;
```

A_cross_B	B_cross_A
-1	1

Example: LINE MULTICROSS END SAME FIRST LEFT and LINE MULTICROSS END SAME FIRST RIGHT

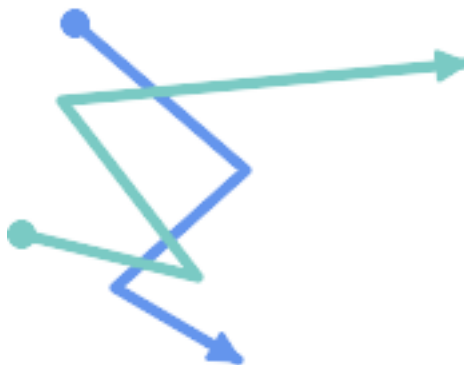


Blue: Line A; Green: Line B

```
SELECT ST_LineCrossingDirection(lineA, lineB) As A_cross_B,
       ST_LineCrossingDirection(lineB, lineA) As B_cross_A
FROM (SELECT
      ST_GeomFromText('LINESTRING(25 169,89 114,40 70,86 43)') As lineA,
      ST_GeomFromText('LINESTRING(171 154,20 140,71 74,161 53)') As lineB
      ) As foo;
```

A_cross_B	B_cross_A
3	-3

Example: LINE MULTICROSS END LEFT and LINE MULTICROSS END RIGHT



Blue: Line A; Green: Line B

```
SELECT ST_LineCrossingDirection(lineA, lineB) As A_cross_B,
       ST_LineCrossingDirection(lineB, lineA) As B_cross_A
FROM (SELECT
      ST_GeomFromText('LINESTRING(25 169,89 114,40 70,86 43)') As lineA,
      ST_GeomFromText('LINESTRING(5 90, 71 74, 20 140, 171 154)') As lineB
      ) As foo;
```

```
A_cross_B | B_cross_A
-----+-----
      -2 |          2
```

Example: Finds all streets that cross

```
SELECT s1.gid, s2.gid, ST_LineCrossingDirection(s1.geom, s2.geom)
  FROM streets s1 CROSS JOIN streets s2
        ON (s1.gid != s2.gid AND s1.geom && s2.geom )
 WHERE ST_LineCrossingDirection(s1.geom, s2.geom)
 > 0;
```

☒☒

ST_Crosses

7.11.1.11 ST_OrderingEquals

ST_OrderingEquals — Tests if two geometries represent the same geometry and have points in the same directional order

Synopsis

boolean **ST_OrderingEquals**(geometry A, geometry B);

☒☒

ST_OrderingEquals compares two geometries and returns t (TRUE) if the geometries are equal and the coordinates are in the same order; otherwise it returns f (FALSE).



Note

This function is implemented as per the ArcSDE SQL specification rather than SQL-MM. http://edndoc.esri.com/arcscde/9.1/sql_api/sqlapi3.htm#ST_OrderingEquals



This method implements the SQL/MM specification. SQL-MM 3: 5.1.43

☒☒

```
SELECT ST_OrderingEquals(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
  ST_GeomFromText('LINESTRING(0 0, 5 5, 10 10)'));
 st_orderingequals
-----
 f
(1 row)
```

```
SELECT ST_OrderingEquals(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
  ST_GeomFromText('LINESTRING(0 0, 0 0, 10 10)'));
 st_orderingequals
```

```

-----
 t
(1 row)

SELECT ST_OrderingEquals(ST_Reverse(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
  ST_GeomFromText('LINESTRING(0 0, 0 0, 10 10)'));
 st_orderingequals
-----
 f
(1 row)

```

[&&](#), [ST_Equals](#), [ST_Reverse](#)

7.11.1.12 ST_Overlaps

ST_Overlaps — Tests if two geometries have the same dimension and intersect, but each has at least one point not in the other

Synopsis

boolean **ST_Overlaps**(geometry A, geometry B);



Returns TRUE if geometry A and B "spatially overlap". Two geometries overlap if they have the same dimension, their interiors intersect in that dimension. and each has at least one point inside the other (or equivalently, neither one covers the other). The overlaps relation is symmetric and irreflexive.

In mathematical terms: $ST_Overlaps(A, B) \Leftrightarrow (dim(A) = dim(B) = dim(Int(A) \cap Int(B))) \wedge (A \cap B \neq A) \wedge (A \cap B \neq B)$



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_Overlaps`.

GEOS 



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION

NOTE: this is the "allowable" version that returns a boolean, not an integer.



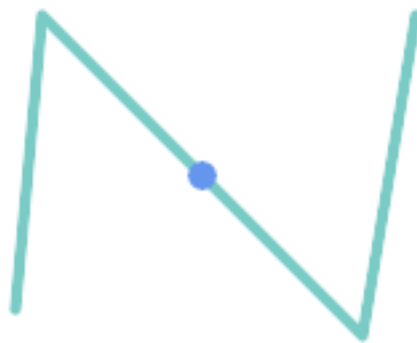
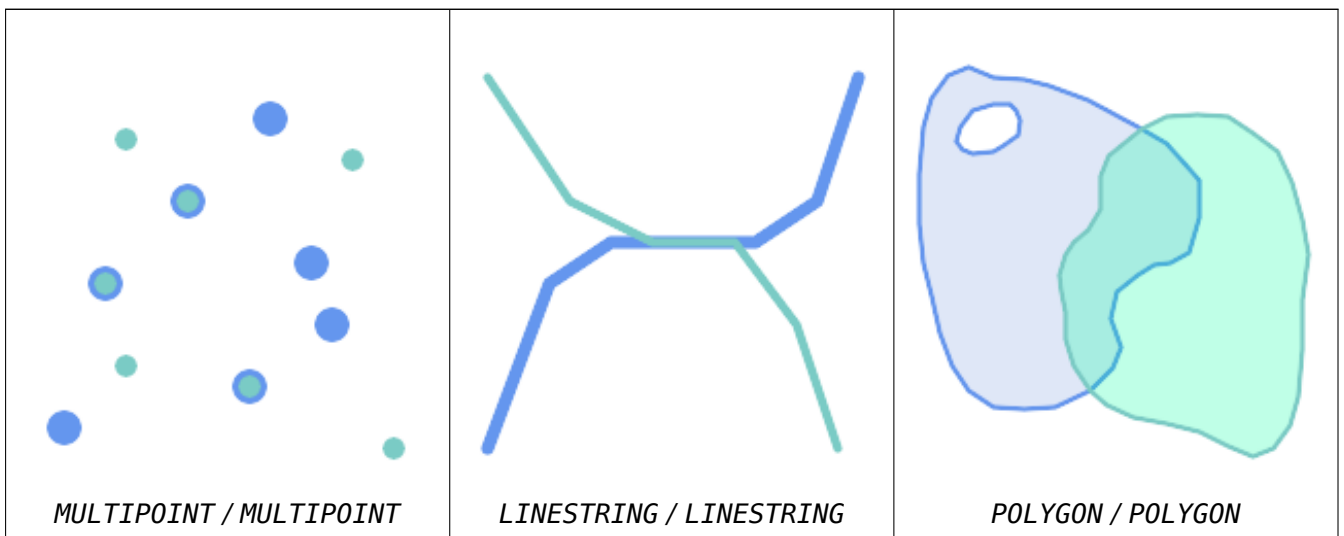
This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3](#)



This method implements the SQL/MM specification. SQL-MM 3: 5.1.32

☒☒

ST_Overlaps returns TRUE in the following situations:



A Point on a LineString is contained, but since it has lower dimension it does not overlap or cross.

```
SELECT ST_Overlaps(a,b) AS overlaps,      ST_Crosses(a,b) AS crosses,
       ST_Intersects(a, b) AS intersects,  ST_Contains(b,a) AS b_contains_a
FROM (SELECT ST_GeomFromText('POINT (100 100)') As a,
          ST_GeomFromText('LINESTRING (30 50, 40 160, 160 40, 180 160)') AS b) AS t
```

overlaps	crosses	intersects	b_contains_a
f	f	t	t



A LineString that partly covers a Polygon intersects and crosses, but does not overlap since it has different dimension.

```
SELECT ST_Overlaps(a,b) AS overlaps,      ST_Crosses(a,b) AS crosses,
       ST_Intersects(a, b) AS intersects,  ST_Contains(a,b) AS contains
FROM (SELECT ST_GeomFromText('POLYGON ((40 170, 90 30, 180 100, 40 170))') AS a,
       ST_GeomFromText('LINESTRING(10 10, 190 190)') AS b) AS t;
```

overlap	crosses	intersects	contains
f	t	t	f



Two Polygons that intersect but with neither contained by the other overlap, but do not cross because their intersection has the same dimension.

```
SELECT ST_Overlaps(a,b) AS overlaps,      ST_Crosses(a,b) AS crosses,
       ST_Intersects(a, b) AS intersects,  ST_Contains(b, a) AS b_contains_a,
       ST_Dimension(a) AS dim_a, ST_Dimension(b) AS dim_b,
       ST_Dimension(ST_Intersection(a,b)) AS dim_int
FROM (SELECT ST_GeomFromText('POLYGON ((40 170, 90 30, 180 100, 40 170))') AS a,
       ST_GeomFromText('POLYGON ((110 180, 20 60, 130 90, 110 180))') AS b) AS t;
```

overlaps	crosses	intersects	b_contains_a	dim_a	dim_b	dim_int
t	f	t	f	2	2	2

☒☒

[ST_Contains](#), [ST_Crosses](#), [ST_Dimension](#), [ST_Intersects](#)

7.11.1.13 ST_Relate

`ST_Relate` — Tests if two geometries have a topological relationship matching an Intersection Matrix pattern, or computes their Intersection Matrix

Synopsis

```
boolean ST_Relate(geometry geomA, geometry geomB, text intersectionMatrixPattern);
text ST_Relate(geometry geomA, geometry geomB);
text ST_Relate(geometry geomA, geometry geomB, integer boundaryNodeRule);
```

☒☒

These functions allow testing and evaluating the spatial (topological) relationship between two geometries, as defined by the [Dimensionally Extended 9-Intersection Model](#) (DE-9IM).

The DE-9IM is specified as a 9-element matrix indicating the dimension of the intersections between the Interior, Boundary and Exterior of two geometries. It is represented by a 9-character text string using the symbols 'F', '0', '1', '2' (e.g. 'FF1FF0102').

A specific kind of spatial relationship can be tested by matching the intersection matrix to an *intersection matrix pattern*. Patterns can include the additional symbols 'T' (meaning "intersection is non-empty") and '*' (meaning "any value"). Common spatial relationships are provided by the named functions [ST_Contains](#), [ST_ContainsProperly](#), [ST_Covers](#), [ST_CoveredBy](#), [ST_Crosses](#), [ST_Disjoint](#), [ST_Equals](#), [ST_Intersects](#), [ST_Overlaps](#), [ST_Touches](#), and [ST_Within](#). Using an explicit pattern allows testing multiple conditions of intersects, crosses, etc in one step. It also allows testing spatial relationships which do not have a named spatial relationship function. For example, the relationship "Interior-Intersects" has the DE-9IM pattern T*****, which is not evaluated by any named predicate.

For more information refer to [Section 5.1](#).

Variant 1: Tests if two geometries are spatially related according to the given `intersectionMatrixPattern`



Note

Unlike most of the named spatial relationship predicates, this does NOT automatically include an index call. The reason is that some relationships are true for geometries which do NOT intersect (e.g. Disjoint). If you are using a relationship pattern that requires intersection, then include the `&&` index call.



Note

It is better to use a named relationship function if available, since they automatically use a spatial index where one exists. Also, they may implement performance optimizations which are not available with full relate evaluation.

Variante 2: Returns the DE-9IM matrix string for the spatial relationship between the two input geometries. The matrix string can be tested for matching a DE-9IM pattern using [ST_RelateMatch](#).

Variante 3: Like variante 2, but allows specifying a **Boundary Node Rule**. A boundary node rule allows finer control over whether the endpoints of MultiLineStrings are considered to lie in the DE-9IM Interior or Boundary. The boundaryNodeRule values are:

- 1: **OGC-Mod2** - line endpoints are in the Boundary if they occur an odd number of times. This is the rule defined by the OGC SFS standard, and is the default for ST_Relate.
- 2: **Endpoint** - all endpoints are in the Boundary.
- 3: **MultivalentEndpoint** - endpoints are in the Boundary if they occur more than once. In other words, the boundary is all the "attached" or "inner" endpoints (but not the "unattached/outer" ones).
- 4: **MonovalentEndpoint** - endpoints are in the Boundary if they occur only once. In other words, the boundary is all the "unattached" or "outer" endpoints.

This function is not in the OGC spec, but is implied. see s2.1.13.2



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#). s2.1.1.2 // s2.1.13.3



This method implements the SQL/MM specification. SQL-MM 3: 5.1.25

GEOS ☒☒☒☒☒

Enhanced: 2.0.0 - added support for specifying boundary node rule.



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION

☒☒

Using the boolean-valued function to test spatial relationships.

```
SELECT ST_Relate('POINT(1 2)', ST_Buffer( 'POINT(1 2)', 2), '0FFFFF212');
st_relate
-----
t
```

```
SELECT ST_Relate(POINT(1 2)', ST_Buffer( 'POINT(1 2)', 2), '*FF*FF212');
st_relate
-----
t
```

Testing a custom spatial relationship pattern as a query condition, with && to enable using a spatial index.

```
-- Find compounds that properly intersect (not just touch) a poly (Interior Intersects)

SELECT c.* , p.name As poly_name
   FROM polys AS p
  INNER JOIN compounds As c
        ON c.geom && p.geom
        AND ST_Relate(p.geom, c.geom, 'T*****');
```

Computing the intersection matrix for spatial relationships.

```
SELECT ST_Relate( 'POINT(1 2)',
                 ST_Buffer( 'POINT(1 2)', 2));
-----
0FFFFFF212

SELECT ST_Relate( 'LINESTRING(1 2, 3 4)',
                 'LINESTRING(5 6, 7 8)' );
-----
FF1FF0102
```

Using different Boundary Node Rules to compute the spatial relationship between a LineString and a MultiLineString with a duplicate endpoint (3 3):

- Using the **OGC-Mod2** rule (1) the duplicate endpoint is in the **interior** of the MultiLineString, so the DE-9IM matrix entry [aB:bI] is 0 and [aB:bB] is F.
- Using the **Endpoint** rule (2) the duplicate endpoint is in the **boundary** of the MultiLineString, so the DE-9IM matrix entry [aB:bI] is F and [aB:bB] is 0.

```
WITH data AS (SELECT
  'LINESTRING(1 1, 3 3)::geometry AS a_line,
  'MULTILINESTRING((3 3, 3 5), (3 3, 5 3)):: geometry AS b_multiline
)
SELECT ST_Relate( a_line, b_multiline, 1) AS bnr_mod2,
       ST_Relate( a_line, b_multiline, 2) AS bnr_endpoint
FROM data;

bnr_mod2 | bnr_endpoint
-----+-----
FF10F0102 | FF1F00102
```



Section 5.1, [ST_RelateMatch](#), [ST_Contains](#), [ST_ContainsProperly](#), [ST_Covers](#), [ST_CoveredBy](#), [ST_Crosses](#), [ST_Disjoint](#), [ST_Equals](#), [ST_Intersects](#), [ST_Overlaps](#), [ST_Touches](#), [ST_Within](#)

7.11.1.14 ST_RelateMatch

`ST_RelateMatch` — Tests if a DE-9IM Intersection Matrix matches an Intersection Matrix pattern

Synopsis

boolean **ST_RelateMatch**(text intersectionMatrix, text intersectionMatrixPattern);



Tests if a **Dimensionally Extended 9-Intersection Model** (DE-9IM) `intersectionMatrix` value satisfies an `intersectionMatrixPattern`. Intersection matrix values can be computed by [ST_Relate](#).

For more information refer to Section 5.1.

GEOS

2.0.0

☒☒

```
SELECT ST_RelateMatch('101202FFF', 'TTTTTFFF') ;
-- result --
t
```

Patterns for common spatial relationships matched against intersection matrix values, for a line in various positions relative to a polygon

```
SELECT pat.name AS relationship, pat.val AS pattern,
       mat.name AS position, mat.val AS matrix,
       ST_RelateMatch(mat.val, pat.val) AS match
FROM (VALUES ( 'Equality', 'T1FF1FFF1' ),
          ( 'Overlaps', 'T*T***T**' ),
          ( 'Within', 'T**F***' ),
          ( 'Disjoint', 'FF**F***' )) AS pat(name,val)
CROSS JOIN
  (VALUES ('non-intersecting', 'FF1FF0212'),
         ('overlapping', '1010F0212'),
         ('inside', '1FF0FF212')) AS mat(name,val);
```

relationship	pattern	position	matrix	match
Equality	T1FF1FFF1	non-intersecting	FF1FF0212	f
Equality	T1FF1FFF1	overlapping	1010F0212	f
Equality	T1FF1FFF1	inside	1FF0FF212	f
Overlaps	T*T***T**	non-intersecting	FF1FF0212	f
Overlaps	T*T***T**	overlapping	1010F0212	t
Overlaps	T*T***T**	inside	1FF0FF212	f
Within	T**F***	non-intersecting	FF1FF0212	f
Within	T**F***	overlapping	1010F0212	f
Within	T**F***	inside	1FF0FF212	t
Disjoint	FF**F***	non-intersecting	FF1FF0212	t
Disjoint	FF**F***	overlapping	1010F0212	f
Disjoint	FF**F***	inside	1FF0FF212	f

☒☒

Section 5.1, [ST_Relate](#)

7.11.1.15 ST_Touches

ST_Touches — Tests if two geometries have at least one point in common, but their interiors do not intersect

Synopsis

boolean **ST_Touches**(geometry A, geometry B);

☒☒

Returns TRUE if A and B intersect, but their interiors do not intersect. Equivalently, A and B have at least one point in common, and the common points lie in at least one boundary. For Point/Point inputs the relationship is always FALSE, since points do not have a boundary.

In mathematical terms: $ST_Touches(A, B) \Leftrightarrow (Int(A) \cap Int(B) = \emptyset) \wedge (A \cap B \neq \emptyset)$

This relationship holds if the DE-9IM Intersection Matrix for the two geometries matches one of:

- FT*****
- F**T*****
- F***T****



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid using an index, use `_ST_Touches` instead.



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION



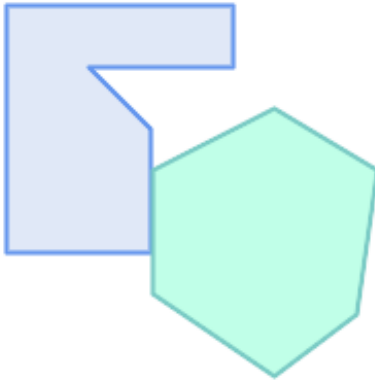
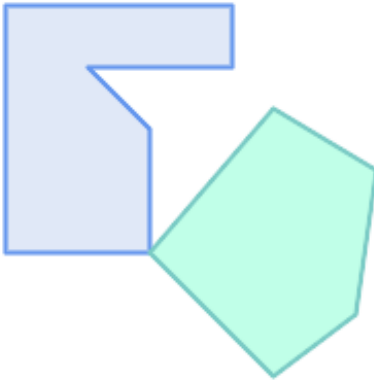
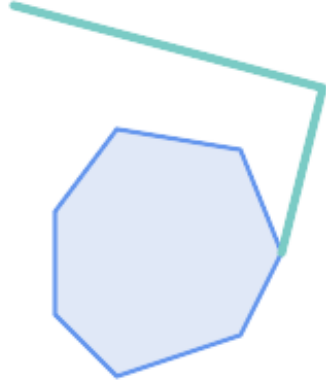
This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3](#)

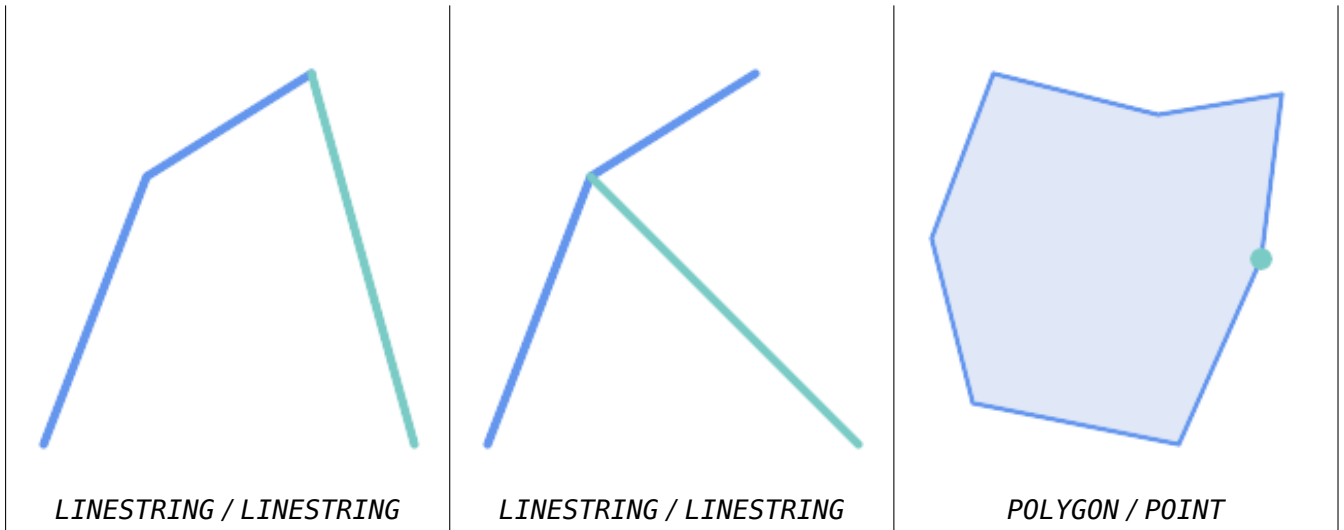


This method implements the SQL/MM specification. SQL-MM 3: 5.1.28

☒☒

The `ST_Touches` predicate returns TRUE in the following examples.

 <p><i>POLYGON / POLYGON</i></p>	 <p><i>POLYGON / POLYGON</i></p>	 <p><i>POLYGON / LINESTRING</i></p>
---	--	--



```
SELECT ST_Touches('LINestring(0 0, 1 1, 0 2)::geometry, 'POINT(1 1)::geometry');
st_toucheš
-----
f
(1 row)

SELECT ST_Touches('LINestring(0 0, 1 1, 0 2)::geometry, 'POINT(0 2)::geometry');
st_toucheš
-----
t
(1 row)
```

7.11.1.16 ST_Within

ST_Within — Tests if every point of A lies in B, and their interiors have a point in common

Synopsis

boolean **ST_Within**(geometry A, geometry B);

☒☒

Returns TRUE if geometry A is within geometry B. A is within B if and only if all points of A lie inside (i.e. in the interior or boundary of) B (or equivalently, no points of A lie in the exterior of B), and the interiors of A and B have at least one point in common.

For this function to make sense, the source geometries must both be of the same coordinate projection, having the same SRID.

In mathematical terms: $ST_Within(A, B) \Leftrightarrow (A \sqcap B = A) \wedge (Int(A) \sqcap Int(B) \neq \square)$

The within relation is reflexive: every geometry is within itself. The relation is antisymmetric: if $ST_Within(A, B) = true$ and $ST_Within(B, A) = true$, then the two geometries must be topologically equal ($ST_Equals(A, B) = true$).

ST_Within is the converse of **ST_Contains**. So, $ST_Within(A, B) = ST_Contains(B, A)$.



Note

Because the interiors must have a common point, a subtlety of the definition is that lines and points lying fully in the boundary of polygons or lines are *not* within the geometry. For further details see [Subtleties of OGC Covers, Contains, Within](#). The `ST_CoveredBy` predicate provides a more inclusive relationship.



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries. To avoid index use, use the function `_ST_Within`.

GEOS ☒☒☒☒☒

Enhanced: 2.3.0 Enhancement to PIP short-circuit for geometry extended to support MultiPoints with few points. Prior versions only supported point in polygon.



Important

Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION



Important

Do not use this function with invalid geometries. You will get unexpected results.

NOTE: this is the "allowable" version that returns a boolean, not an integer.



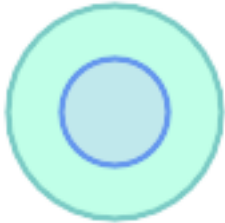
This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.2 // s2.1.13.3 - a.Relate\(b, 'T**F***'\)](#)



This method implements the SQL/MM specification. SQL-MM 3: 5.1.30

☒☒

```
--a circle within a circle
SELECT ST_Within(smallc,smallc) As smallinsmall,
       ST_Within(smallc, bigc) As smallinbig,
       ST_Within(bigc,smallc) As biginsmall,
       ST_Within(ST_Union(smallc, bigc), bigc) as unioninbig,
       ST_Within(bigc, ST_Union(smallc, bigc)) as beginunion,
       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 | beginunion | bigisunion
-----+-----+-----+-----+-----+-----
t             | t           | f           | t           | t           | t
(1 row)
```



☒☒

[ST_Contains](#), [ST_CoveredBy](#), [ST_Equals](#), [ST_IsValid](#)

7.11.2 Distance Relationships

7.11.2.1 ST_3DDWithin

`ST_3DDWithin` — Tests if two 3D geometries are within a given 3D distance

Synopsis

boolean **ST_3DDWithin**(geometry g1, geometry g2, double precision distance_of_srid);

☒☒

Returns true if the 3D distance between two geometry values is no larger than distance `distance_of_srid`. The distance is specified in units defined by the spatial reference system of the geometries. For this function to make sense the source geometries must be in the same coordinate system (have the same SRID).



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.



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



This function supports Polyhedral surfaces.



This method implements the SQL/MM specification. SQL-MM ?

2.0.0 ☒☒☒☒☒☒☒☒☒☒.

☒☒

```
-- Geometry example - units in meters (SRID: 2163 US National Atlas Equal area) (3D point ↔
  and line compared 2D point and line)
-- Note: currently no vertical datum support so Z is not transformed and assumed to be same ↔
  units as final.
SELECT ST_3DDWithin(
  ST_Transform(ST_GeomFromEWKT('SRID=4326;POINT(-72.1235 42.3521 4)'),2163),
  ST_Transform(ST_GeomFromEWKT('SRID=4326;LINESTRING(-72.1260 42.45 15, -72.123 42.1546 ↔
    20)'),2163),
  126.8
) As within_dist_3d,
ST_DWithin(
  ST_Transform(ST_GeomFromEWKT('SRID=4326;POINT(-72.1235 42.3521 4)'),2163),
  ST_Transform(ST_GeomFromEWKT('SRID=4326;LINESTRING(-72.1260 42.45 15, -72.123 42.1546 ↔
    20)'),2163),
  126.8
) As within_dist_2d;

within_dist_3d | within_dist_2d
-----+-----
f              | t
```

☒☒

[ST_3DDFullyWithin](#), [ST_DWithin](#), [ST_DFullyWithin](#), [ST_3DDistance](#), [ST_Distance](#), [ST_3DMaxDistance](#), [ST_Transform](#)

7.11.2.2 ST_3DDFullyWithin

ST_3DDFullyWithin — Tests if two 3D geometries are entirely within a given 3D distance

Synopsis

boolean **ST_3DDFullyWithin**(geometry g1, geometry g2, double precision distance);

☒☒

Returns true if the 3D geometries are fully within the specified distance of one another. The distance is specified in units defined by the spatial reference system of the geometries. For this function to make sense, the source geometries must both be of the same coordinate projection, having the same SRID.



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



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



This function supports Polyhedral surfaces.

☒☒

```
-- This compares the difference between fully within and distance within as well
-- as the distance fully within for the 2D footprint of the line/point vs. the 3d fully
  within
  SELECT ST_3DDFullyWithin(geom_a, geom_b, 10) as D3DFullyWithin10, ST_3DDWithin(geom_a,
  geom_b, 10) as D3DWithin10,
  ST_DFullyWithin(geom_a, geom_b, 20) as D2DFullyWithin20,
  ST_3DDFullyWithin(geom_a, geom_b, 20) as D3DFullyWithin20 from
  (select ST_GeomFromEWKT('POINT(1 1 2)') as geom_a,
  ST_GeomFromEWKT('LINESTRING(1 5 2, 2 7 20, 1 9 100, 14 12 3)') as geom_b) t1;
d3dfullywithin10 | d3dwithin10 | d2dfullywithin20 | d3dfullywithin20
-----+-----+-----+-----
f                | t           | t           | f
```

☒☒

[ST_3DDWithin](#), [ST_DWithin](#), [ST_DFullyWithin](#), [ST_3DMaxDistance](#)

7.11.2.3 ST_DFullyWithin

ST_DFullyWithin — Tests if a geometry is entirely inside a distance of another

Synopsis

boolean **ST_DFullyWithin**(geometry g1, geometry g2, double precision distance);

☒☒

Returns true if g2 is entirely within distance of g1. Visually, the condition is true if g2 is contained within a distance buffer of g1. The distance is specified in units defined by the spatial reference system of the geometries.



Note

This function automatically includes a bounding box comparison that makes use of any spatial indexes that are available on the geometries.

1.5.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Changed: 3.5.0 : the logic behind the function now uses a test of containment within a buffer, rather than the ST_MaxDistance algorithm. Results will differ from prior versions, but should be closer to user expectations.

☒☒

```
SELECT
  ST_DFullyWithin(geom_a, geom_b, 10) AS DFullyWithin10,
  ST_DWithin(geom_a, geom_b, 10) AS DWithin10,
  ST_DFullyWithin(geom_a, geom_b, 20) AS DFullyWithin20
FROM (VALUES
  ('POINT(1 1)', 'LINESTRING(1 5, 2 7, 1 9, 14 12)')
) AS v(geom_a, geom_b)
```

dfullywithin10		dwithin10		dfullywithin20
-----	+	-----	+	-----
f		t		t

☒☒

[ST_MaxDistance](#), [ST_DWithin](#), [ST_3DDWithin](#), [ST_3DDFullyWithin](#)

7.11.2.4 ST_DWithin

ST_DWithin — Tests if two geometries are within a given distance

Synopsis

boolean **ST_DWithin**(geometry g1, geometry g2, double precision distance_of_srid);
 boolean **ST_DWithin**(geography gg1, geography gg2, double precision distance_meters, boolean use_spheroid = true);

☒☒

Returns true if the geometries are within a given distance

For geometry: The distance is specified in units defined by the spatial reference system of the geometries. For this function to make sense, the source geometries must be in the same coordinate system (have the same SRID).

For geography: units are in meters and distance measurement defaults to `use_spheroid = true`. For faster evaluation use `use_spheroid = false` to measure on the sphere.



Note

Use [ST_3DDWithin](#) for 3D geometries.



Note

This function call includes a bounding box comparison that makes use of any indexes that are available on the geometries.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).

Availability: 1.5.0 support for geography was introduced

Enhanced: 2.1.0 improved speed for geography. See [Making Geography faster](#) for details.

Enhanced: 2.1.0 support for curved geometries was introduced.

Prior to 1.3, [ST_Expand](#) was commonly used in conjunction with `&&` and `ST_Distance` to test for distance, and in pre-1.3.4 this function used that logic. From 1.3.4, `ST_DWithin` uses a faster short-circuit distance function.

☒☒

```

-- Find the nearest hospital to each school
-- that is within 3000 units of the school.
-- We do an ST_DWithin search to utilize indexes to limit our search list
-- that the non-indexable ST_Distance needs to process
-- If the units of the spatial reference is meters then units would be meters
SELECT DISTINCT ON (s.gid) s.gid, s.school_name, s.geom, h.hospital_name
  FROM schools s
  LEFT JOIN hospitals h ON ST_DWithin(s.geom, h.geom, 3000)
  ORDER BY s.gid, ST_Distance(s.geom, h.geom);

-- The schools with no close hospitals
-- Find all schools with no hospital within 3000 units
-- away from the school. Units is in units of spatial ref (e.g. meters, feet, degrees)
SELECT s.gid, s.school_name
  FROM schools s
  LEFT JOIN hospitals h ON ST_DWithin(s.geom, h.geom, 3000)
  WHERE h.gid IS NULL;

-- Find broadcasting towers that receiver with limited range can receive.
-- Data is geometry in Spherical Mercator (SRID=3857), ranges are approximate.

-- Create geometry index that will check proximity limit of user to tower
CREATE INDEX ON broadcasting_towers using gist (geom);

-- Create geometry index that will check proximity limit of tower to user
CREATE INDEX ON broadcasting_towers using gist (ST_Expand(geom, sending_range));

-- Query towers that 4-kilometer receiver in Minsk Hackerspace can get
-- Note: two conditions, because shorter LEAST(b.sending_range, 4000) will not use index.
SELECT b.tower_id, b.geom
  FROM broadcasting_towers b
  WHERE ST_DWithin(b.geom, 'SRID=3857;POINT(3072163.4 7159374.1)', 4000)
  AND ST_DWithin(b.geom, 'SRID=3857;POINT(3072163.4 7159374.1)', b.sending_range);

```

☒☒

ST_Distance, ST_3DDWithin

7.11.2.5 ST_PointInsideCircle

ST_PointInsideCircle — Tests if a point geometry is inside a circle defined by a center and radius

Synopsis

boolean **ST_PointInsideCircle**(geometry a_point, float center_x, float center_y, float radius);

☒☒

Returns true if the geometry is a point and is inside the circle with center center_x,center_y and radius radius.



Warning

Does not use spatial indexes. Use **ST_DWithin** instead.

Availability: 1.2

Changed: 2.2.0 In prior versions this was called ST_Point_Inside_Circle

SQL

```
SELECT ST_PointInsideCircle(ST_Point(1,2), 0.5, 2, 3);
      st_pointinsidecircle
-----
t
```

SQL

ST_DWithin

7.12 Measurement Functions

7.12.1 ST_Area

ST_Area — Returns the area of a geometry.

Synopsis

```
float ST_Area(geometry g1);
float ST_Area(geography geog, boolean use_spheroid = true);
```




SQL

ST_Surface and ST_MultiSurface - Returns the area of a geometry. SRID must be 2 or greater. If use_spheroid is true, ST_Area(geog,true) returns the area of a curved surface. If use_spheroid is false, ST_Area(geog,false) returns the area of a flat surface.

2.0.0: Returns the area of a polyhedral surface.

2.2.0: Relies on GeographicLib and Proj 4.9.0.

Changed: 3.0.0 - does not depend on SFCGAL anymore.

-  This method implements the **OGC Simple Features Implementation Specification for SQL 1.1**.
-  This method implements the SQL/MM specification. SQL-MM 3: 8.1.2, 9.5.3
-  This function supports Polyhedral surfaces.



Note

Area calculation using ST_Area, (2.5 degrees) 2 degrees. 2.5 degrees 0 degrees (non-zero) XY coordinates.

Plot

Plot (plot) coordinates, EPSG:2249 coordinates.

```
select ST_Area(geom) sqft,
       ST_Area(geom) * 0.3048 ^ 2 sqm
from (
  select 'SRID=2249;POLYGON((743238 2967416,743238 2967450,
                            743265 2967450,743265.625 2967416,743238 2967416))' ::
        geometry geom
  ) subquery;
b' | b' sqft b' | b' sqm b' | b'
b' | b' 928.625 b' | b' 86.27208552 b' | b'
```

Area calculation using ST_Area and ST_Transform, (EPSG:26986) coordinates, EPSG:2249 coordinates, EPSG:26986 coordinates.

```
select ST_Area(geom) sqft,
       ST_Area(ST_Transform(geom, 26986)) As sqm
from (
  select
    'SRID=2249;POLYGON((743238 2967416,743238 2967450,
                      743265 2967450,743265.625 2967416,743238 2967416))' :: geometry geom
  ) subquery;
b' | b' sqft b' | b' sqm b' | b'
b' | b' 928.625 b' | b' 86.272430607008 b' | b'
```

Area calculation using ST_Area and ST_Area_Spheroid, WGS84 coordinates, WGS84 coordinates.

```
select ST_Area(geog) / 0.3048 ^ 2 sqft_spheroid,
       ST_Area(geog, false) / 0.3048 ^ 2 sqft_sphere,
       ST_Area(geog) sqm_spheroid
from (
```

```

select ST_Transform(
  'SRID=2249;POLYGON((743238 2967416,743238 2967450,743265
    2967450,743265.625 2967416,743238 2967416))'::geometry,
  4326
) :: geography geog
) as subquery;

```

If your data is in geography already:

```

select ST_Area(geog) / 0.3048 ^ 2 sqft,
  ST_Area(the_geog) sqm
from somegeogtable;

```



[ST_3DArea](#), [ST_GeomFromEWKT](#), [ST_LengthSpheroid](#), [ST_Perimeter](#), [ST_Transform](#)

7.12.2 ST_Azimuth

ST_Azimuth — [Geography](#) 2 [Geometry](#).

Synopsis

```

float ST_Azimuth(geometry origin, geometry target);
float ST_Azimuth(geography origin, geography target);

```



Returns the azimuth in radians of the target point from the origin point, or NULL if the two points are coincident. The azimuth angle is a positive clockwise angle referenced from the positive Y axis (geometry) or the North meridian (geography): North = 0; Northeast = $\pi/4$; East = $\pi/2$; Southeast = $3\pi/4$; South = π ; Southwest $5\pi/4$; West = $3\pi/2$; Northwest = $7\pi/4$.

For the geography type, the azimuth solution is known as the **inverse geodesic problem**.

The azimuth is a mathematical concept defined as the angle between a reference vector and a point, with angular units in radians. The result value in radians can be converted to degrees using the PostgreSQL function `degrees()`.

ST_Translate [Pgsqlfunctions PostGIS wiki section](#) `upgis_lineshift`

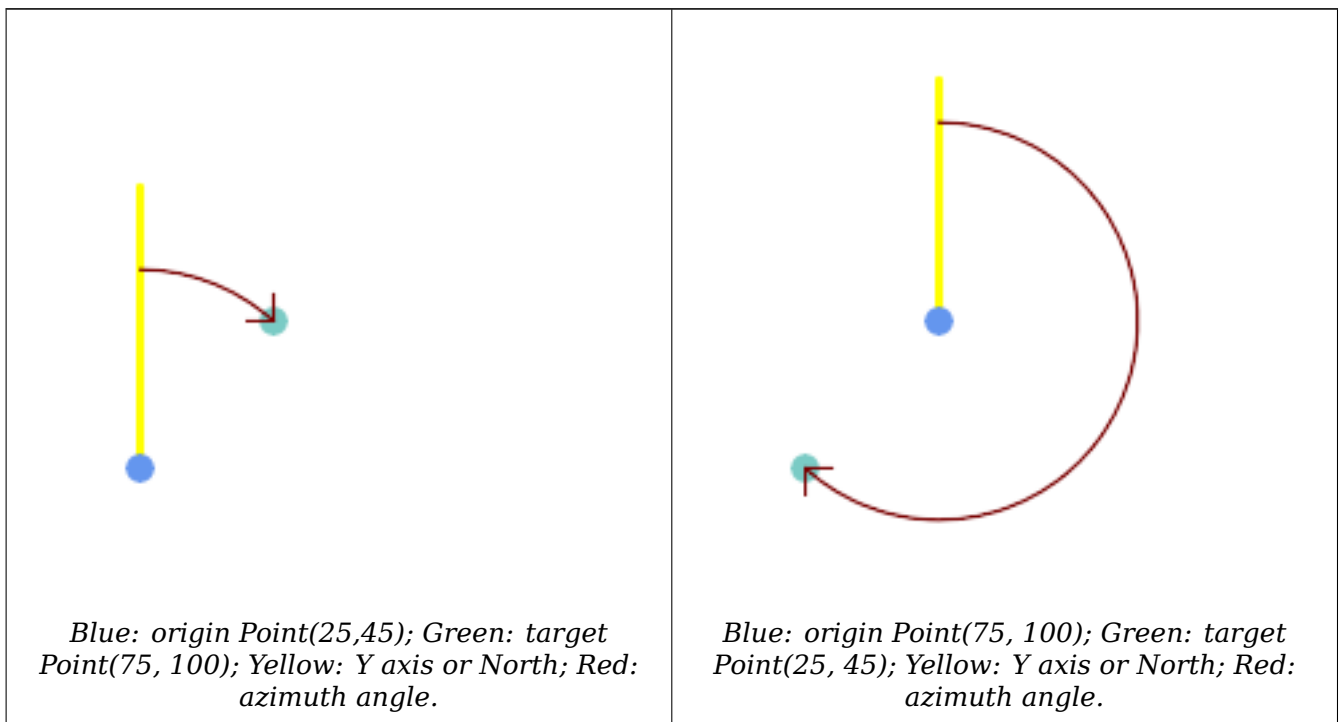
1.1.0

2.0.0

2.2.0 GeographicLib Proj 4.9.0

```
SELECT degrees(ST_Azimuth( ST_Point(25, 45), ST_Point(75, 100))) AS degA_B,
degrees(ST_Azimuth( ST_Point(75, 100), ST_Point(25, 45) )) AS degB_A;
```

dega_b	degb_a
42.2736890060937	222.273689006094



[ST_Angle](#), [ST_Translate](#), [ST_Project](#), [PostgreSQL Math Functions](#)

7.12.3 ST_Angle

ST_Angle — 3 (longest)

Synopsis

float **ST_Angle**(geometry point1, geometry point2, geometry point3, geometry point4);
 float **ST_Angle**(geometry line1, geometry line2);

degrees 3 (longest)

Variant 1: computes the angle enclosed by the points P1-P2-P3. If a 4th point provided computes the angle points P1-P2 and P3-P4

Variant 2: computes the angle between two vectors S1-E1 and S2-E2, defined by the start and end points of the input lines

PostgreSQL `degrees()`

Note that `ST_Angle(P1,P2,P3) = ST_Angle(P2,P1,P2,P3)`.

Availability: 2.5.0

```
SELECT degrees( ST_Angle('POINT(0 0)', 'POINT(10 10)', 'POINT(20 0)') );
```

```
degrees
-----
      270
```

Angle between vectors defined by four points

```
SELECT degrees( ST_Angle('POINT (10 10)', 'POINT (0 0)', 'POINT(90 90)', 'POINT (100 80)') );
```

```
degrees
-----
269.999999999999
```

Angle between vectors defined by the start and end points of lines

```
SELECT degrees( ST_Angle('LINESTRING(0 0, 0.3 0.7, 1 1)', 'LINESTRING(0 0, 0.2 0.5, 1 0)') );
```

```
degrees
-----
      45
```

ST_Azimuth

7.12.4 ST_ClosestPoint

`ST_ClosestPoint` — Returns the 2D point on g1 that is closest to g2. This is the first point of the shortest line from one geometry to the other.

Synopsis

geometry **ST_ClosestPoint**(geometry geom1, geometry geom2);
 geography **ST_ClosestPoint**(geography geom1, geography geom2, boolean use_spheroid = true);

Returns the 2-dimensional point on geom1 that is closest to geom2. This is the first point of the shortest line between the geometries (as computed by [ST_ShortestLine](#)).

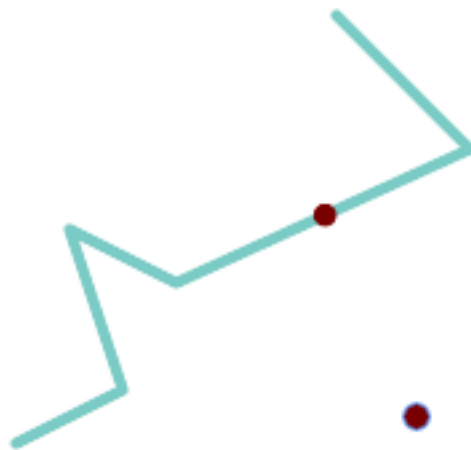


Note

3 [ST_3DClosestPoint](#)

Enhanced: 3.4.0 - Support for geography.

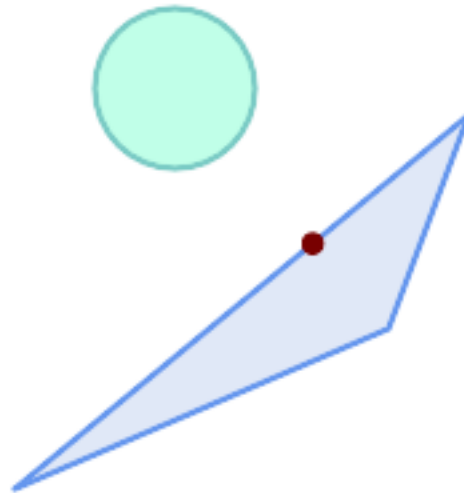
1.5.0



The closest point for a Point and a LineString is the point itself. The closest point for a LineString and a Point is a point on the line.

```
SELECT ST_AsText( ST_ClosestPoint(pt,line)) AS cp_pt_line,
       ST_AsText( ST_ClosestPoint(line,pt)) AS cp_line_pt
FROM (SELECT 'POINT (160 40)::geometry AS pt,
            'LINESTRING (10 30, 50 50, 30 110, 70 90, 180 140, 130 190)::geometry AS line ) AS t;
```

cp_pt_line	cp_line_pt
POINT(160 40)	POINT(125.75342465753425 115.34246575342466)



The closest point on polygon A to polygon B

```
SELECT ST_AsText( ST_ClosestPoint(
                    'POLYGON ((190 150, 20 10, 160 70, 190 150))',
                    ST_Buffer('POINT(80 160)', 30)
                )) As ptwkt;
-----
POINT(131.59149149528952 101.89887534906197)
```

☒☒

[ST_3DClosestPoint](#), [ST_Distance](#), [ST_LongestLine](#), [ST_ShortestLine](#), [ST_MaxDistance](#)

7.12.5 ST_3DClosestPoint

`ST_3DClosestPoint` — g2 ☒☒☒☒☒☒ g1 ☒☒☒☒ 3 ☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒ 3D ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_3DClosestPoint**(geometry g1, geometry g2);

☒☒

g2 ☒☒☒☒☒☒ g1 ☒☒☒☒ 3 ☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒ 3D ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. 3D ☒☒☒☒☒☒ 3D ☒☒☒☒ 3D ☒☒☒☒☒☒.

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

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒.

☒☒☒☒: 2.2.0 ☒☒☒☒ 2D ☒☒☒☒☒☒☒☒☒☒☒☒, (☒☒☒☒☒☒☒ Z ☒ 0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒) 2D ☒☒☒☒☒☒☒☒☒☒☒☒. 2D ☒ 3D ☒☒☒, ☒☒☒ Z ☒☒☒☒☒ Z ☒ 0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒


```

-- 3D, 2D ST_ClosestPoint (closest point)
SELECT ST_AsEWKT(ST_3DClosestPoint(line,pt)) AS cp3d_line_pt,
       ST_AsEWKT(ST_ClosestPoint(line,pt)) As cp2d_line_pt
FROM (SELECT 'POINT(100 100 30)::geometry As pt,
            'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 1000)::geometry As line
      ) As foo;

cp3d_line_pt | cp2d_line_pt
-----+-----
POINT(54.6993798867619 128.935022917228 11.5475869506606) | POINT(73.0769230769231 115.384615384615)

-- 3D, 2D ST_ClosestPoint (closest point)
SELECT ST_AsEWKT(ST_3DClosestPoint(line,pt)) AS cp3d_line_pt,
       ST_AsEWKT(ST_ClosestPoint(line,pt)) As cp2d_line_pt
FROM (SELECT 'MULTIPOINT(100 100 30, 50 74 1000)::geometry As pt,
            'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 900)::geometry As line
      ) As foo;

cp3d_line_pt | cp2d_line_pt
-----+-----
POINT(54.6993798867619 128.935022917228 11.5475869506606) | POINT(50 75)

-- 3D, 2D ST_ClosestPoint (closest point)
SELECT ST_AsEWKT(ST_3DClosestPoint(poly, mline)) As cp3d,
       ST_AsEWKT(ST_ClosestPoint(poly, mline)) As cp2d
FROM (SELECT ST_GeomFromEWKT('POLYGON((175 150 5, 20 40 5, 35 45 5, 50 60 5, 100 100 5, 175 150 5))') As poly,
            ST_GeomFromEWKT('MULTILINESTRING((175 155 2, 20 40 20, 50 60 -2, 125 100 1, 175 155 1), (1 10 2, 5 20 1))') As mline ) As foo;

cp3d | cp2d
-----+-----
POINT(39.993580415989 54.1889925532825 5) | POINT(20 40)
    
```

☒☒

[ST_AsEWKT](#), [ST_ClosestPoint](#), [ST_3DDistance](#), [ST_3DShortestLine](#)

7.12.6 ST_Distance

ST_Distance — ☒☒☒☒☒☒ 3 ☒☒☒☒ (longest) ☒☒☒☒☒☒☒.

Synopsis

```
float ST_Distance(geometry g1, geometry g2);
float ST_Distance(geography geog1, geography geog2, boolean use_spheroid = true);
```

⊠

⊠, ⊠ 3 ⊠ (SRS ⊠) ⊠.

For **geography** types defaults to return the minimum geodesic distance between two geographies in meters, compute on the spheroid determined by the SRID. If `use_spheroid` is false, a faster spherical calculation is used.

- ✔ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).
- ✔ This method implements the SQL/MM specification. SQL-MM 3: 5.1.23
- ✔ This method supports Circular Strings and Curves.

1.5.0 ⊠. ⊠. ⊠.

⊠: 2.1.0 ⊠. ⊠ [Making Geography faster](#) ⊠.

⊠: 2.1.0 ⊠.

⊠: 2.2.0 ⊠ GeographicLib ⊠. ⊠ Proj 4.9.0 ⊠.

Changed: 3.0.0 - does not depend on SFCGAL anymore.

⊠

Geometry example - units in planar degrees 4326 is WGS 84 long lat, units are degrees.

```
SELECT ST_Distance(
  'SRID=4326;POINT(-72.1235 42.3521)::geometry,
  'SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)::geometry );
-----
0.00150567726382282
```

Geometry example - units in meters (SRID: 3857, proportional to pixels on popular web maps). Although the value is off, nearby ones can be compared correctly, which makes it a good choice for algorithms like KNN or KMeans.

```
SELECT ST_Distance(
  ST_Transform('SRID=4326;POINT(-72.1235 42.3521)::geometry, 3857),
  ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)::geometry, 3857) ) ←
  ;
-----
167.441410065196
```

Geometry example - units in meters (SRID: 3857 as above, but corrected by $\cos(\text{lat})$ to account for distortion)

```
SELECT ST_Distance(
  ST_Transform('SRID=4326;POINT(-72.1235 42.3521)::geometry, 3857),
  ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)::geometry, 3857)
) * cosd(42.3521);
-----
123.742351254151
```

Geometry example - units in meters (SRID: 26986 Massachusetts state plane meters) (most accurate for Massachusetts)

```
SELECT ST_Distance(
  ST_Transform('SRID=4326;POINT(-72.1235 42.3521)::geometry, 26986),
  ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)::geometry, 26986) ←
);
-----
123.797937878454
```

Geometry example - units in meters (SRID: 2163 US National Atlas Equal area) (least accurate)

```
SELECT ST_Distance(
  ST_Transform('SRID=4326;POINT(-72.1235 42.3521)::geometry, 2163),
  ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)::geometry, 2163) ) ←
;
-----
126.664256056812
```

Geography

Same as geometry example but note units in meters - use sphere for slightly faster and less accurate computation.

```
SELECT ST_Distance(gg1, gg2) As spheroid_dist, ST_Distance(gg1, gg2, false) As sphere_dist
FROM (SELECT
  'SRID=4326;POINT(-72.1235 42.3521)::geography as gg1,
  'SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)::geography as gg2
) As foo ;

spheroid_dist | sphere_dist
-----+-----
123.802076746848 | 123.475736916397
```

Other

[ST_3DDistance](#), [ST_DWithin](#), [ST_DistanceSphere](#), [ST_DistanceSpheroid](#), [ST_MaxDistance](#), [ST_HausdorffDistance](#), [ST_FrechetDistance](#), [ST_Transform](#)

7.12.7 ST_3DDistance


ST_3DDistance — Returns the 3D distance between two geometries in SRID *srid* (SRID *srid*) 3D distance between two geometries in SRID *srid*.

Synopsis

float **ST_3DDistance**(geometry g1, geometry g2);

Geography

ST_3DDistance(geography g1, geography g2, integer srid) Returns the 3D distance between two geographies in SRID *srid*.

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

- ✔ This function supports Polyhedral surfaces.
 - ✔ This method implements the SQL/MM specification. SQL-MM ISO/IEC 13249-3 2.0.0.
- 2.2.0: 2.2.0, 2D & 3D Z 0.
- Changed: 3.0.0 - SFCGAL version removed

☒

```
-- Geometry example - units in meters (SRID: 2163 US National Atlas Equal area) (3D point and line compared 2D point and line)
-- Note: currently no vertical datum support so Z is not transformed and assumed to be same units as final.
SELECT ST_3DDistance(
    ST_Transform('SRID=4326;POINT(-72.1235 42.3521 4)::geometry,2163),
    ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45 15, -72.123 42.1546 20)::geometry,2163)
) As dist_3d,
ST_Distance(
    ST_Transform('SRID=4326;POINT(-72.1235 42.3521)::geometry,2163),
    ST_Transform('SRID=4326;LINESTRING(-72.1260 42.45, -72.123 42.1546)::geometry,2163)
) As dist_2d;

dist_3d      |      dist_2d
-----+-----
127.295059324629 | 126.66425605671
```

```
-- Multilinestring and polygon both 3d and 2d distance
-- Same example as 3D closest point example
SELECT ST_3DDistance(poly, mline) As dist3d,
    ST_Distance(poly, mline) As dist2d
FROM (SELECT 'POLYGON((175 150 5, 20 40 5, 35 45 5, 50 60 5, 100 100 5, 175 150 5))'::geometry as poly,
    'MULTILINESTRING((175 155 2, 20 40 20, 50 60 -2, 125 100 1, 175 155 1), (1 10 2, 5 20 1))'::geometry as mline) as foo;

dist3d      |      dist2d
-----+-----
0.716635696066337 | 0
```

☒

[ST_Distance](#), [ST_3DClosestPoint](#), [ST_3DDWithin](#), [ST_3DMaxDistance](#), [ST_3DShortestLine](#), [ST_Transform](#)

7.12.8 ST_DistanceSphere

ST_DistanceSphere — PostGIS 1.5.

Synopsis

float **ST_DistanceSphere**(geometry geom1lonlatA, geometry geom1lonlatB, float8 radius=6371008);

¶¶

¶¶¶¶¶ 2 ¶¶¶¶¶. SRID ¶¶¶¶¶. **ST_DistanceSpheroid** ¶¶¶¶¶, ¶¶¶¶¶. PostGIS 1.5 ¶¶¶¶¶.

1.5 ¶¶¶¶¶. 1.5 ¶¶¶¶¶.

¶¶¶¶: 2.2.0 ¶¶¶¶¶ ST_Distance_Sphere ¶¶¶¶¶.

¶¶

```

SELECT round(CAST(ST_DistanceSphere(ST_Centroid(geom), ST_GeomFromText('POINT(-118 38) ←
',4326)) As numeric),2) As dist_meters,
round(CAST(ST_Distance(ST_Transform(ST_Centroid(geom),32611),
      ST_Transform(ST_GeomFromText('POINT(-118 38)', 4326),32611)) As numeric),2) ←
      As dist_utm11_meters,
round(CAST(ST_Distance(ST_Centroid(geom), ST_GeomFromText('POINT(-118 38)', 4326)) As ←
      numeric),5) As dist_degrees,
round(CAST(ST_Distance(ST_Transform(geom,32611),
      ST_Transform(ST_GeomFromText('POINT(-118 38)', 4326),32611)) As numeric),2) ←
      As min_dist_line_point_meters
FROM
  (SELECT ST_GeomFromText('LINESTRING(-118.584 38.374,-118.583 38.5)', 4326) As geom) ←
  as foo;
  dist_meters | dist_utm11_meters | dist_degrees | min_dist_line_point_meters
-----+-----+-----+-----
          70424.47 |          70438.00 |          0.72900 |          65871.18

```

¶¶

ST_Distance, ST_DistanceSpheroid

7.12.9 ST_DistanceSpheroid

ST_DistanceSpheroid — ¶¶¶¶¶. PostGIS 1.5 ¶¶¶¶¶.

Synopsis

float **ST_DistanceSpheroid**(geometry geom1lonlatA, geometry geom1lonlatB, spheroid measurement_spheroid)

¶¶

¶¶¶¶¶. ¶¶¶¶¶ **ST_LengthSpheroid** ¶¶¶¶¶. PostGIS 1.5 ¶¶¶¶¶.



Note

¶¶¶¶¶ SRID ¶¶¶¶¶. ¶¶¶¶¶.

1.5. ST_Distance_Spheroid. 1.5. ST_DistanceSphere.

2.2.0 ST_Distance_Spheroid.

SQL

```

SELECT round(CAST(
    ST_DistanceSpheroid(ST_Centroid(geom), ST_GeomFromText('POINT(-118 38) ←
    ',4326), 'SPHEROID["WGS 84",6378137,298.257223563]')
    As numeric),2) As dist_meters_spheroid,
    round(CAST(ST_DistanceSphere(ST_Centroid(geom), ST_GeomFromText('POINT(-118 ←
    38)',4326)) As numeric),2) As dist_meters_sphere,
round(CAST(ST_Distance(ST_Transform(ST_Centroid(geom),32611),
    ST_Transform(ST_GeomFromText('POINT(-118 38)', 4326),32611)) As numeric),2) ←
    As dist_utm11_meters
FROM
    (SELECT ST_GeomFromText('LINESTRING(-118.584 38.374,-118.583 38.5)', 4326) As geom) ←
    as foo;
dist_meters_spheroid | dist_meters_sphere | dist_utm11_meters
-----+-----+-----
                70454.92 |                70424.47 |                70438.00

```

SQL

ST_Distance, ST_DistanceSphere

7.12.10 ST_FrechetDistance

ST_FrechetDistance — 3 (shortest).

Synopsis

```
float ST_FrechetDistance(geometry g1, geometry g2, float densifyFrac = -1);
```

SQL

Implements algorithm for computing the Fréchet distance restricted to discrete points for both geometries, based on Computing Discrete Fréchet Distance. The Fréchet distance is a measure of similarity between curves that takes into account the location and ordering of the points along the curves. Therefore it is often better than the Hausdorff distance.

When the optional densifyFrac is specified, this function performs a segment densification before computing the discrete Fréchet distance. The densifyFrac parameter sets the fraction by which to densify each segment. Each segment will be split into a number of equal-length subsegments, whose fraction of the total length is closest to the given fraction.

Units are in the units of the spatial reference system of the geometries.



Note

ST_FrechetDistance. ST_FrechetDistance.

**Note**

The smaller `densifyFrac` we specify, the more accurate Fréchet distance we get. But, the computation time and the memory usage increase with the square of the number of subsegments.

GEOS

Availability: 2.4.0 - requires GEOS \geq 3.7.0

```
postgres=# SELECT st_frechetdistance('LINESTRING (0 0, 100 0)::geometry, 'LINESTRING (0 0, ↵
          50 50, 100 0)::geometry');
 st_frechetdistance
-----
          70.7106781186548
(1 row)
```

```
SELECT st_frechetdistance('LINESTRING (0 0, 100 0)::geometry, 'LINESTRING (0 0, 50 50, 100 ↵
          0)::geometry, 0.5);
 st_frechetdistance
-----
                    50
(1 row)
```

ST_HausdorffDistance

7.12.11 ST_HausdorffDistance

`ST_HausdorffDistance` — (shortest)


Synopsis

```
float ST_HausdorffDistance(geometry g1, geometry g2);
float ST_HausdorffDistance(geometry g1, geometry g2, float densifyFrac);
```

Returns the **Hausdorff distance** between two geometries. The Hausdorff distance is a measure of how similar or dissimilar 2 geometries are.

The function actually computes the “Discrete Hausdorff Distance”. This is the Hausdorff distance computed at discrete points on the geometries. The *densifyFrac* parameter can be specified, to provide a more accurate answer by densifying segments before computing the discrete Hausdorff distance. Each segment is split into a number of equal-length subsegments whose fraction of the segment length is closest to the given fraction.

Units are in the units of the spatial reference system of the geometries.

Note  This algorithm is NOT equivalent to the standard Hausdorff distance. However, it computes an approximation that is correct for a large subset of useful cases. One important case is Linestrings that are roughly parallel to each other, and roughly equal in length. This is a useful metric for line matching.

1.5.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒



Hausdorff distance (red) and distance (yellow) between two lines

```
SELECT ST_HausdorffDistance(geomA, geomB),
       ST_Distance(geomA, geomB)
FROM (SELECT 'LINESTRING (20 70, 70 60, 110 70, 170 70)::geometry AS geomA,
            'LINESTRING (20 90, 130 90, 60 100, 190 100)::geometry AS geomB) AS t;
st_hausdorffdistance | st_distance
-----+-----
37.26206567625497 |          20
```

Example: Hausdorff distance with densification.

```
SELECT ST_HausdorffDistance(
    'LINESTRING (130 0, 0 0, 0 150)::geometry,
    'LINESTRING (10 10, 10 150, 130 10)::geometry,
    0.5);
-----
70
```

Example: For each building, find the parcel that best represents it. First we require that the parcel intersect with the building geometry. `DISTINCT ON` guarantees we get each building listed only once. `ORDER BY .. ST_HausdorffDistance` selects the parcel that is most similar to the building.

```
SELECT DISTINCT ON (buildings.gid) buildings.gid, parcels.parcel_id
FROM buildings
INNER JOIN parcels
ON ST_Intersects(buildings.geom, parcels.geom)
ORDER BY buildings.gid, ST_HausdorffDistance(buildings.geom, parcels.geom);
```



```
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
```

案例

WGS84 经纬度转平面坐标。

```
-- the default calculation uses a spheroid
SELECT ST_Length(the_geog) As length_spheroid, ST_Length(the_geog,false) As length_sphere
FROM (SELECT ST_GeographyFromText(
'SRID=4326;LINESTRING(-72.1260 42.45, -72.1240 42.45666, -72.123 42.1546)') As the_geog)
As foo;

length_spheroid | length_sphere
-----+-----
34310.5703627288 | 34346.2060960742
```

函数

[ST_GeographyFromText](#), [ST_GeomFromEWKT](#), [ST_LengthSpheroid](#), [ST_Perimeter](#), [ST_Transform](#)

7.12.13 ST_Length2D

ST_Length2D — 返回 2 维线段的长度。与 ST_Length 类似。

Synopsis

float **ST_Length2D**(geometry a_2dlinestring);

参数

返回 2 维线段的长度。与 ST_Length 类似。

[?]

ST_Length, ST_3DLength

7.12.14 ST_3DLength



ST_3DLength — [?][?][?][?][?][?][?][?][?][?][?][?][?][?][?]

Synopsis

float **ST_3DLength**(geometry a_3dlinestring);

[?]

[?][?][?][?][?][?][?][?][?][?][?][?][?][?][?][?][?] 3 [?][?][?] 2 [?][?][?][?][?][?][?][?][?][?][?]. 2 [?][?][?][?][?] 2 [?][?][?][?][?][?][?][?][?][?][?][?][?] (ST_Length [?] ST_Length2D [?][?][?][?]).

-  This function supports 3d and will not drop the z-index.
 -  This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 7.1, 10.3
- [?][?][?]: 2.0.0 [?][?][?][?][?] ST_Length3D [?][?][?][?][?][?][?].

[?]

3 [?][?][?][?][?][?][?][?][?][?][?][?][?][?][?][?][?]. [?][?] EPSG:2249 [?][?][?][?][?][?][?][?][?][?][?][?][?][?][?][?][?] [?][?][?][?][?][?][?][?].

```
SELECT ST_3DLength(ST_GeomFromText('LINESTRING(743238 2967416 1,743238 2967450 1,743265 ←
      2967450 3,
743265.625 2967416 3,743238 2967416 3)',2249));
ST_3DLength
-----
122.704716741457
```

[?]

ST_Length, ST_Length2D

7.12.15 ST_LengthSpheroid

ST_LengthSpheroid — [?][?][?][?][?][?][?][?][?][?][?][?][?][?]

Synopsis

float **ST_LengthSpheroid**(geometry a_geometry, spheroid a_spheroid);

7.12.16 ST_LongestLine

ST_LongestLine — Returns the 2-dimensional longest line between the points of two geometries.

Synopsis

```
geometry ST_LongestLine(geometry g1, geometry g2);
```

Returns

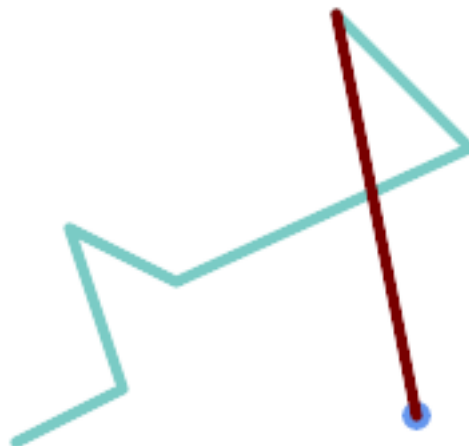
Returns the 2-dimensional longest line between the points of two geometries. The line returned starts on g1 and ends on g2.

The longest line always occurs between two vertices. The function returns the first longest line if more than one is found. The length of the line is equal to the distance returned by [ST_MaxDistance](#).

If g1 and g2 are the same geometry, returns the line between the two vertices farthest apart in the geometry. The endpoints of the line lie on the circle computed by [ST_MinimumBoundingCircle](#).

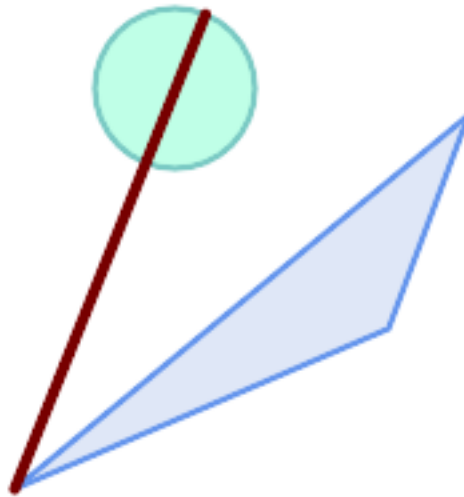
1.5.0

Example



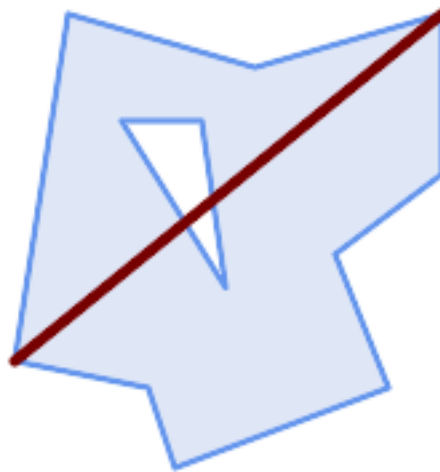
Example

```
SELECT ST_AsText( ST_LongestLine(
    'POINT (160 40)',
    'LINESTRING (10 30, 50 50, 30 110, 70 90, 180 140, 130 190)' )
    ) AS lline;
-----
LINESTRING(160 40,130 190)
```



☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒

```
SELECT ST_AsText( ST_LongestLine(
    'POLYGON ((190 150, 20 10, 160 70, 190 150))',
    ST_Buffer('POINT(80 160)', 30)
) ) AS llinewkt;
-----
LINESTRING(20 10,105.3073372946034 186.95518130045156)
```



Longest line across a single geometry. The length of the line is equal to the Maximum Distance. The endpoints of the line lie on the Minimum Bounding Circle.

```
SELECT ST_AsText( ST_LongestLine( geom, geom) ) AS llinewkt,
       ST_MaxDistance( geom, geom) AS max_dist,
       ST_Length( ST_LongestLine(geom, geom) ) AS lenll
FROM (SELECT 'POLYGON ((40 180, 110 160, 180 180, 180 120, 140 90, 160 40, 80 10, 70 40, 20 ←
50, 40 180),
(60 140, 99 77.5, 90 140, 60 140))'::geometry AS geom) AS t;

-----
      llinewkt          |      max_dist          |      lenll
-----+-----+-----
LINESTRING(20 50,180 180) | 206.15528128088303    | 206.15528128088303
```

ST_MaxDistance, ST_ShortestLine, ST_3DLongestLine, ST_MinimumBoundingCircle

7.12.17 ST_3DLongestLine

ST_3DLongestLine — 3 (longest) .



Synopsis

geometry **ST_3DLongestLine**(geometry g1, geometry g2);

3 (longest) . , . g1 g2 3 **ST_3DMaxDistance** g1 g2 .

2.0.0 .

: 2.2.0 2D , (Z 0) 2D . 2D 3D , Z Z 0 .

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

```

-- 3D, 2D
SELECT ST_AsEWKT(ST_3DLongestLine(line,pt)) AS lol3d_line_pt,
       ST_AsEWKT(ST_LongestLine(line,pt)) As lol2d_line_pt
FROM (SELECT 'POINT(100 100 30)::geometry As pt,
            'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 1000)>::
       geometry As line
       ) As foo;

      lol3d_line_pt           |      lol2d_line_pt
-----+-----
LINESTRING(50 75 1000,100 100 30) | LINESTRING(98 190,100 100)

```

```

-- 3D, 2D
SELECT ST_AsEWKT(ST_3DLongestLine(line,pt)) AS lol3d_line_pt,
       ST_AsEWKT(ST_LongestLine(line,pt)) As lol2d_line_pt
FROM (SELECT 'MULTIPOINT(100 100 30, 50 74 1000)>::geometry As pt,
            'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 900)>:: ←
       geometry As line
       ) As foo;

lol3d_line_pt | lol2d_line_pt
-----+-----
LINESTRING(98 190 1,50 74 1000) | LINESTRING(98 190,50 74)

-- 3D, 2D
SELECT ST_AsEWKT(ST_3DLongestLine(poly, mline)) As lol3d,
       ST_AsEWKT(ST_LongestLine(poly, mline)) As lol2d
FROM (SELECT ST_GeomFromEWKT('POLYGON((175 150 5, 20 40 5, 35 45 5, 50 60 5, ←
100 100 5, 175 150 5))') As poly,
       ST_GeomFromEWKT('MULTILINESTRING((175 155 2, 20 40 20, 50 60 -2, 125 ←
100 1, 175 155 1),
       (1 10 2, 5 20 1))') As mline ) As foo;

lol3d | lol2d
-----+-----
LINESTRING(175 150 5,1 10 2) | LINESTRING(175 150,1 10)

```

[ST_3DClosestPoint](#), [ST_3DDistance](#), [ST_LongestLine](#), [ST_3DShortestLine](#), [ST_3DMaxDistance](#)

7.12.18 ST_MaxDistance

ST_MaxDistance — 2

Synopsis

float **ST_MaxDistance**(geometry g1, geometry g2);

2 . g1 g2

2 . g1 g2

1.5.0


```
SELECT ST_MaxDistance('POINT(0 0)::geometry, 'LINESTRING ( 2 0, 0 2 ) '::geometry);
-----
2

SELECT ST_MaxDistance('POINT(0 0)::geometry, 'LINESTRING ( 2 2, 2 2 ) '::geometry);
-----
2.82842712474619
```

Maximum distance between vertices of a single geometry.

```
SELECT ST_MaxDistance('POLYGON ((10 10, 10 0, 0 0, 10 10))::geometry,
                        'POLYGON ((10 10, 10 0, 0 0, 10 10))::geometry);
-----
14.142135623730951
```

[ST_Distance](#), [ST_LongestLine](#), [ST_DFullyWithin](#)



7.12.19 ST_3DMaxDistance

ST_3DMaxDistance — Returns the maximum distance between two geometries (SRID `SRID`) in 3D space.

Synopsis

float **ST_3DMaxDistance**(geometry g1, geometry g2);

`SRID`, `SRID` 3D space (SRID `SRID`)

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

2.0.0

`SRID`: 2.2.0, 2D `SRID` 3D `SRID` Z `SRID` Z `SRID` 0

```
-- Geometry example - units in meters (SRID: 2163 US National Atlas Equal area) (3D point ↔
-- and line compared 2D point and line)
-- Note: currently no vertical datum support so Z is not transformed and assumed to be same ↔
-- units as final.
SELECT ST_3DMaxDistance(
    ST_Transform(ST_GeomFromEWKT('SRID=4326;POINT(-72.1235 42.3521 10000)'),2163),
    ST_Transform(ST_GeomFromEWKT('SRID=4326;LINESTRING(-72.1260 42.45 15, -72.123 42.1546 20)'),2163)
) As dist_3d,
ST_MaxDistance(
```




[ST_MinimumClearanceLine](#), [ST_Crosses](#), [ST_Dimension](#), [ST_Intersects](#)

7.12.21 ST_MinimumClearanceLine

ST_MinimumClearanceLine — Returns a  2  geometry, .

Synopsis

Geometry **ST_MinimumClearanceLine**(geometry g);



Returns the two-point LineString spanning a geometry’s minimum clearance. If the geometry does not have a minimum clearance, LINESTRING EMPTY is returned.

GEOS 

2.3.0 . GEOS 3.6.0 .



```
SELECT ST_AsText(ST_MinimumClearanceLine('POLYGON ((0 0, 1 0, 1 1, 0.5 3.2e-4, 0 0))'));
-----
LINESTRING(0.5 0.00032,0.5 0)
```



[ST_MinimumClearance](#)

7.12.22 ST_Perimeter

ST_Perimeter — Returns the length of the boundary of a polygonal geometry or geography.

Synopsis

float **ST_Perimeter**(geometry g1);
 float **ST_Perimeter**(geography geog, boolean use_spheroid = true);



/ ST_Surface, ST_MultiSurface(, ) / 2 
.  0 .  [ST_Length](#) . , 
.

For geography types, the calculations are performed using the inverse geodesic problem, where perimeter units are in meters. If PostGIS is compiled with PROJ version 4.8.0 or later, the spheroid is

specified by the SRID, otherwise it is exclusive to WGS84. If use_spheroid = false, then calculations will approximate a sphere instead of a spheroid.

`ST_Perimeter2D`, `ST_Perimeter2D`.

 This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.5.1](#)

 This method implements the SQL/MM specification. SQL-MM 3: 8.1.3, 9.5.4

Version: 2.0.0

Usage:

`ST_Perimeter` `geom` [`SRID`] [`use_spheroid`]. `SRID` EPSG:2249 `use_spheroid` `use_spheroid`.

```
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)
```

Usage:

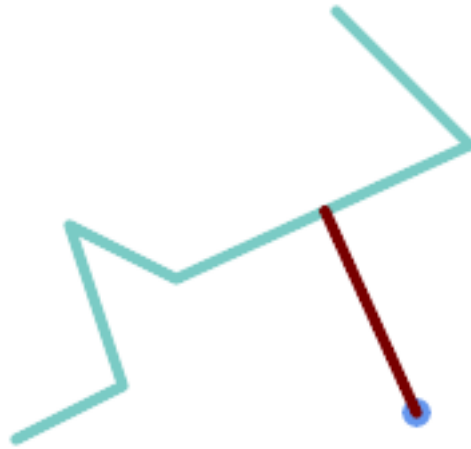
`ST_Perimeter` `geom` [`SRID`] [`use_spheroid`]. `SRID` WGS84 `use_spheroid`.

```
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

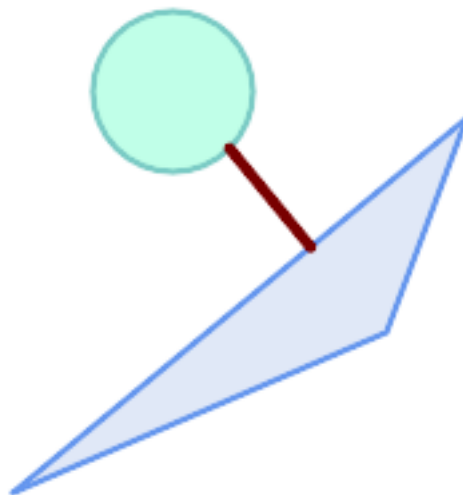
-- MultiPolygon example --
SELECT ST_Perimeter(geog) As per_meters, ST_Perimeter(geog,false) As per_sphere_meters, ↔
ST_Perimeter(geog)/0.3048 As per_ft
```


☒☒



Shortest line between Point and LineString

```
SELECT ST_AsText( ST_ShortestLine(
  'POINT (160 40)',
  'LINESTRING (10 30, 50 50, 30 110, 70 90, 180 140, 130 190)')
) As sline;
-----
LINESTRING(160 40,125.75342465753425 115.34246575342466)
```



Shortest line between Polygons

```
SELECT ST_AsText( ST_ShortestLine(
  'POLYGON ((190 150, 20 10, 160 70, 190 150))',
  ST_Buffer('POINT(80 160)', 30)
) ) AS llinewkt;
-----
LINESTRING(131.59149149528952 101.89887534906197,101.21320343559644 138.78679656440357)
```



```

-- 3D, 2D
SELECT ST_AsEWKT(ST_3DShortestLine(line,pt)) AS shl3d_line_pt,
       ST_AsEWKT(ST_ShortestLine(line,pt)) As shl2d_line_pt
FROM (SELECT 'MULTIPOINT(100 100 30, 50 74 1000)>:::geometry As pt,
            'LINESTRING (20 80 20, 98 190 1, 110 180 3, 50 75 900)>:::
geometry As line
      ) As foo;

shl2d_line_pt      shl3d_line_pt      |
-----+-----
LINESTRING(54.6993798867619 128.935022917228 11.5475869506606,100 100 30) | LINESTRING
(50 75,50 74)

-- 3D, 2D
SELECT ST_AsEWKT(ST_3DShortestLine(poly, mline)) As shl3d,
       ST_AsEWKT(ST_ShortestLine(poly, mline)) As shl2d
FROM (SELECT ST_GeomFromEWKT('POLYGON((175 150 5, 20 40 5, 35 45 5, 50 60 5,
100 100 5, 175 150 5))') As poly,
       ST_GeomFromEWKT('MULTILINESTRING((175 155 2, 20 40 20, 50 60 -2, 125
100 1, 175 155 1),
(1 10 2, 5 20 1))') As mline ) As foo;

shl3d      shl2d
-----+-----
LINESTRING(39.993580415989 54.1889925532825 5,40.4078575708294 53.6052383805529
5.03423778139177) | LINESTRING(20 40,20 40)
    
```

☒☒

[ST_3DClosestPoint](#), [ST_3DDistance](#), [ST_LongestLine](#), [ST_ShortestLine](#), [ST_3DMaxDistance](#)

7.13 Overlay Functions

7.13.1 ST_ClipByBox2D

ST_ClipByBox2D — Computes the portion of a geometry falling within a rectangle.

Synopsis

geometry **ST_ClipByBox2D**(geometry geom, box2d box);

☒☒

Clips a geometry by a 2D box in a fast and tolerant but possibly invalid way. Topologically invalid input geometries do not result in exceptions being thrown. The output geometry is not guaranteed to be valid (in particular, self-intersections for a polygon may be introduced).

GEOS ☒☒☒☒☒

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
-- Rely on implicit cast from geometry to box2d for the second parameter
SELECT ST_ClipByBox2D(geom, ST_MakeEnvelope(0,0,10,10)) FROM mytab;
```

☒☒

[ST_Intersection](#), [ST_MakeBox2D](#), [ST_MakeEnvelope](#)

7.13.2 ST_Difference

ST_Difference — Computes a geometry representing the part of geometry A that does not intersect geometry B.

Synopsis

geometry **ST_Difference**(geometry geomA, geometry geomB, float8 gridSize = -1);

☒☒

Returns a geometry representing the part of geometry A that does not intersect geometry B. This is equivalent to $A - ST_Intersection(A,B)$. If A is completely contained in B then an empty atomic geometry of appropriate type is returned.



Note

This is the only overlay function where input order matters. **ST_Difference**(A, B) always returns a portion of A.

If the optional `gridSize` argument is provided, the inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)

GEOS ☒☒☒☒☒

Enhanced: 3.1.0 accept a `gridSize` parameter.

Requires GEOS \geq 3.9.0 to use the `gridSize` parameter.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3](#)

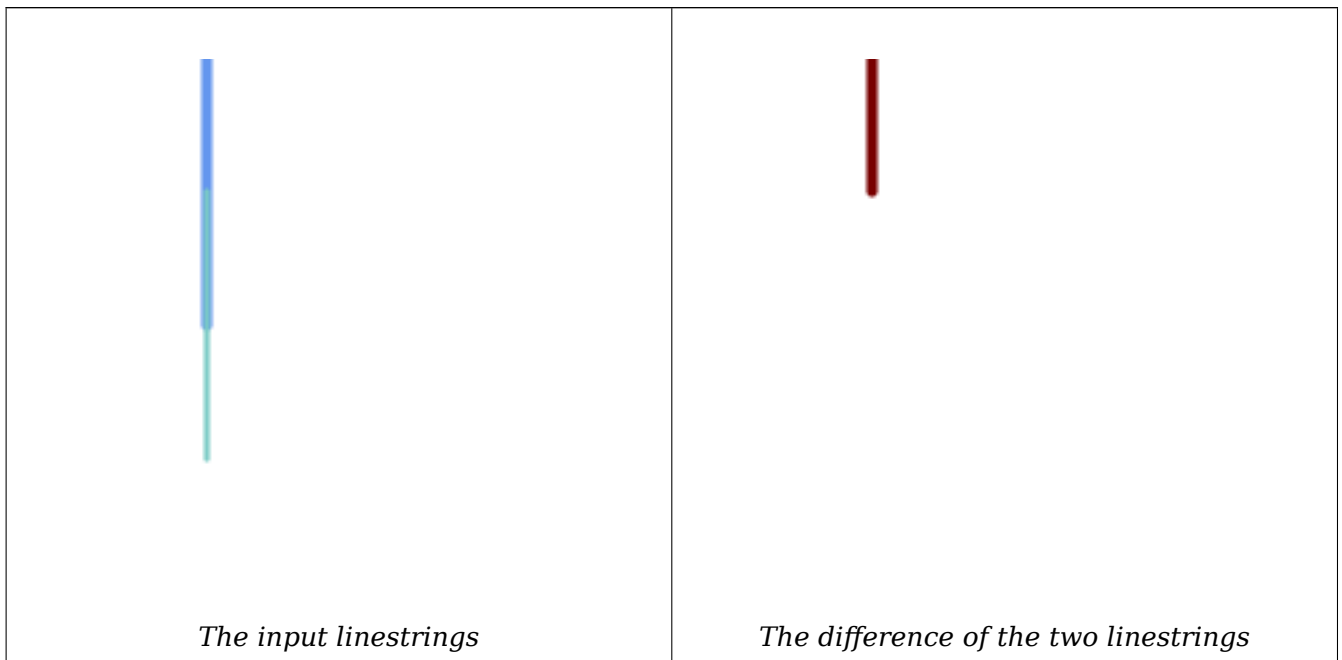


This method implements the SQL/MM specification. SQL-MM 3: 5.1.20



This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

☒☒



The difference of 2D linestrings.

```
SELECT ST_AsText(
  ST_Difference(
    'LINESTRING(50 100, 50 200)::geometry',
    'LINESTRING(50 50, 50 150)::geometry'
  )
);
```

```
st_astext
-----
LINESTRING(50 150,50 200)
```

The difference of 3D points.

```
SELECT ST_AsEWKT( ST_Difference(
  'MULTIPOINT(-118.58 38.38 5, -118.60 38.329 6, -118.614 38.281 7)' :: ←
    geometry,
  'POINT(-118.614 38.281 5)' :: geometry
) );
```

```
st_asewkt
-----
MULTIPOINT(-118.6 38.329 6, -118.58 38.38 5)
```

☒☒

[ST_SymDifference](#), [ST_Intersection](#), [ST_Union](#)

7.13.3 ST_Intersection

`ST_Intersection` — Computes a geometry representing the shared portion of geometries A and B.

Synopsis

```
geometry ST_Intersection( geometry geomA , geometry geomB , float8 gridSize = -1 );
geography ST_Intersection( geography geogA , geography geogB );
```

☒☒

Returns a geometry representing the point-set intersection of two geometries. In other words, that portion of geometry A and geometry B that is shared between the two geometries.

If the geometries have no points in common (i.e. are disjoint) then an empty atomic geometry of appropriate type is returned.

If the optional `gridSize` argument is provided, the inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)

`ST_Intersection` in conjunction with `ST_Intersects` is useful for clipping geometries such as in bounding box, buffer, or region queries where you only require the portion of a geometry that is inside a country or region of interest.

Note



For geography this is a thin wrapper around the geometry implementation. It first determines the best SRID that fits the bounding box of the 2 geography objects (if geography objects are within one half zone UTM but not same UTM will pick one of those) (favoring UTM or Lambert Azimuthal Equal Area (LAEA) north/south pole, and falling back on mercator in worst case scenario) and then intersection in that best fit planar spatial ref and retransforms back to WGS84 geography.



Warning

This function will drop the M coordinate values if present.



Warning

If working with 3D geometries, you may want to use SFGCAL based `ST_3DIntersection` which does a proper 3D intersection for 3D geometries. Although this function works with Z-coordinate, it does an averaging of Z-Coordinate.

GEOS ☒☒☒☒☒

Enhanced: 3.1.0 accept a `gridSize` parameter

Requires GEOS \geq 3.9.0 to use the `gridSize` parameter

Changed: 3.0.0 does not depend on SFCGAL.

Availability: 1.5 support for geography data type was introduced.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3](#)



This method implements the SQL/MM specification. SQL-MM 3: 5.1.18



This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

☒☒

```

SELECT ST_AsText(ST_Intersection('POINT(0 0)::geometry, 'LINESTRING ( 2 0, 0 2 )':: ←
  geometry));
  st_astext
-----
GEOMETRYCOLLECTION EMPTY

SELECT ST_AsText(ST_Intersection('POINT(0 0)::geometry, 'LINESTRING ( 0 0, 0 2 )':: ←
  geometry));
  st_astext
-----
POINT(0 0)

```

Clip all lines (trails) by country. Here we assume country geom are POLYGON or MULTIPOLYGONS. NOTE: we are only keeping intersections that result in a LINESTRING or MULTILINESTRING because we don't care about trails that just share a point. The dump is needed to expand a geometry collection into individual single MULT* parts. The below is fairly generic and will work for polys, etc. by just changing the where clause.

```

select clipped.gid, clipped.f_name, clipped_geom
from (
  select trails.gid, trails.f_name,
         (ST_Dump(ST_Intersection(country.geom, trails.geom))).geom clipped_geom
  from country
  inner join trails on ST_Intersects(country.geom, trails.geom)
) as clipped
where ST_Dimension(clipped.clipped_geom) = 1;

```

For polys e.g. polygon landmarks, you can also use the sometimes faster hack that buffering anything by 0.0 except a polygon results in an empty geometry collection. (So a geometry collection containing polys, lines and points buffered by 0.0 would only leave the polygons and dissolve the collection shell.)

```

select poly.gid,
  ST_Multi(
    ST_Buffer(
      ST_Intersection(country.geom, poly.geom),
      0.0
    )
  ) clipped_geom
from country
  inner join poly on ST_Intersects(country.geom, poly.geom)
where not ST_IsEmpty(ST_Buffer(ST_Intersection(country.geom, poly.geom), 0.0));

```

Examples: 2.5Dish

Note this is not a true intersection, compare to the same example using [ST_3DIntersection](#).

```

select ST_AsText(ST_Intersection(linestring, polygon)) As wkt
from ST_GeomFromText('LINESTRING Z (2 2 6,1.5 1.5 7,1 1 8,0.5 0.5 8,0 0 10)') AS ←
  linestring
CROSS JOIN ST_GeomFromText('POLYGON((0 0 8, 0 1 8, 1 1 8, 1 0 8, 0 0 8))') AS polygon;

  st_astext
-----
LINESTRING Z (1 1 8,0.5 0.5 8,0 0 10)

```

☒☒

[ST_3DIntersection](#), [ST_Difference](#), [ST_Union](#), [ST_Dimension](#), [ST_Dump](#), [ST_Force2D](#), [ST_SymDifference](#), [ST_Intersects](#), [ST_Multi](#)

7.13.4 ST_MemUnion

`ST_MemUnion` — Aggregate function which unions geometries in a memory-efficient but slower way

Synopsis

geometry **ST_MemUnion**(geometry set geomfield);

☒☒

An aggregate function that unions the input geometries, merging them to produce a result geometry with no overlaps. The output may be a single geometry, a MultiGeometry, or a Geometry Collection.



Note

Produces the same result as [ST_Union](#), but uses less memory and more processor time. This aggregate function works by unioning the geometries incrementally, as opposed to the `ST_Union` aggregate which first accumulates an array and then unions the contents using a fast algorithm.



This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

☒☒

```
SELECT id,
       ST_MemUnion(geom) as singlegeom
FROM sometable f
GROUP BY id;
```

☒☒

[ST_Union](#)

7.13.5 ST_Node

`ST_Node` — Nodes a collection of lines.

Synopsis

geometry **ST_Node**(geometry geom);

☒☒

Returns a (Multi)LineString representing the fully noded version of a collection of linestrings. The noding preserves all of the input nodes, and introduces the least possible number of new nodes. The resulting linework is dissolved (duplicate lines are removed).

This is a good way to create fully-noded linework suitable for use as input to [ST_Polygonize](#).

[ST_UnaryUnion](#) can also be used to node and dissolve linework. It provides an option to specify a `gridSize`, which can provide simpler and more robust output. See also [ST_Union](#) for an aggregate variant.



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

GEOS ☒☒☒☒☒

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Changed: 2.4.0 this function uses `GEOSNode` internally instead of `GEOSUnaryUnion`. This may cause the resulting linestrings to have a different order and direction compared to PostGIS < 2.4.

☒☒

Noding a 3D LineString which self-intersects

```
SELECT ST_AsText(
  ST_Node('LINESTRINGZ(0 0 0, 10 10 10, 0 10 5, 10 0 3)::geometry')
) As output;
output
-----
MULTILINESTRING Z ((0 0 0,5 5 4.5),(5 5 4.5,10 10 10,0 10 5,5 5 4.5),(5 5 4.5,10 0 3))
```

Noding two LineStrings which share common linework. Note that the result linework is dissolved.

```
SELECT ST_AsText(
  ST_Node('MULTILINESTRING ((2 5, 2 1, 7 1), (6 1, 4 1, 2 3, 2 5))::geometry')
) As output;
output
-----
MULTILINESTRING((2 5,2 3),(2 3,2 1,4 1),(4 1,2 3),(4 1,6 1),(6 1,7 1))
```

☒☒

[ST_UnaryUnion](#), [ST_AsBinary](#)

7.13.6 ST_Split

`ST_Split` — Returns a collection of geometries created by splitting a geometry by another geometry.

Synopsis

geometry **ST_Split**(geometry input, geometry blade);



The function supports splitting a `LineString` by a `(Multi)Point`, `(Multi)LineString` or `(Multi)Polygon` boundary, or a `(Multi)Polygon` by a `LineString`. When a `(Multi)Polygon` is used as the blade, its linear components (the boundary) are used for splitting the input. The result geometry is always a collection.

This function is in a sense the opposite of `ST_Union`. Applying `ST_Union` to the returned collection should theoretically yield the original geometry (although due to numerical rounding this may not be exactly the case).



Note

If the the input and blade do not intersect due to numerical precision issues, the input may not be split as expected. To avoid this situation it may be necessary to snap the input to the blade first, using `ST_Snap` with a small tolerance.

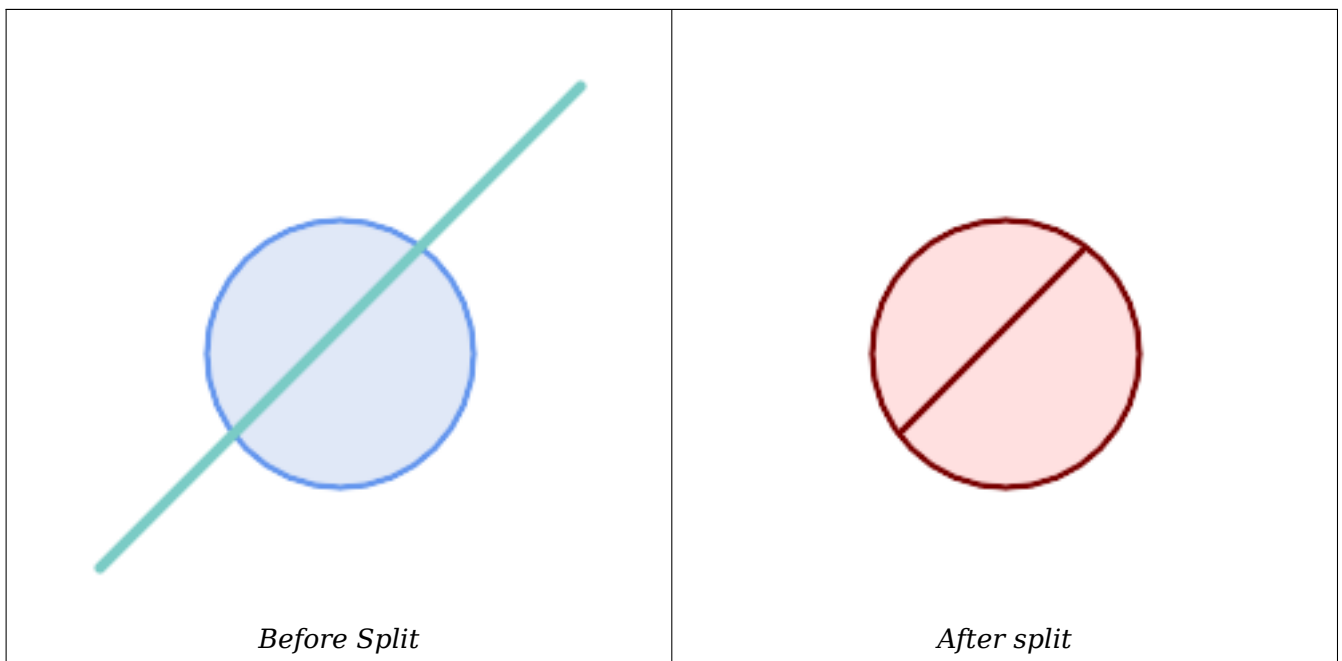
Availability: 2.0.0 requires GEOS

Enhanced: 2.2.0 support for splitting a line by a multiline, a multipoint or (multi)polygon boundary was introduced.

Enhanced: 2.5.0 support for splitting a polygon by a multiline was introduced.



Split a Polygon by a Line.



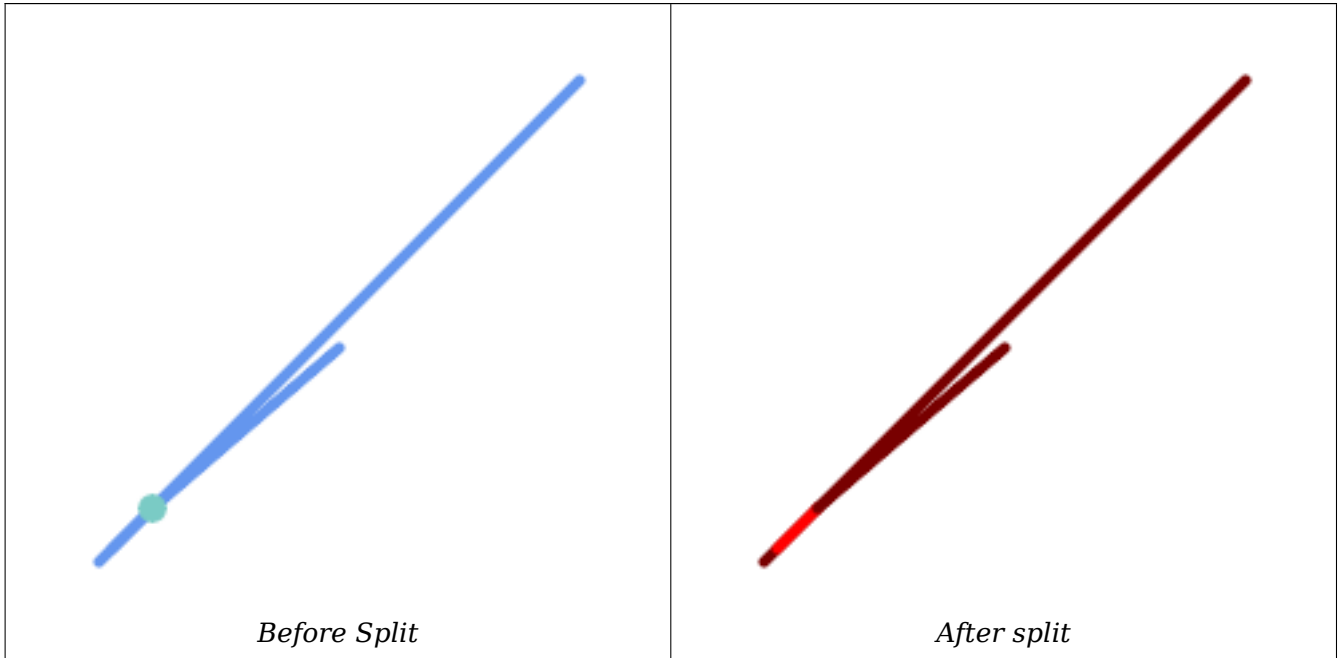
```
SELECT ST_AsText( ST_Split(
    ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50), -- circle
    ST_MakeLine(ST_Point(10, 10),ST_Point(190, 190)) -- line
));

-- result --
GEOMETRYCOLLECTION(
```



```
POLYGON((150 90,149.039264020162 80.2454838991936,146.193976625564 ←
        70.8658283817455,..),
POLYGON(..)
)
```

Split a MultiLineString by a Point, where the point lies exactly on both LineStrings elements.



```
SELECT ST_AsText(ST_Split(
    'MULTILINESTRING((10 10, 190 190), (15 15, 30 30, 100 90))',
    ST_Point(30,30))) As split;

split
-----
GEOMETRYCOLLECTION(
  LINESTRING(10 10,30 30),
  LINESTRING(30 30,190 190),
  LINESTRING(15 15,30 30),
  LINESTRING(30 30,100 90)
)
```

Split a LineString by a Point, where the point does not lie exactly on the line. Shows using **ST_Snap** to snap the line to the point to allow it to be split.

```
WITH data AS (SELECT
    'LINESTRING(0 0, 100 100)::geometry AS line,
    'POINT(51 50):: geometry AS point
)
SELECT ST_AsText( ST_Split( ST_Snap(line, point, 1), point)) AS snapped_split,
       ST_AsText( ST_Split(line, point)) AS not_snapped_not_split
FROM data;

                snapped_split | not_snapped_not_split |
-----+-----
GEOMETRYCOLLECTION(LINESTRING(0 0,51 50),LINESTRING(51 50,100 100)) | GEOMETRYCOLLECTION( ←
  LINESTRING(0 0,100 100))
```

 ☒☒

[ST_Snap](#), [ST_AsBinary](#)

7.13.7 ST_Subdivide

ST_Subdivide — Computes a rectilinear subdivision of a geometry.

Synopsis

setof geometry **ST_Subdivide**(geometry geom, integer max_vertices=256, float8 gridSize = -1);

☒☒

Returns a set of geometries that are the result of dividing geom into parts using rectilinear lines, with each part containing no more than max_vertices.

max_vertices must be 5 or more, as 5 points are needed to represent a closed box. gridSize can be specified to have clipping work in fixed-precision space (requires GEOS-3.9.0+).

Point-in-polygon and other spatial operations are normally faster for indexed subdivided datasets. Since the bounding boxes for the parts usually cover a smaller area than the original geometry bbox, index queries produce fewer "hit" cases. The "hit" cases are faster because the spatial operations executed by the index recheck process fewer points.



Note

This is a **set-returning function** (SRF) that return a set of rows containing single geometry values. It can be used in a SELECT list or a FROM clause to produce a result set with one record for each result geometry.

GEOS ☒☒☒☒☒

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

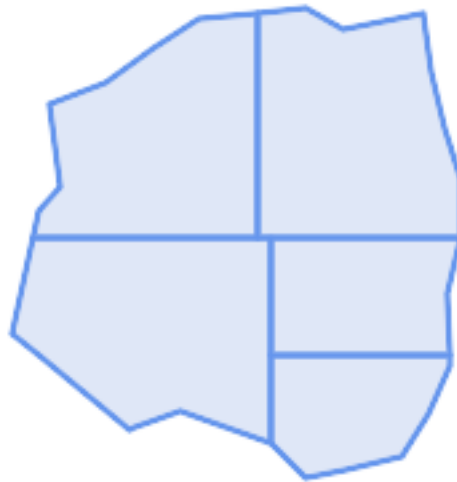
Enhanced: 2.5.0 reuses existing points on polygon split, vertex count is lowered from 8 to 5.

Enhanced: 3.1.0 accept a gridSize parameter.

Requires GEOS >= 3.9.0 to use the gridSize parameter

☒☒

Example: Subdivide a polygon into parts with no more than 10 vertices, and assign each part a unique id.

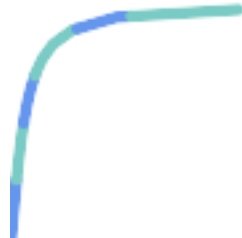


Subdivided to maximum 10 vertices

```
SELECT row_number() OVER() As rn, ST_AsText(geom) As wkt
FROM (SELECT ST_SubDivide(
      'POLYGON((132 10,119 23,85 35,68 29,66 28,49 42,32 56,22 64,32 110,40 119,36 150,
      57 158,75 171,92 182,114 184,132 186,146 178,176 184,179 162,184 141,190 122,
      190 100,185 79,186 56,186 52,178 34,168 18,147 13,132 10))'::geometry,10)) AS f(
      geom);
```

rn	wkt
1	POLYGON((119 23,85 35,68 29,66 28,32 56,22 64,29.8260869565217 100,119 100,119 23))
2	POLYGON((132 10,119 23,119 56,186 56,186 52,178 34,168 18,147 13,132 10))
3	POLYGON((119 56,119 100,190 100,185 79,186 56,119 56))
4	POLYGON((29.8260869565217 100,32 110,40 119,36 150,57 158,75 171,92 182,114 184,114 100,29.8260869565217 100))
5	POLYGON((114 184,132 186,146 178,176 184,179 162,184 141,190 122,190 100,114 100,114 184))

Example: Densify a long geography line using ST_Segmentize(geography, distance), and use ST_Subdivide to split the resulting line into sublines of 8 vertices.



The densified and split lines.

```
SELECT ST_AsText( ST_Subdivide(
    ST_Segmentize('LINESTRING(0 0, 85 85)::geography,
    1200000)::geometry, 8));
```

```
LINESTRING(0 0,0.487578359029357 5.57659056746196,0.984542144675897 ↔
  11.1527721155093,1.50101059639722 16.7281035483571,1.94532113630331 21.25)
LINESTRING(1.94532113630331 21.25,2.04869538062779 22.3020741387339,2.64204641967673 ↔
  27.8740533545155,3.29994062412787 33.443216802941,4.04836719489742 ↔
  39.0084282520239,4.59890468420694 42.5)
LINESTRING(4.59890468420694 42.5,4.92498503922732 44.5680389206321,5.98737409390639 ↔
  50.1195229244701,7.3290919767674 55.6587646879025,8.79638749938413 60.1969505994924)
LINESTRING(8.79638749938413 60.1969505994924,9.11375579533779 ↔
  61.1785363177625,11.6558166691368 66.6648504160202,15.642041247655 ↔
  72.0867690601745,22.8716627200212 77.3609628116894,24.6991785131552 77.8939011989848)
LINESTRING(24.6991785131552 77.8939011989848,39.4046096622744 ↔
  82.1822848017636,44.7994523421035 82.5156766227011)
LINESTRING(44.7994523421035 82.5156766227011,85 85)
```

Example: Subdivide the complex geometries of a table in-place. The original geometry records are deleted from the source table, and new records for each subdivided result geometry are inserted.

```
WITH complex_areas_to_subdivide AS (
  DELETE from polygons_table
  WHERE ST_NPoints(geom)
> 255
  RETURNING id, column1, column2, column3, geom
)
INSERT INTO polygons_table (fid, column1, column2, column3, geom)
  SELECT fid, column1, column2, column3,
  ST_Subdivide(geom, 255) as geom
FROM complex_areas_to_subdivide;
```

Example: Create a new table containing subdivided geometries, retaining the key of the original geometry so that the new table can be joined to the source table. Since `ST_Subdivide` is a set-returning (table) function that returns a set of single-value rows, this syntax automatically produces a table with one row for each result part.

```
CREATE TABLE subdivided_geoms AS
```

```
SELECT pkey, ST_Subdivide(geom) AS geom
FROM original_geoms;
```

☒☒

[ST_ClipByBox2D](#), [ST_Segmentize](#), [ST_Split](#), [ST_NPoints](#)

7.13.8 ST_SymDifference

`ST_SymDifference` — Computes a geometry representing the portions of geometries A and B that do not intersect.

Synopsis

geometry **ST_SymDifference**(geometry geomA, geometry geomB, float8 gridSize = -1);

☒☒

Returns a geometry representing the portions of geometries A and B that do not intersect. This is equivalent to `ST_Union(A,B) - ST_Intersection(A,B)`. It is called a symmetric difference because `ST_SymDifference(A,B) = ST_SymDifference(B,A)`.

If the optional `gridSize` argument is provided, the inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)

GEOS ☒☒☒☒☒

Enhanced: 3.1.0 accept a `gridSize` parameter.

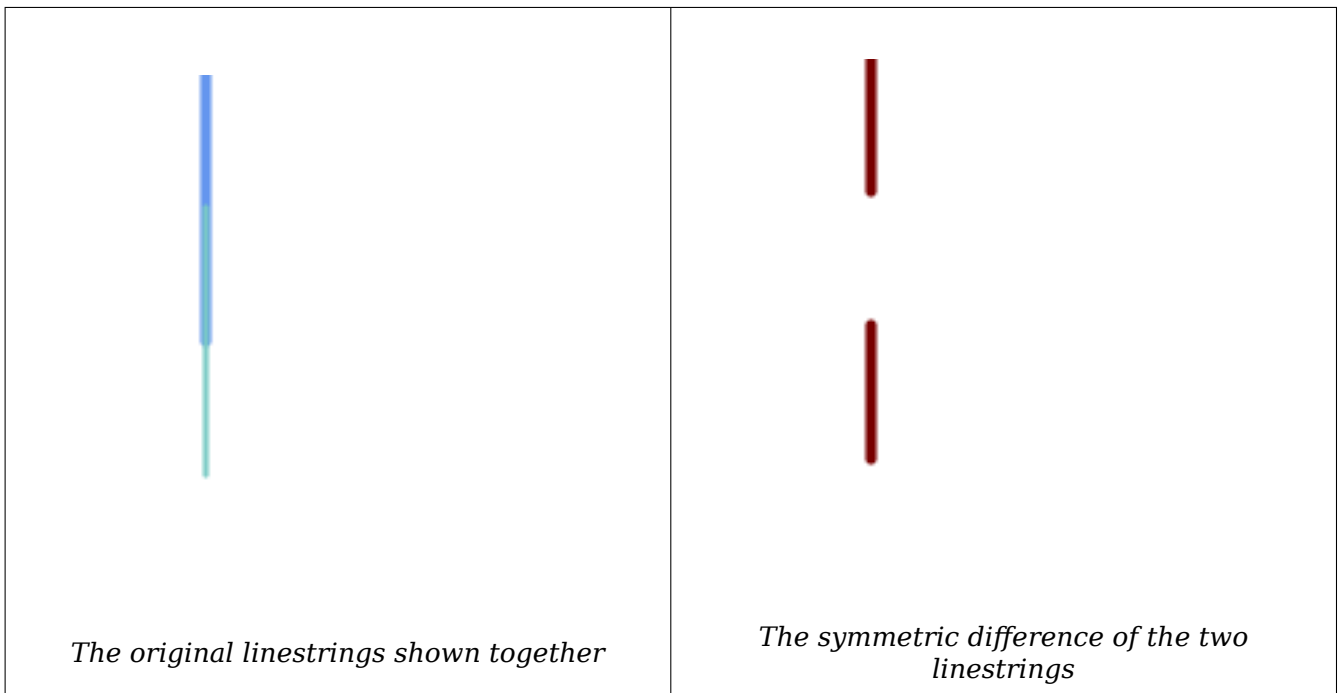
Requires GEOS >= 3.9.0 to use the `gridSize` parameter

✔ This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3](#)

✔ This method implements the SQL/MM specification. SQL-MM 3: 5.1.21

✔ This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

☒☒



```
--Safe for 2d - symmetric difference of 2 linestrings
SELECT ST_AsText(
  ST_SymDifference(
    ST_GeomFromText('LINESTRING(50 100, 50 200)'),
    ST_GeomFromText('LINESTRING(50 50, 50 150)')
  )
);

st_astext
-----
MULTILINESTRING((50 150,50 200),(50 50,50 100))
```

```
--When used in 3d doesn't quite do the right thing
SELECT ST_AsEWKT(ST_SymDifference(ST_GeomFromEWKT('LINESTRING(1 2 1, 1 4 2)'),
  ST_GeomFromEWKT('LINESTRING(1 1 3, 1 3 4)')));

st_astext
-----
MULTILINESTRING((1 3 2.75,1 4 2),(1 1 3,1 2 2.25))
```

☒☒

[ST_Difference](#), [ST_Intersection](#), [ST_Union](#)

7.13.9 ST_UnaryUnion

ST_UnaryUnion — Computes the union of the components of a single geometry.

Synopsis

geometry **ST_UnaryUnion**(geometry geom, float8 gridSize = -1);

☒☒

A single-input variant of **ST_Union**. The input may be a single geometry, a MultiGeometry, or a GeometryCollection. The union is applied to the individual elements of the input.

This function can be used to fix MultiPolygons which are invalid due to overlapping components. However, the input components must each be valid. An invalid input component such as a bow-tie polygon may cause an error. For this reason it may be better to use **ST_MakeValid**.

Another use of this function is to node and dissolve a collection of linestrings which cross or overlap to make them **simple**. (**ST_Node** also does this, but it does not provide the gridSize option.)

It is possible to combine ST_UnaryUnion with **ST_Collect** to fine-tune how many geometries are be unioned at once. This allows trading off between memory usage and compute time, striking a balance between ST_Union and **ST_MemUnion**.

If the optional gridSize argument is provided, the inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)



This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

Enhanced: 3.1.0 accept a gridSize parameter.

Requires GEOS >= 3.9.0 to use the gridSize parameter

2.0.0 ☒☒☒☒☒☒☒☒☒☒.

☒☒

ST_Union, **ST_MemUnion**, **ST_MakeValid**, **ST_Collect**, **ST_Node**

7.13.10 ST_Union

ST_Union — Computes a geometry representing the point-set union of the input geometries.

Synopsis

```
geometry ST_Union(geometry g1, geometry g2);
geometry ST_Union(geometry g1, geometry g2, float8 gridSize);
geometry ST_Union(geometry[] g1_array);
geometry ST_Union(geometry set g1field);
geometry ST_Union(geometry set g1field, float8 gridSize);
```

☒☒

Unions the input geometries, merging geometry to produce a result geometry with no overlaps. The output may be an atomic geometry, a MultiGeometry, or a Geometry Collection. Comes in several variants:

Two-input variant: returns a geometry that is the union of two input geometries. If either input is NULL, then NULL is returned.

Array variant: returns a geometry that is the union of an array of geometries.

Aggregate variant: returns a geometry that is the union of a rowset of geometries. The ST_Union() function is an "aggregate" function in the terminology of PostgreSQL. That means that it operates on

rows of data, in the same way the SUM() and AVG() functions do and like most aggregates, it also ignores NULL geometries.

See [ST_UnaryUnion](#) for a non-aggregate, single-input variant.

The ST_Union array and set variants use the fast Cascaded Union algorithm described in <http://blog.cleverelephant.ca/2009/01/must-faster-unions-in-postgis-14.html>

A gridSize can be specified to work in fixed-precision space. The inputs are snapped to a grid of the given size, and the result vertices are computed on that same grid. (Requires GEOS-3.9.0 or higher)



Note

[ST_Collect](#) may sometimes be used in place of ST_Union, if the result is not required to be non-overlapping. ST_Collect is usually faster than ST_Union because it performs no processing on the collected geometries.

GEOS ☒☒☒☒☒

ST_Union creates MultiLineString and does not sew LineStrings into a single LineString. Use [ST_LineMerge](#) to sew LineStrings.

NOTE: this function was formerly called GeomUnion(), which was renamed from "Union" because UNION is an SQL reserved word.

Enhanced: 3.1.0 accept a gridSize parameter.

Requires GEOS >= 3.9.0 to use the gridSize parameter

Changed: 3.0.0 does not depend on SFCGAL.

Availability: 1.4.0 - ST_Union was enhanced. ST_Union(geomarray) was introduced and also faster aggregate collection in PostgreSQL.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3](#)



Note

Aggregate version is not explicitly defined in OGC SPEC.



This method implements the SQL/MM specification. SQL-MM 3: 5.1.19 the z-index (elevation) when polygons are involved.



This function supports 3d and will not drop the z-index. However, the result is computed using XY only. The result Z values are copied, averaged or interpolated.

☒☒

Aggregate example

```
SELECT id,
       ST_Union(geom) as singlegeom
FROM sometable f
GROUP BY id;
```

Non-Aggregate example


```
select ST_AsText(ST_Union('POINT(1 2)' :: geometry, 'POINT(-2 3)' :: geometry))

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

select ST_AsText(ST_Union('POINT(1 2)' :: geometry, 'POINT(1 2)' :: geometry))

st_astext
-----
POINT(1 2)
```

3D example - sort of supports 3D (and with mixed dimensions!)

```
select ST_AsEWKT(ST_Union(geom))
from (
  select 'POLYGON((-7 4.2,-7.1 4.2,-7.1 4.3, -7 4.2))'::geometry geom
  union all
  select 'POINT(5 5 5)'::geometry geom
  union all
  select 'POINT(-2 3 1)'::geometry geom
  union all
  select 'LINESTRING(5 5 5, 10 10 10)'::geometry geom
) as foo;

st_asewkt
-----
GEOMETRYCOLLECTION(POINT(-2 3 1),LINESTRING(5 5 5,10 10 10),POLYGON((-7 4.2 5,-7.1 4.2 5,-7.1 4.3 5,-7 4.2 5)));
```

3d example not mixing dimensions

```
select ST_AsEWKT(ST_Union(geom))
from (
  select 'POLYGON((-7 4.2 2,-7.1 4.2 3,-7.1 4.3 2, -7 4.2 2))'::geometry geom
  union all
  select 'POINT(5 5 5)'::geometry geom
  union all
  select 'POINT(-2 3 1)'::geometry geom
  union all
  select 'LINESTRING(5 5 5, 10 10 10)'::geometry geom
) as foo;

st_asewkt
-----
GEOMETRYCOLLECTION(POINT(-2 3 1),LINESTRING(5 5 5,10 10 10),POLYGON((-7 4.2 2,-7.1 4.2 3,-7.1 4.3 2,-7 4.2 2)));

--Examples using new Array construct
SELECT ST_Union(ARRAY(SELECT geom FROM sometable));

SELECT ST_AsText(ST_Union(ARRAY[ST_GeomFromText('LINESTRING(1 2, 3 4)'),
  ST_GeomFromText('LINESTRING(3 4, 4 5)']))) As wktunion;

--wktunion---
MULTILINESTRING((3 4,4 5),(1 2,3 4))
```

☒☒

[ST_Collect](#), [ST_UnaryUnion](#), [ST_MemUnion](#), [ST_Intersection](#), [ST_Difference](#), [ST_SymDifference](#)

7.14 ☒☒☒☒☒☒

7.14.1 ST_Buffer

`ST_Buffer` — Computes a geometry covering all points within a given distance from a geometry.

Synopsis

```
geometry ST_Buffer(geometry g1, float radius_of_buffer, text buffer_style_parameters = "");
geometry ST_Buffer(geometry g1, float radius_of_buffer, integer num_seg_quarter_circle);
geography ST_Buffer(geography g1, float radius_of_buffer, text buffer_style_parameters);
geography ST_Buffer(geography g1, float radius_of_buffer, integer num_seg_quarter_circle);
```

☒☒

Computes a POLYGON or MULTIPOLYGON that represents all points whose distance from a geometry/geography is less than or equal to a given distance. A negative distance shrinks the geometry rather than expanding it. A negative distance may shrink a polygon completely, in which case POLYGON EMPTY is returned. For points and lines negative distances always return empty results.

For geometry, the distance is specified in the units of the Spatial Reference System of the geometry. For geography, the distance is specified in meters.

The optional third parameter controls the buffer accuracy and style. The accuracy of circular arcs in the buffer is specified as the number of line segments used to approximate a quarter circle (default is 8). The buffer style can be specified by providing a list of blank-separated key=value pairs as follows:

- `'quad_segs=#'` : number of line segments used to approximate a quarter circle (default is 8).
- `'endcap=round|flat|square'` : endcap style (defaults to "round"). `'butt'` is accepted as a synonym for `'flat'`.
- `'join=round|mitre|bevel'` : join style (defaults to "round"). `'miter'` is accepted as a synonym for `'mitre'`.
- `'mitre_limit=#.#'` : mitre ratio limit (only affects mitered join style). `'miter_limit'` is accepted as a synonym for `'mitre_limit'`.
- `'side=both|left|right'` : `'left'` or `'right'` performs a single-sided buffer on the geometry, with the buffered side relative to the direction of the line. This is only applicable to LINestring geometry and does not affect POINT or POLYGON geometries. By default end caps are square.

Note



For geography this is a thin wrapper around the geometry implementation. It determines a planar spatial reference system that best fits the bounding box of the geography object (trying UTM, Lambert Azimuthal Equal Area (LAEA) North/South pole, and finally Mercator). The buffer is computed in the planar space, and then transformed back to WGS84. This may not produce the desired behavior if the input object is much larger than a UTM zone or crosses the dateline

**Note**

Buffer output is always a valid polygonal geometry. Buffer can handle invalid inputs, so buffering by distance 0 is sometimes used as a way of repairing invalid polygons. [ST_MakeValid](#) can also be used for this purpose.

**Note**

Buffering is sometimes used to perform a within-distance search. For this use case it is more efficient to use [ST_DWithin](#).

**Note**

This function ignores the Z dimension. It always gives a 2D result even when used on a 3D geometry.

Enhanced: 2.5.0 - [ST_Buffer](#) geometry support was enhanced to allow for side buffering specification `side=both|left|right`.

Availability: 1.5 - [ST_Buffer](#) was enhanced to support different endcaps and join types. These are useful for example to convert road linestrings into polygon roads with flat or square edges instead of rounded edges. Thin wrapper for geography was added.

GEOS ☒☒☒☒☒☒

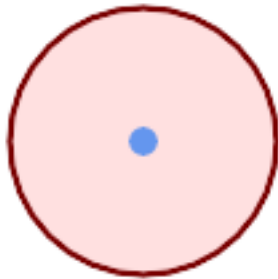


This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3](#)



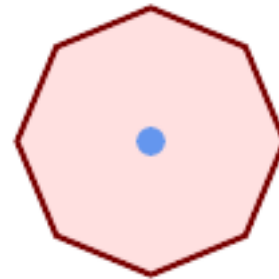
This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1.30

☒☒



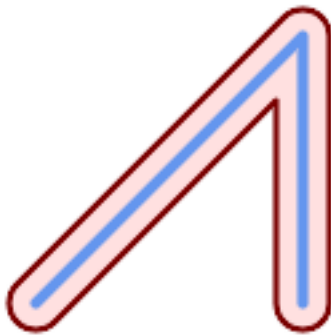
quad_segs=8 (☒☒☒)

```
SELECT ST_Buffer(
  ST_GeomFromText('POINT(100 90)'),
  50, 'quad_segs=8');
```



quad_segs=2 (☒☒)

```
SELECT ST_Buffer(
  ST_GeomFromText('POINT(100 90)'),
  50, 'quad_segs=2');
```



endcap=round join=round (☒☒☒)

```
SELECT ST_Buffer(
  ST_GeomFromText(
    'LINESTRING(50 50,150 150,150 50)'
  ), 10, 'endcap=round join=round');
```



endcap=square

```
SELECT ST_Buffer(
  ST_GeomFromText(
    'LINESTRING(50 50,150 150,150 50)'
  ), 10, 'endcap=square join=round');
```



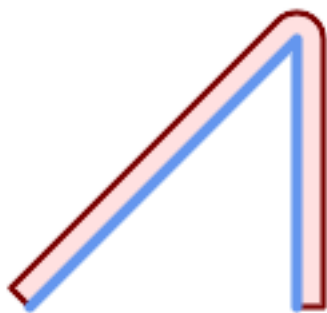
join=bevel

```
SELECT ST_Buffer(
  ST_GeomFromText(
    'LINESTRING(50 50,150 150,150 50)'
  ), 10, 'join=bevel');
```



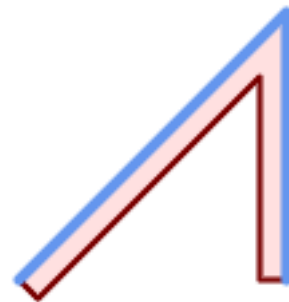
join=mitre mitre_limit=5.0 (☒☒☒☒☒☒☒☒)

```
SELECT ST_Buffer(
  ST_GeomFromText(
    'LINESTRING(50 50,150 150,150 50)'
  ), 10, 'join=mitre mitre_limit=5.0');
```



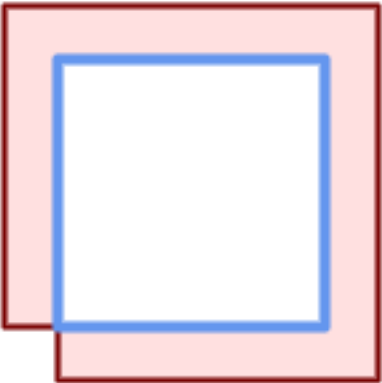
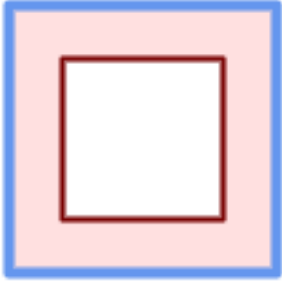
side=left

```
SELECT ST_Buffer(
  ST_GeomFromText(
    'LINESTRING(50 50,150 150,150 50)'
  ), 10, 'side=left');
```



side=right

```
SELECT ST_Buffer(
  ST_GeomFromText(
    'LINESTRING(50 50,150 150,150 50)'
  ), 10, 'side=right');
```

	
<p><i>right-hand-winding, polygon boundary side=left</i></p>	<p><i>right-hand-winding, polygon boundary side=right</i></p>
<pre>SELECT ST_Buffer(ST_ForceRHR(ST_Boundary(ST_GeomFromText('POLYGON ((50 50, 50 150, 150 150, 150 50, 50 50))'),), 20, 'side=left');</pre>	<pre>SELECT ST_Buffer(ST_ForceRHR(ST_Boundary(ST_GeomFromText('POLYGON ((50 50, 50 150, 150 150, 150 50, 50 50))'),), 20, 'side=right');</pre>

```
--A buffered point approximates a circle
-- A buffered point forcing approximation of (see diagram)
-- 2 points per quarter circle is poly with 8 sides (see diagram)
SELECT ST_NPoints(ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50)) As promisingcircle_pcount,
ST_NPoints(ST_Buffer(ST_GeomFromText('POINT(100 90)'), 50, 2)) As lamecircle_pcount;

promisingcircle_pcount | lamecircle_pcount
-----+-----
33 | 9

--A lighter but lamer circle
-- only 2 points per quarter circle is an octagon
--Below is a 100 meter octagon
-- Note coordinates are in NAD 83 long lat which we transform
to Mass state plane meter and then buffer to get measurements in meters;
SELECT ST_AsText(ST_Buffer(
ST_Transform(
ST_SetSRID(ST_Point(-71.063526, 42.35785),4269), 26986)
,100,2)) As octagon;
-----
POLYGON((236057.59057465 900908.759918696,236028.301252769 900838.049240578,235
957.59057465 900808.759918696,235886.879896532 900838.049240578,235857.59057465
900908.759918696,235886.879896532 900979.470596815,235957.59057465 901008.759918
696,236028.301252769 900979.470596815,236057.59057465 900908.759918696))
```

☒☒

[ST_Collect](#), [ST_DWithin](#), [ST_SetSRID](#), [ST_Transform](#), [ST_Union](#), [ST_MakeValid](#)

7.14.2 ST_BuildArea

`ST_BuildArea` — Creates a polygonal geometry formed by the linework of a geometry.

Synopsis

```
geometry ST_BuildArea(geometry geom);
```

☒☒

Creates an areal geometry formed by the constituent linework of the input geometry. The input can be a LineString, MultiLineString, Polygon, MultiPolygon or a GeometryCollection. The result is a Polygon or MultiPolygon, depending on input. If the input linework does not form polygons, NULL is returned.

Unlike [ST_MakePolygon](#), this function accepts rings formed by multiple lines, and can form any number of polygons.

This function converts inner rings into holes. To turn inner rings into polygons as well, use [ST_Polygonize](#).



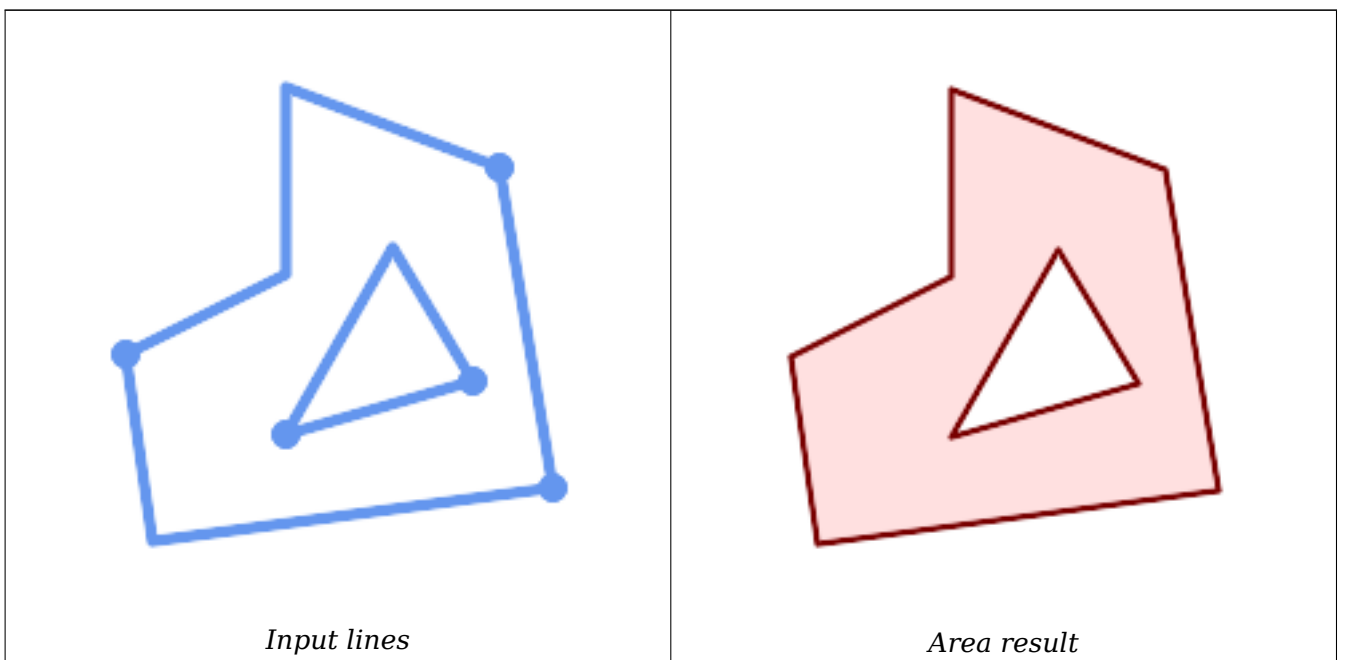
Note

Input linework must be correctly noded for this function to work properly. [ST_Node](#) can be used to node lines.

If the input linework crosses, this function will produce invalid polygons. [ST_MakeValid](#) can be used to ensure the output is valid.

1.1.0 ☒☒☒☒☒☒☒☒☒☒.

☒☒



```
WITH data(geom) AS (VALUES
  ('LINESTRING (180 40, 30 20, 20 90)::geometry)
  ,('LINESTRING (180 40, 160 160)::geometry)
  ,('LINESTRING (160 160, 80 190, 80 120, 20 90)::geometry)
  ,('LINESTRING (80 60, 120 130, 150 80)::geometry)
  ,('LINESTRING (80 60, 150 80)::geometry)
)
SELECT ST_AsText( ST_BuildArea( ST_Collect( geom )))
FROM data;
```

```
-----
POLYGON((180 40,30 20,20 90,80 120,80 190,160 160,180 40),(150 80,120 130,80 60,150 80))
```



Create a donut from two circular polygons

```
SELECT ST_BuildArea(ST_Collect(inring,outring))
FROM (SELECT
  ST_Buffer('POINT(100 90)', 25) As inring,
  ST_Buffer('POINT(100 90)', 50) As outring) As t;
```

☒☒

[ST_Collect](#), [ST_MakePolygon](#), [ST_MakeValid](#), [ST_Node](#), [ST_Polygonize](#), [ST_BdPolyFromText](#), [ST_BdMPolyFromText](#)
(wrappers to this function with standard OGC interface)

7.14.3 ST_Centroid

ST_Centroid — ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

```
geometry ST_Centroid(geometry g1);
geography ST_Centroid(geography g1, boolean use_spheroid = true);
```


☒☒

Computes a point which is the geometric center of mass of a geometry. For [MULTI]POINTS, the centroid is the arithmetic mean of the input coordinates. For [MULTI]LINESTRINGS, the centroid is computed using the weighted length of each line segment. For [MULTI]POLYGONS, the centroid is computed in terms of area. If an empty geometry is supplied, an empty GEOMETRYCOLLECTION is returned. If NULL is supplied, NULL is returned. If CIRCULARSTRING or COMPOUNDCURVE are supplied, they are converted to linestring with CurveToLine first, then same than for LINESTRING

For mixed-dimension input, the result is equal to the centroid of the component Geometries of highest dimension (since the lower-dimension geometries contribute zero "weight" to the centroid).

Note that for polygonal geometries the centroid does not necessarily lie in the interior of the polygon. For example, see the diagram below of the centroid of a C-shaped polygon. To construct a point guaranteed to lie in the interior of a polygon use [ST_PointOnSurface](#).

New in 2.3.0 : supports CIRCULARSTRING and COMPOUNDCURVE (using CurveToLine)

Availability: 2.4.0 support for geography was introduced.



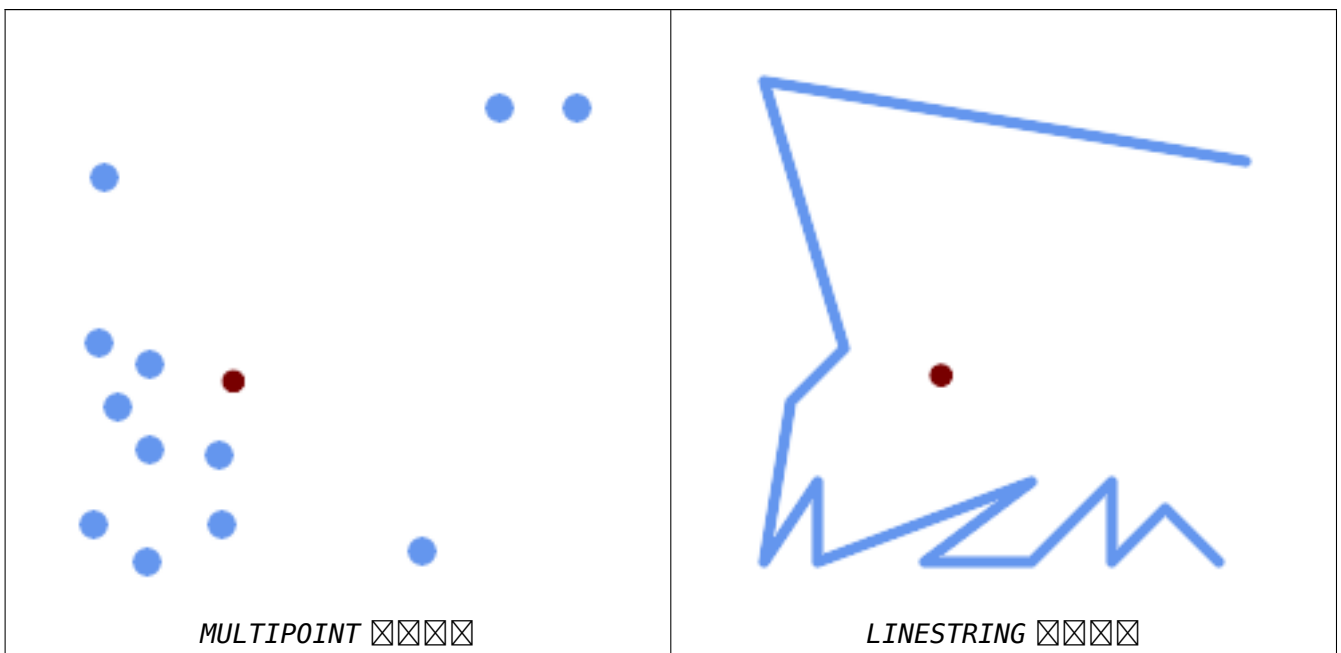
This method implements the [OGC Simple Features Implementation Specification for SQL 1.1](#).

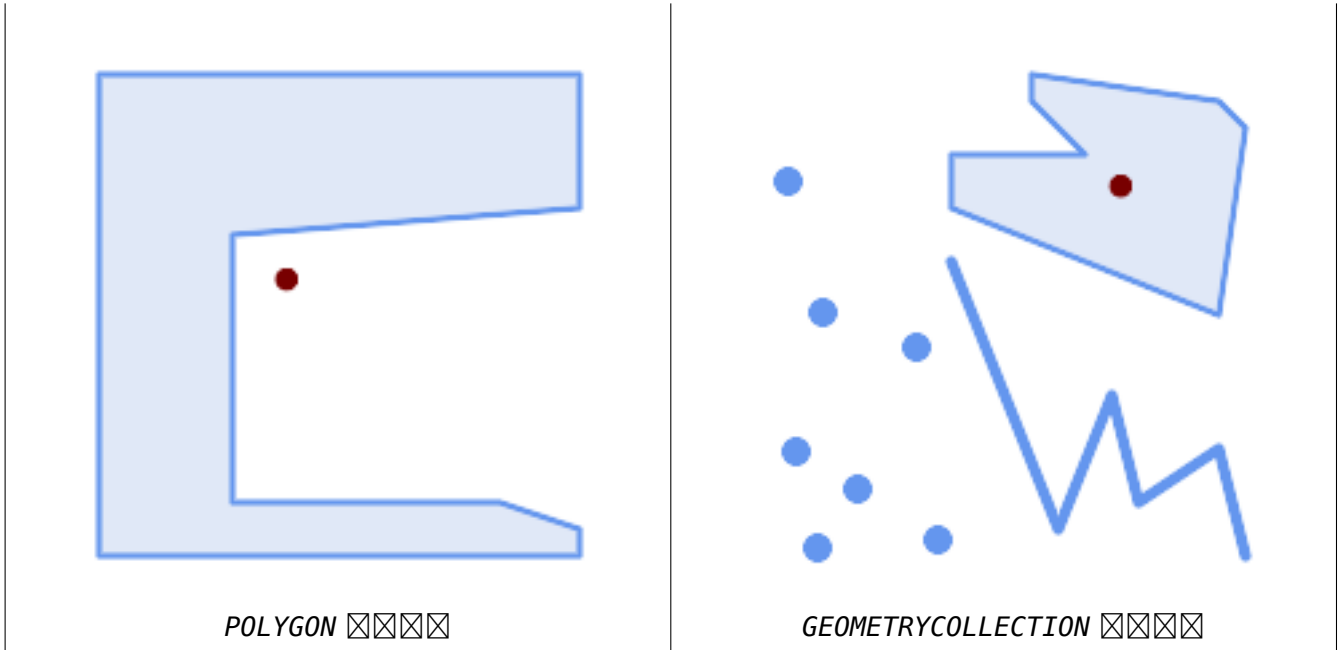


This method implements the SQL/MM specification. SQL-MM 3: 8.1.4, 9.5.5

☒☒

In the following illustrations the red dot is the centroid of the source geometry.





```

SELECT ST_AsText(ST_Centroid('MULTIPOINT ( -1 0, -1 2, -1 3, -1 4, -1 7, 0 1, 0 3, 1 1, 2 0, 6 0, 7 8, 9 8, 10 6 )'));
           st_astext
-----
POINT(2.30769230769231 3.30769230769231)
(1 row)

SELECT ST_AsText(ST_centroid(g))
FROM ST_GeomFromText('CIRCULARSTRING(0 2, -1 1,0 0, 0.5 0, 1 0, 2 1, 1 2, 0.5 2, 0 2)') AS g ;
-----
POINT(0.5 1)

SELECT ST_AsText(ST_centroid(g))
FROM ST_GeomFromText('COMPOUNDCURVE(CIRCULARSTRING(0 2, -1 1,0 0),(0 0, 0.5 0, 1 0), CIRCULARSTRING( 1 0, 2 1, 1 2),(1 2, 0.5 2, 0 2))' ) AS g;
-----
POINT(0.5 1)
    
```

☒☒

[ST_PointOnSurface](#), [ST_GeometricMedian](#)

7.14.4 ST_ChaikinSmoothing

ST_ChaikinSmoothing — Returns a smoothed version of a geometry, using the Chaikin algorithm

Synopsis

geometry **ST_ChaikinSmoothing**(geometry geom, integer nIterations = 1, boolean preserveEndPoints = false);

☒☒

Smooths a linear or polygonal geometry using **Chaikin's algorithm**. The degree of smoothing is controlled by the `nIterations` parameter. On each iteration, each interior vertex is replaced by two vertices located at 1/4 of the length of the line segments before and after the vertex. A reasonable degree of smoothing is provided by 3 iterations; the maximum is limited to 5.

If `preserveEndpoints` is true, the endpoints of Polygon rings are not smoothed. The endpoints of LineStrings are always preserved.



Note

The number of vertices doubles with each iteration, so the result geometry may have many more points than the input. To reduce the number of points use a simplification function on the result (see [ST_Simplify](#), [ST_SimplifyPreserveTopology](#) and [ST_SimplifyVW](#)).

The result has interpolated values for the Z and M dimensions when present.



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

Availability: 2.5.0

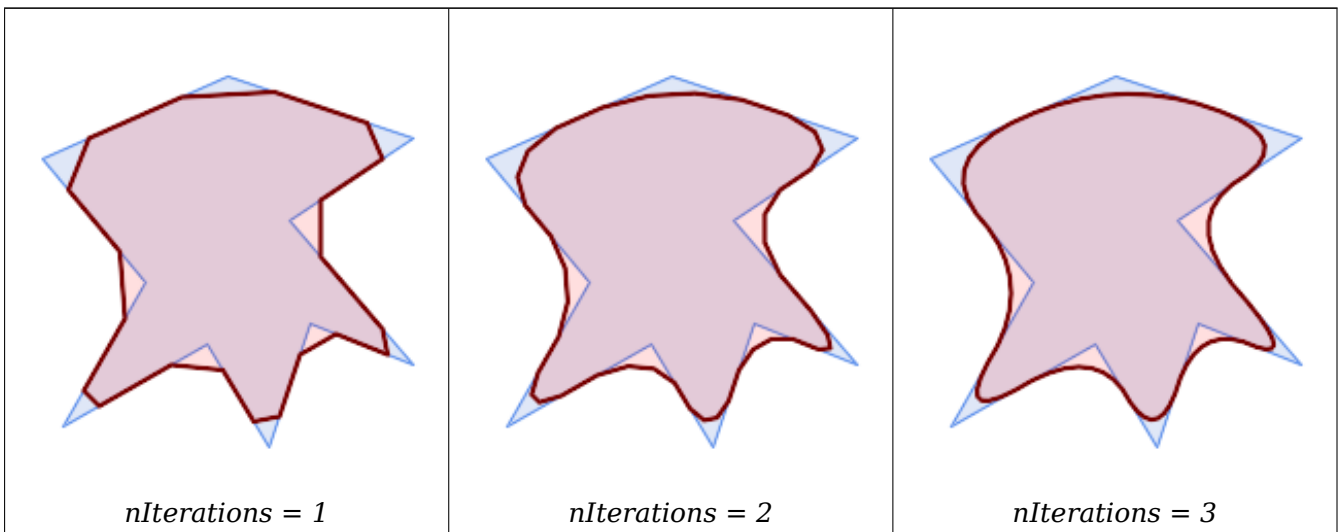
☒☒

Smoothing a triangle:

```
SELECT ST_AsText(ST_ChaikinSmoothing(geom)) smoothed
FROM (SELECT 'POLYGON((0 0, 8 8, 0 16, 0 0))'::geometry geom) AS foo;

          smoothed
b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''- ←
  b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b'' ←
    '-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b'' ←
      '-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b''-b''b'' ←
POLYGON((2 2,6 6,6 10,2 14,0 12,0 4,2 2))
```

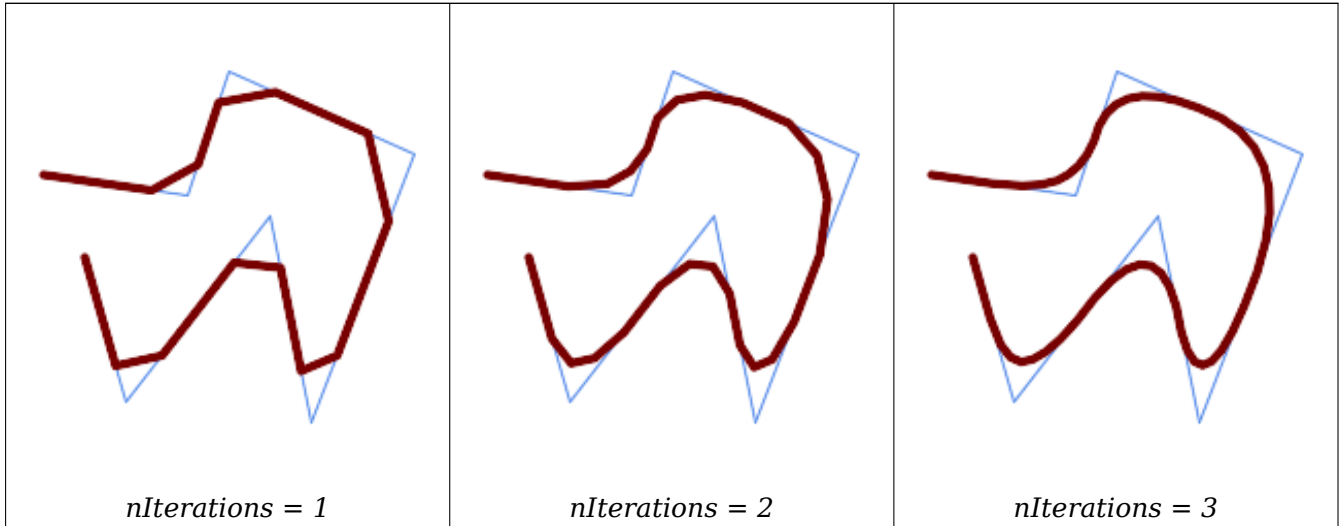
Smoothing a Polygon using 1, 2 and 3 iterations:



```
SELECT ST_ChaikinSmoothing(
```

```
'POLYGON ((20 20, 60 90, 10 150, 100 190, 190 160, 130 120, 190 50, 140 70, 120 ←
  10, 90 60, 20 20))',
generate_series(1, 3) );
```

Smoothing a LineString using 1, 2 and 3 iterations:



```
SELECT ST_ChaikinSmoothing(
  'LINESTRING (10 140, 80 130, 100 190, 190 150, 140 20, 120 120, 50 30, 30 100) ←
  ',
  generate_series(1, 3) );
```

☒☒

[ST_Simplify](#), [ST_SimplifyPreserveTopology](#), [ST_SimplifyVW](#)

7.14.5 ST_ConcaveHull

`ST_ConcaveHull` — Computes a possibly concave geometry that contains all input geometry vertices

Synopsis

geometry **ST_ConcaveHull**(geometry param_geom, float param_pctconvex, boolean param_allow_holes = false);

☒☒

A concave hull is a (usually) concave geometry which contains the input, and whose vertices are a subset of the input vertices. In the general case the concave hull is a Polygon. The concave hull of two or more collinear points is a two-point LineString. The concave hull of one or more identical points is a Point. The polygon will not contain holes unless the optional `param_allow_holes` argument is specified as true.

One can think of a concave hull as “shrink-wrapping” a set of points. This is different to the [convex hull](#), which is more like wrapping a rubber band around the points. A concave hull generally has a smaller area and represents a more natural boundary for the input points.

The `param_pctconvex` controls the concaveness of the computed hull. A value of 1 produces the convex hull. Values between 1 and 0 produce hulls of increasing concaveness. A value of 0 produces a hull with maximum concaveness (but still a single polygon). Choosing a suitable value depends on the nature of the input data, but often values between 0.3 and 0.1 produce reasonable results.



Note

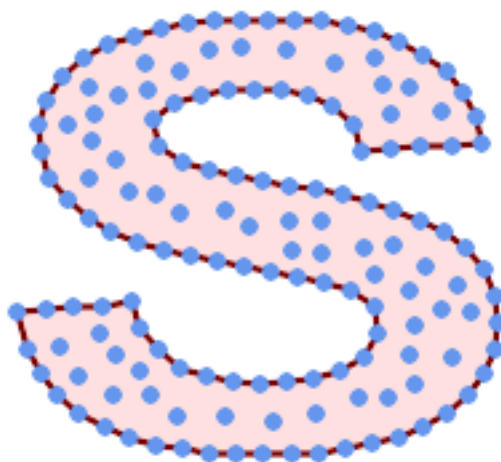
Technically, the `param_pctconvex` determines a length as a fraction of the difference between the longest and shortest edges in the Delaunay Triangulation of the input points. Edges longer than this length are "eroded" from the triangulation. The triangles remaining form the concave hull.

For point and linear inputs, the hull will enclose all the points of the inputs. For polygonal inputs, the hull will enclose all the points of the input *and also* all the areas covered by the input. If you want a point-wise hull of a polygonal input, convert it to points first using [ST_Points](#).

This is not an aggregate function. To compute the concave hull of a set of geometries use [ST_Collect](#) (e.g. `ST_ConcaveHull(ST_Collect(geom), 0.80)`).

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Enhanced: 3.3.0, GEOS native implementation enabled for GEOS 3.11+



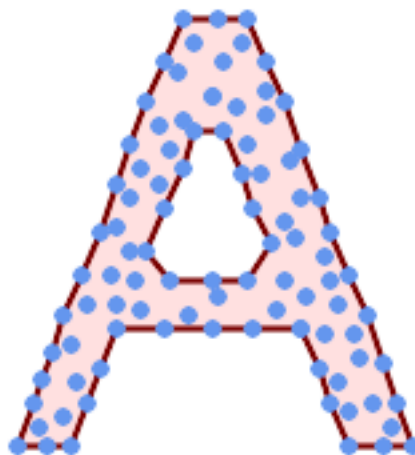
Concave Hull of a MultiPoint

```
SELECT ST_AsText( ST_ConcaveHull(
  'MULTIPOINT ((10 72), (53 76), (56 66), (63 58), (71 51), (81 48), (91 46), (101 ←
    45), (111 46), (121 47), (131 50), (140 55), (145 64), (144 74), (135 80), (125 ←
    83), (115 85), (105 87), (95 89), (85 91), (75 93), (65 95), (55 98), (45 102), ←
    (37 107), (29 114), (22 122), (19 132), (18 142), (21 151), (27 160), (35 167), ←
    (44 172), (54 175), (64 178), (74 180), (84 181), (94 181), (104 181), (114 181) ←
    , (124 181), (134 179), (144 177), (153 173), (162 168), (171 162), (177 154), ←
    (182 145), (184 135), (139 132), (136 142), (128 149), (119 153), (109 155), (99 ←
    155), (89 155), (79 153), (69 150), (61 144), (63 134), (72 128), (82 125), (92 ←
    123), (102 121), (112 119), (122 118), (132 116), (142 113), (151 110), (161 ←
    106), (170 102), (178 96), (185 88), (189 78), (190 68), (189 58), (185 49), ←
    (179 41), (171 34), (162 29), (153 25), (143 23), (133 21), (123 19), (113 19), ←
    (102 19), (92 19), (82 19), (72 21), (62 22), (52 25), (43 29), (33 34), (25 41) ←
```

```

, (19 49), (14 58), (21 73), (31 74), (42 74), (173 134), (161 134), (150 133), ←
(97 104), (52 117), (157 156), (94 171), (112 106), (169 73), (58 165), (149 40) ←
, (70 33), (147 157), (48 153), (140 96), (47 129), (173 55), (144 86), (159 67) ←
, (150 146), (38 136), (111 170), (124 94), (26 59), (60 41), (71 162), (41 64), ←
(88 110), (122 34), (151 97), (157 56), (39 146), (88 33), (159 45), (47 56), ←
(138 40), (129 165), (33 48), (106 31), (169 147), (37 122), (71 109), (163 89), ←
(37 156), (82 170), (180 72), (29 142), (46 41), (59 155), (124 106), (157 80), ←
(175 82), (56 50), (62 116), (113 95), (144 167))',
0.1 ) );
---st_astext--
POLYGON ((18 142, 21 151, 27 160, 35 167, 44 172, 54 175, 64 178, 74 180, 84 181, 94 181, ←
104 181, 114 181, 124 181, 134 179, 144 177, 153 173, 162 168, 171 162, 177 154, 182 ←
145, 184 135, 173 134, 161 134, 150 133, 139 132, 136 142, 128 149, 119 153, 109 155, 99 ←
155, 89 155, 79 153, 69 150, 61 144, 63 134, 72 128, 82 125, 92 123, 102 121, 112 119, ←
122 118, 132 116, 142 113, 151 110, 161 106, 170 102, 178 96, 185 88, 189 78, 190 68, ←
189 58, 185 49, 179 41, 171 34, 162 29, 153 25, 143 23, 133 21, 123 19, 113 19, 102 19, ←
92 19, 82 19, 72 21, 62 22, 52 25, 43 29, 33 34, 25 41, 19 49, 14 58, 10 72, 21 73, 31 ←
74, 42 74, 53 76, 56 66, 63 58, 71 51, 81 48, 91 46, 101 45, 111 46, 121 47, 131 50, 140 ←
55, 145 64, 144 74, 135 80, 125 83, 115 85, 105 87, 95 89, 85 91, 75 93, 65 95, 55 98, ←
45 102, 37 107, 29 114, 22 122, 19 132, 18 142))

```



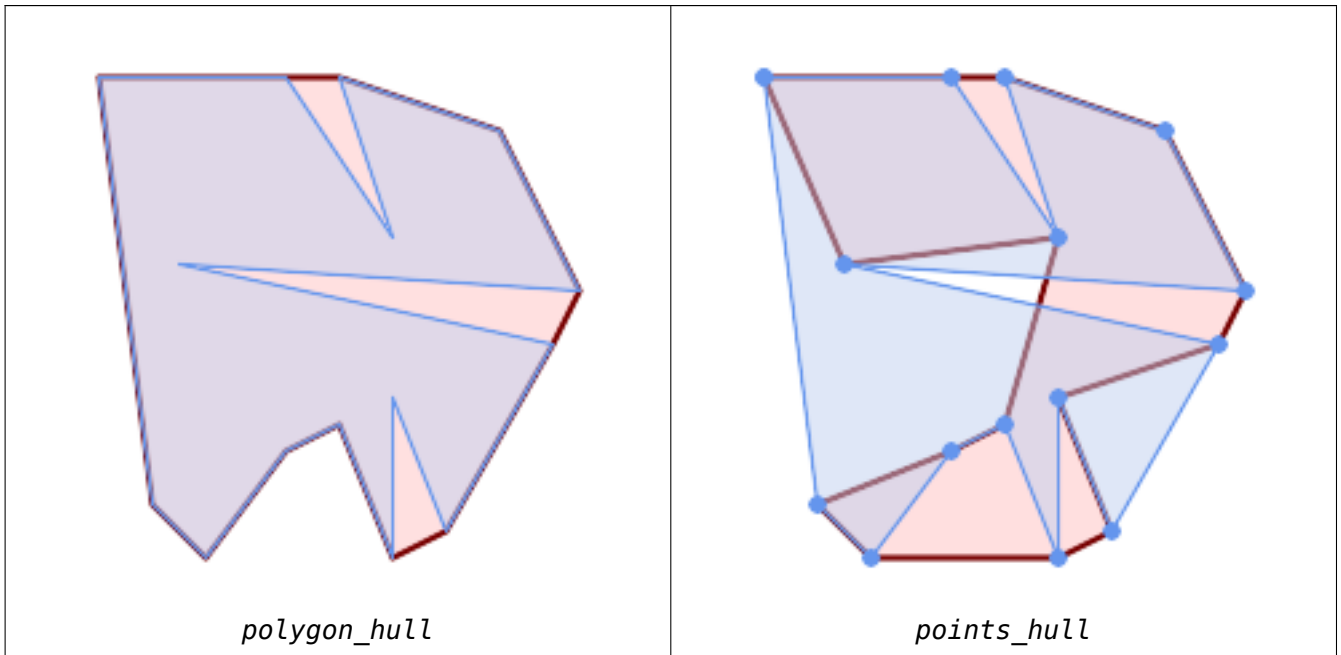
Concave Hull of a MultiPoint, allowing holes

```

SELECT ST_AsText( ST_ConcaveHull(
'MULTIPOINT ((132 64), (114 64), (99 64), (81 64), (63 64), (57 49), (52 36), (46 ←
20), (37 20), (26 20), (32 36), (39 55), (43 69), (50 84), (57 100), (63 118), ←
(68 133), (74 149), (81 164), (88 180), (101 180), (112 180), (119 164), (126 ←
149), (132 131), (139 113), (143 100), (150 84), (157 69), (163 51), (168 36), ←
(174 20), (163 20), (150 20), (143 36), (139 49), (132 64), (99 151), (92 138), ←
(88 124), (81 109), (74 93), (70 82), (83 82), (99 82), (112 82), (126 82), (121 ←
96), (114 109), (110 122), (103 138), (99 151), (34 27), (43 31), (48 44), (46 ←
58), (52 73), (63 73), (61 84), (72 71), (90 69), (101 76), (123 71), (141 62), ←
(166 27), (150 33), (159 36), (146 44), (154 53), (152 62), (146 73), (134 76), ←
(143 82), (141 91), (130 98), (126 104), (132 113), (128 127), (117 122), (112 ←
133), (119 144), (108 147), (119 153), (110 171), (103 164), (92 171), (86 160), ←
(88 142), (79 140), (72 124), (83 131), (79 118), (68 113), (63 102), (68 93), ←
(35 45))',
0.15, true ) );
---st_astext--
POLYGON ((43 69, 50 84, 57 100, 63 118, 68 133, 74 149, 81 164, 88 180, 101 180, 112 180, ←
119 164, 126 149, 132 131, 139 113, 143 100, 150 84, 157 69, 163 51, 168 36, 174 20, 163 ←

```

```
20, 150 20, 143 36, 139 49, 132 64, 114 64, 99 64, 81 64, 63 64, 57 49, 52 36, 46 20, ←
37 20, 26 20, 32 36, 35 45, 39 55, 43 69), (88 124, 81 109, 74 93, 83 82, 99 82, 112 82, ←
121 96, 114 109, 110 122, 103 138, 92 138, 88 124))
```



Comparing a concave hull of a Polygon to the concave hull of the constituent points. The hull respects the boundary of the polygon, whereas the points-based hull does not.

```
WITH data(geom) AS (VALUES
  ('POLYGON ((10 90, 39 85, 61 79, 50 90, 80 80, 95 55, 25 60, 90 45, 70 16, 63 38, 60 10, ←
    50 30, 43 27, 30 10, 20 20, 10 90))'::geometry)
)
SELECT ST_ConcaveHull( geom, 0.1) AS polygon_hull,
       ST_ConcaveHull( ST_Points(geom), 0.1) AS points_hull
FROM data;
```

Using with ST_Collect to compute the concave hull of a geometry set.

```
-- Compute estimate of infected area based on point observations
SELECT disease_type,
       ST_ConcaveHull( ST_Collect(obs_pnt), 0.3 ) AS geom
FROM disease_obs
GROUP BY disease_type;
```

☒☒

[ST_ConvexHull](#), [ST_Collect](#), [ST_AlphaShape](#), [ST_OptimalAlphaShape](#)

7.14.6 ST_ConvexHull

ST_ConvexHull — Computes the convex hull of a geometry.

Synopsis

geometry **ST_ConvexHull**(geometry geomA);

☒☒

Computes the convex hull of a geometry. The convex hull is the smallest convex geometry that encloses all geometries in the input.

One can think of the convex hull as the geometry obtained by wrapping an rubber band around a set of geometries. This is different from a **concave hull** which is analogous to "shrink-wrapping" the geometries. A convex hull is often used to determine an affected area based on a set of point observations.

In the general case the convex hull is a Polygon. The convex hull of two or more collinear points is a two-point LineString. The convex hull of one or more identical points is a Point.

This is not an aggregate function. To compute the convex hull of a set of geometries, use **ST_Collect** to aggregate them into a geometry collection (e.g. `ST_ConvexHull(ST_Collect(geom))`).

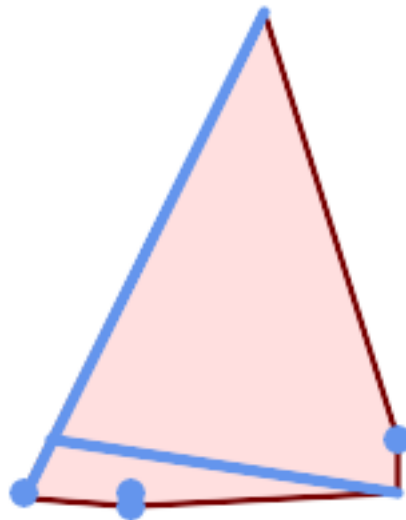
GEOS ☒☒☒☒☒

✔ This method implements the **OGC Simple Features Implementation Specification for SQL 1.1. s2.1.1.3**

✔ This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1.16

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

☒☒



Convex Hull of a MultiLineString and a MultiPoint

```
SELECT ST_AsText(ST_ConvexHull(
  ST_Collect(
    ST_GeomFromText('MULTILINESTRING((100 190,10 8),(150 10, 20 30))'),
    ST_GeomFromText('MULTIPOINT(50 5, 150 30, 50 10, 10 10)')
  )));
---st_astext--
POLYGON((50 5,10 8,10 10,100 190,150 30,150 10,50 5))
```

Using with `ST_Collect` to compute the convex hulls of geometry sets.


```
--Get estimate of infected area based on point observations
SELECT d.disease_type,
       ST_ConvexHull(ST_Collect(d.geom)) As geom
FROM disease_obs As d
GROUP BY d.disease_type;
```

☒☒

[ST_Collect](#), [ST_ConcaveHull](#), [ST_MinimumBoundingCircle](#)

7.14.7 ST_DelaunayTriangles

ST_DelaunayTriangles — Returns the Delaunay triangulation of the vertices of a geometry.

Synopsis

geometry **ST_DelaunayTriangles**(geometry g1, float tolerance = 0.0, int4 flags = 0);

☒☒

Computes the [Delaunay triangulation](#) of the vertices of the input geometry. The optional tolerance can be used to snap nearby input vertices together, which improves robustness in some situations. The result geometry is bounded by the convex hull of the input vertices. The result geometry representation is determined by the flags code:

- 0 - a GEOMETRYCOLLECTION of triangular POLYGONS (default)
- 1 - a MULTILINESTRING of the edges of the triangulation
- 2 - A TIN of the triangulation

GEOS ☒☒☒☒☒

2.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒.

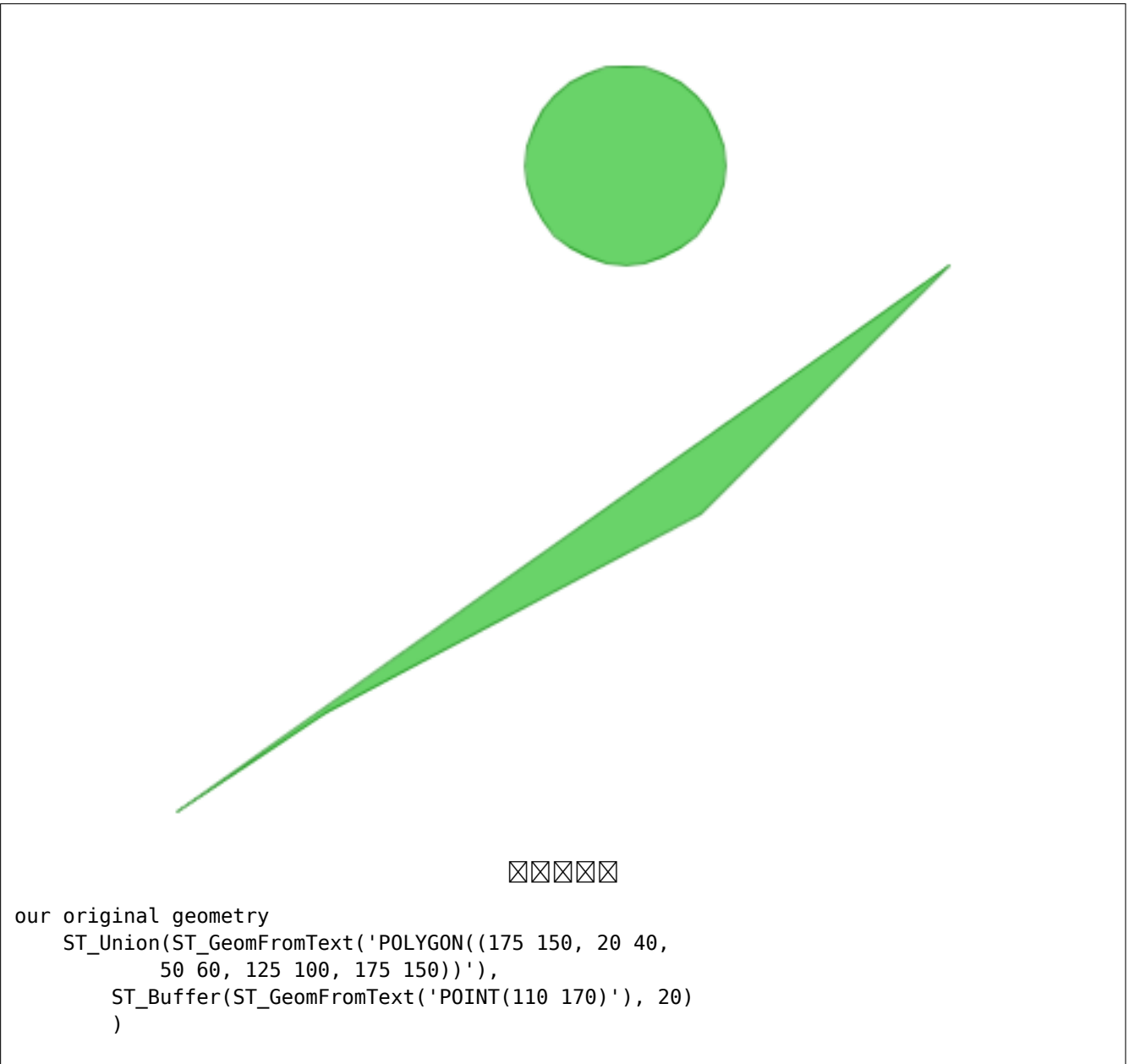


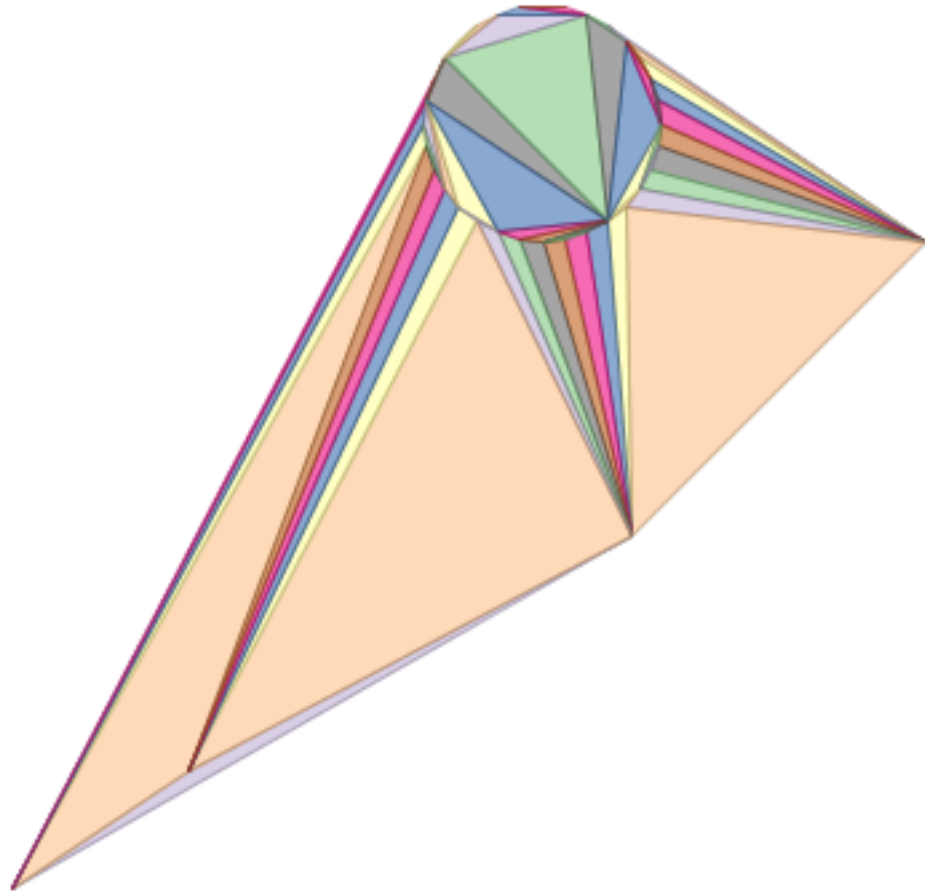
This function supports 3d and will not drop the z-index.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

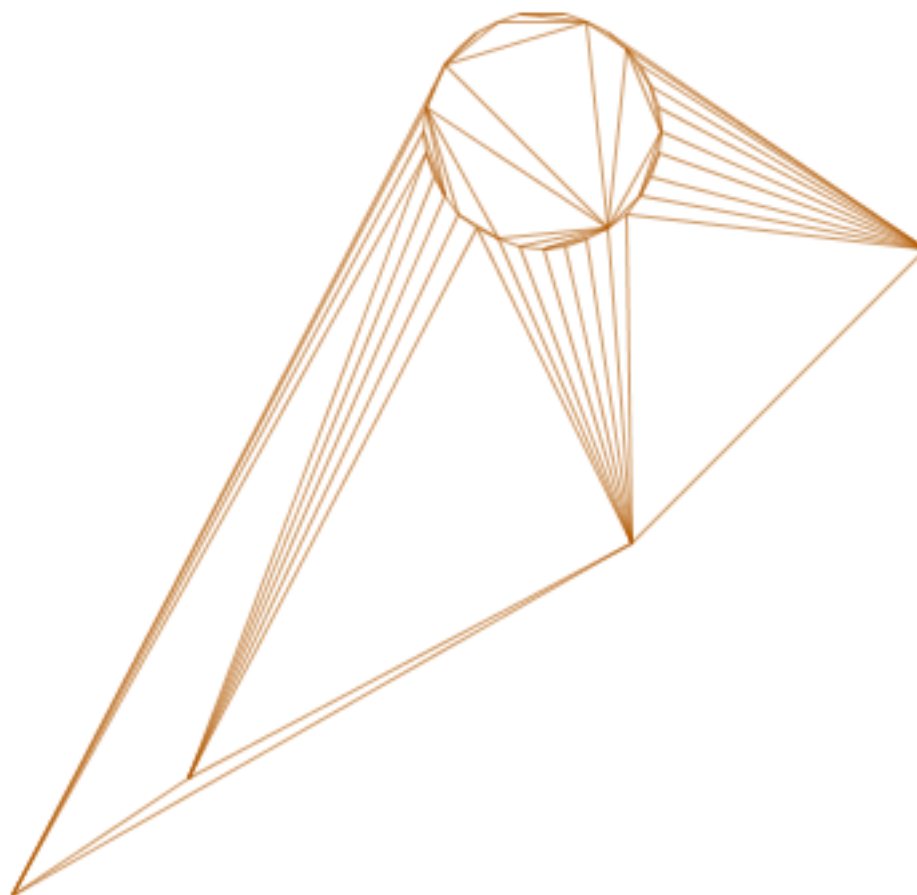




`ST_DelaunayTriangles`: geometries overlaid multilinestring triangles

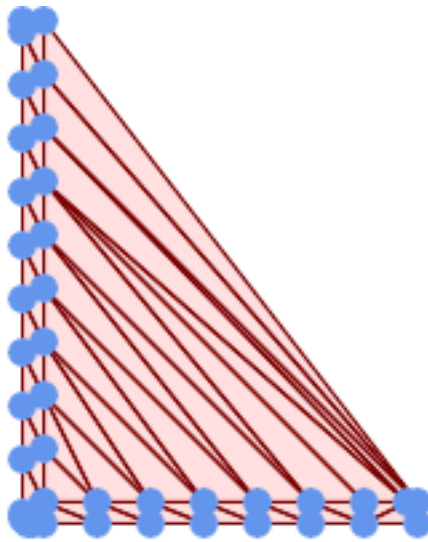
geometries overlaid multilinestring triangles

```
SELECT
  ST_DelaunayTriangles(
    ST_Union(ST_GeomFromText('POLYGON((175 150, 20 40,
      50 60, 125 100, 175 150))'),
    ST_Buffer(ST_GeomFromText('POINT(110 170)'), 20)
  )
  As dtriag;
```



```
--
```

```
SELECT
  ST_DelaunayTriangles(
    ST_Union(ST_GeomFromText('POLYGON((175 150, 20 40,
      50 60, 125 100, 175 150))'),
    ST_Buffer(ST_GeomFromText('POINT(110 170)'), 20)
  ),0.001,1)
  As dtriag;
```



```
-- ☒☒☒☒☒☒☒ 55 ☒☒☒☒☒☒☒ 45 ☒☒☒☒☒☒☒☒☒☒
```

this produces a table of 42 points that form an L shape

```
SELECT (ST_DumpPoints(ST_GeomFromText(
'MULTIPOINT(14 14,34 14,54 14,74 14,94 14,114 14,134 14,
150 14,154 14,154 6,134 6,114 6,94 6,74 6,54 6,34 6,
14 6,10 6,8 6,7 7,6 8,6 10,6 30,6 50,6 70,6 90,6 110,6 130,
6 150,6 170,6 190,6 194,14 194,14 174,14 154,14 134,14 114,
14 94,14 74,14 54,14 34,14 14)'))).geom
    INTO TABLE l_shape;
```

output as individual polygon triangles

```
SELECT ST_AsText((ST_Dump(geom)).geom) As wkt
FROM ( SELECT ST_DelaunayTriangles(ST_Collect(geom)) As geom
FROM l_shape) As foo;
```

wkt

```
POLYGON((6 194,6 190,14 194,6 194))
POLYGON((14 194,6 190,14 174,14 194))
POLYGON((14 194,14 174,154 14,14 194))
POLYGON((154 14,14 174,14 154,154 14))
POLYGON((154 14,14 154,150 14,154 14))
POLYGON((154 14,150 14,154 6,154 14))
```

Example using vertices with Z values.

3D multipoint

```
SELECT ST_AsText(ST_DelaunayTriangles(ST_GeomFromText(
'MULTIPOINT Z(14 14 10, 150 14 100,34 6 25, 20 10 150)')))) As wkt;
```

wkt

```
GEOMETRYCOLLECTION Z (POLYGON Z ((14 14 10,20 10 150,34 6 25,14 14 10))
,POLYGON Z ((14 14 10,34 6 25,150 14 100,14 14 10)))
```

☒☒

[ST_VoronoiPolygons](#), [ST_TriangulatePolygon](#), [ST_ConstrainedDelaunayTriangles](#), [ST_VoronoiLines](#), [ST_Con](#)

7.14.8 ST_FilterByM

ST_FilterByM — Removes vertices based on their M value

Synopsis

geometry **ST_FilterByM**(geometry geom, double precision min, double precision max = null, boolean returnM = false);

☒☒

Filters out vertex points based on their M-value. Returns a geometry with only vertex points that have a M-value larger or equal to the min value and smaller or equal to the max value. If max-value argument is left out only min value is considered. If fourth argument is left out the m-value will not be in the resulting geometry. If resulting geometry have too few vertex points left for its geometry type an empty geometry will be returned. In a geometry collection geometries without enough points will just be left out silently.

This function is mainly intended to be used in conjunction with ST_SetEffectiveArea. ST_EffectiveArea sets the effective area of a vertex in its m-value. With ST_FilterByM it then is possible to get a simplified version of the geometry without any calculations, just by filtering



Note

There is a difference in what ST_SimplifyVW returns when not enough points meet the criteria compared to ST_FilterByM. ST_SimplifyVW returns the geometry with enough points while ST_FilterByM returns an empty geometry



Note

Note that the returned geometry might be invalid



Note

This function returns all dimensions, including the Z and M values

Availability: 2.5.0

☒☒

A linestring is filtered

```
SELECT ST_AsText(ST_FilterByM(geom,30)) simplified
FROM (SELECT ST_SetEffectiveArea('LINESTRING(5 2, 3 8, 6 20, 7 25, 10 10)::geometry) geom ←
) As foo;
```

result

```
          simplified
-----
LINESTRING(5 2,7 25,10 10)
```

☒☒

[ST_SetEffectiveArea](#), [ST_SimplifyVW](#)

7.14.9 ST_GeneratePoints

`ST_GeneratePoints` — Generates a multipoint of random points contained in a Polygon or MultiPolygon.

Synopsis

geometry **ST_GeneratePoints**(geometry g, integer npoints, integer seed = 0);

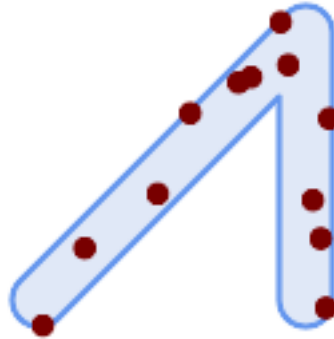
☒☒

`ST_GeneratePoints` generates a multipoint consisting of a given number of pseudo-random points which lie within the input area. The optional seed is used to regenerate a deterministic sequence of points, and must be greater than zero.

2.3.0 ☒☒☒☒☒☒☒☒☒☒☒.

Enhanced: 3.0.0, added seed parameter

☒☒



Generated a multipoint consisting of 12 Points overlaid on top of original polygon using a random seed value 1996

```
SELECT ST_GeneratePoints(geom, 12, 1996)
FROM (
  SELECT ST_Buffer(
    ST_GeomFromText(
      'LINESTRING(50 50,150 150,150 50)'),
    10, 'endcap=round join=round') AS geom
) AS s;
```

Given a table of polygons s, return 12 individual points per polygon. Results will be different each time you run.

```
SELECT s.id, dp.path[1] AS pt_id, dp.geom
FROM s, ST_DumpPoints(ST_GeneratePoints(s.geom,12)) AS dp;
```

☒☒

ST_DumpPoints

7.14.10 ST_GeometricMedian

ST_GeometricMedian — ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ (median) ☒☒☒☒☒☒.

Synopsis

geometry **ST_GeometricMedian** (geometry geom, float8 tolerance = NULL, int max_iter = 10000, boolean fail_if_not_converged = false);

☒☒

Computes the approximate geometric median of a MultiPoint geometry using the Weiszfeld algorithm. The geometric median is the point minimizing the sum of distances to the input points. It provides a centrality measure that is less sensitive to outlier points than the centroid (center of mass).

The algorithm iterates until the distance change between successive iterations is less than the supplied tolerance parameter. If this condition has not been met after `max_iterations` iterations, the function produces an error and exits, unless `fail_if_not_converged` is set to `false` (the default).

If a tolerance argument is not provided, the tolerance value is calculated based on the extent of the input geometry.

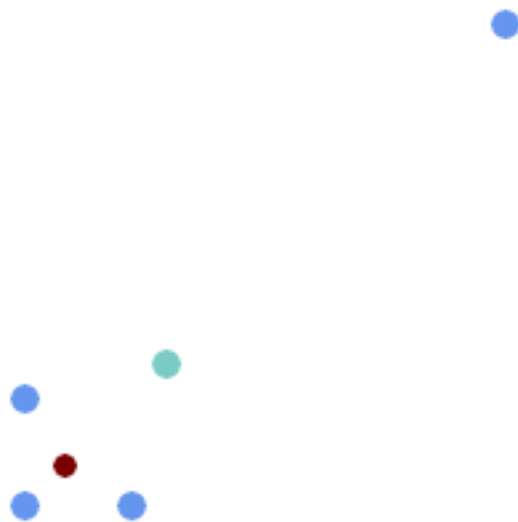
If present, the input point M values are interpreted as their relative weights.

2.3.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Enhanced: 2.5.0 Added support for M as weight of points.

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

☒☒



Comparison of the geometric median (red) and centroid (turquoise) of a MultiPoint.

```
WITH test AS (
SELECT 'MULTIPOINT((10 10), (10 40), (40 10), (190 190))'::geometry geom)
SELECT
  ST_AsText(ST_Centroid(geom)) centroid,
  ST_AsText(ST_GeometricMedian(geom)) median
FROM test;
```

centroid		median
POINT(62.5 62.5)		POINT(25.01778421249728 25.01778421249728)

(1 row)

☒☒

ST_Centroid

7.14.11 ST_LineMerge

ST_LineMerge — Return the lines formed by sewing together a MultiLineString.

Synopsis

```
geometry ST_LineMerge(geometry amultilinestring);  
geometry ST_LineMerge(geometry amultilinestring, boolean directed);
```

☒☒

Returns a LineString or MultiLineString formed by joining together the line elements of a MultiLineString. Lines are joined at their endpoints at 2-way intersections. Lines are not joined across intersections of 3-way or greater degree.

If **directed** is TRUE, then ST_LineMerge will not change point order within LineStrings, so lines with opposite directions will not be merged



Note

Only use with MultiLineString/LineStrings. Other geometry types return an empty GeometryCollection

GEOS ☒☒☒☒☒

Enhanced: 3.3.0 accept a directed parameter.

Requires GEOS >= 3.11.0 to use the directed parameter.

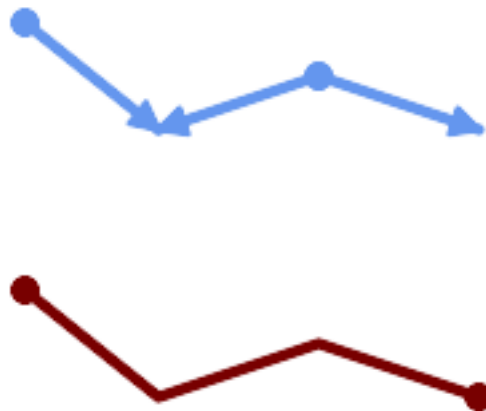
1.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



Warning

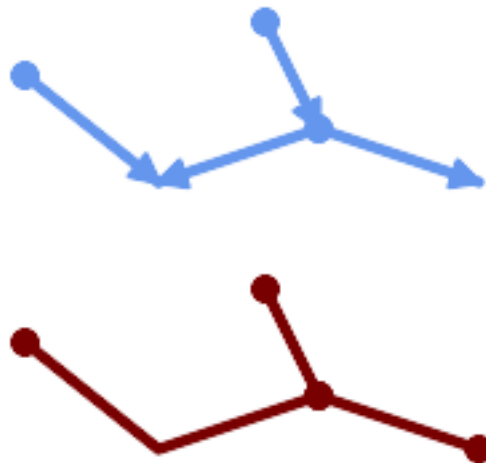
This function strips the M dimension.

☒☒



Merging lines with different orientation.

```
SELECT ST_AsText(ST_LineMerge(
'MULTILINESTRING((10 160, 60 120), (120 140, 60 120), (120 140, 180 120))'
));
-----
LINESTRING(10 160,60 120,120 140,180 120)
```

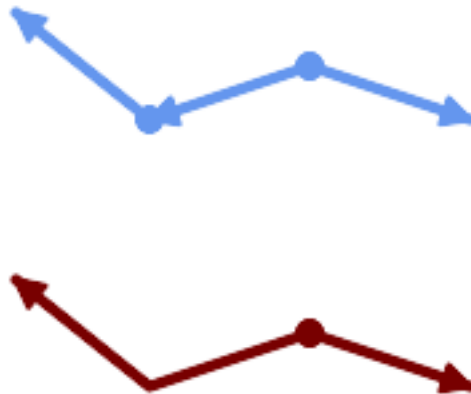


Lines are not merged across intersections with degree > 2.

```
SELECT ST_AsText(ST_LineMerge(
'MULTILINESTRING((10 160, 60 120), (120 140, 60 120), (120 140, 180 120), (100 180, 120 140))'
));
-----
MULTILINESTRING((10 160,60 120,120 140),(100 180,120 140),(120 140,180 120))
```

If merging is not possible due to non-touching lines, the original MultiLineString is returned.

```
SELECT ST_AsText(ST_LineMerge(
'MULTILINESTRING((-29 -27,-30 -29.7,-36 -31,-45 -33),(-45.2 -33.2,-46 -32))'
));
-----
MULTILINESTRING((-45.2 -33.2,-46 -32),(-29 -27,-30 -29.7,-36 -31,-45 -33))
```



Lines with opposite directions are not merged if `directed = TRUE`.

```
SELECT ST_AsText(ST_LineMerge(
'MULTILINESTRING((60 30, 10 70), (120 50, 60 30), (120 50, 180 30))',
TRUE));
-----
MULTILINESTRING((120 50,60 30,10 70),(120 50,180 30))
```

Example showing Z-dimension handling.

```
SELECT ST_AsText(ST_LineMerge(
'MULTILINESTRING((-29 -27 11,-30 -29.7 10,-36 -31 5,-45 -33 6), (-29 -27 12,-30 -29.7 ←
5), (-45 -33 1,-46 -32 11))'
));
-----
LINESTRING Z (-30 -29.7 5,-29 -27 11,-30 -29.7 10,-36 -31 5,-45 -33 1,-46 -32 11)
```



[ST_Segmentize](#), [ST_LineSubstring](#)

7.14.12 ST_MaximumInscribedCircle

ST_MaximumInscribedCircle — 简体中文

Synopsis

(geometry, geometry, double precision) **ST_MaximumInscribedCircle**(geometry geom);

☒☒

Finds the largest circle that is contained within a (multi)polygon, or which does not overlap any lines and points. Returns a record with fields:

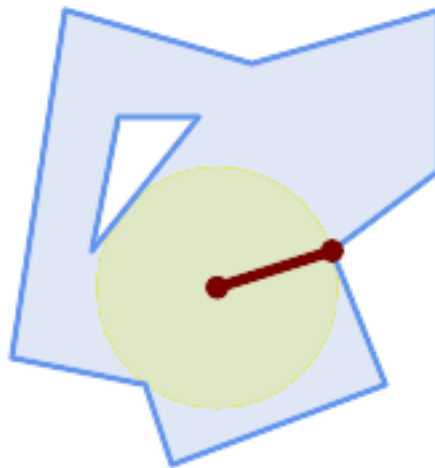
- center - center point of the circle
- nearest - a point on the geometry nearest to the center
- radius - radius of the circle

For polygonal inputs, the circle is inscribed within the boundary rings, using the internal rings as boundaries. For linear and point inputs, the circle is inscribed within the convex hull of the input, using the input lines and points as further boundaries.

Availability: 3.1.0.

Requires GEOS >= 3.9.0.

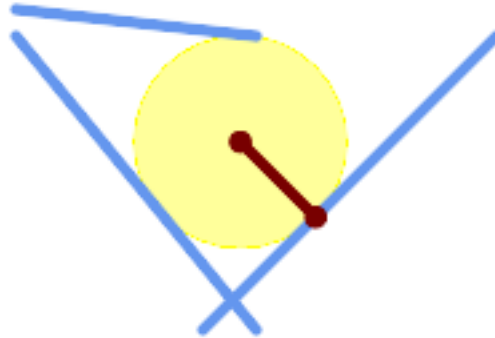
☒☒



Maximum inscribed circle of a polygon. Center, nearest point, and radius are returned.

```
SELECT radius, ST_AsText(center) AS center, ST_AsText(nearest) AS nearest
FROM ST_MaximumInscribedCircle(
  'POLYGON ((40 180, 110 160, 180 180, 180 120, 140 90, 160 40, 80 10, 70 40, 20 50, 40 180),
    (60 140, 50 90, 90 140, 60 140))');
```

radius	center	nearest
45.165845650018	POINT(96.953125 76.328125)	POINT(140 90)



Maximum inscribed circle of a multi-linestring. Center, nearest point, and radius are returned.

☒☒

[ST_MinimumBoundingRadius](#), [ST_LargestEmptyCircle](#)

7.14.13 ST_LargestEmptyCircle

`ST_LargestEmptyCircle` — Computes the largest circle not overlapping a geometry.

Synopsis

(geometry, geometry, double precision) **ST_LargestEmptyCircle**(geometry geom, double precision tolerance=0.0, geometry boundary=POINT EMPTY);

☒☒

Finds the largest circle which does not overlap a set of point and line obstacles. (Polygonal geometries may be included as obstacles, but only their boundary lines are used.) The center of the circle is constrained to lie inside a polygonal boundary, which by default is the convex hull of the input geometry. The circle center is the point in the interior of the boundary which has the farthest distance from the obstacles. The circle itself is provided by the center point and a nearest point lying on an obstacle determining the circle radius.

The circle center is determined to a given accuracy specified by a distance tolerance, using an iterative algorithm. If the accuracy distance is not specified a reasonable default is used.

Returns a record with fields:

- center - center point of the circle
- nearest - a point on the geometry nearest to the center
- radius - radius of the circle

To find the largest empty circle in the interior of a polygon, see [ST_MaximumInscribedCircle](#).

Availability: 3.4.0.

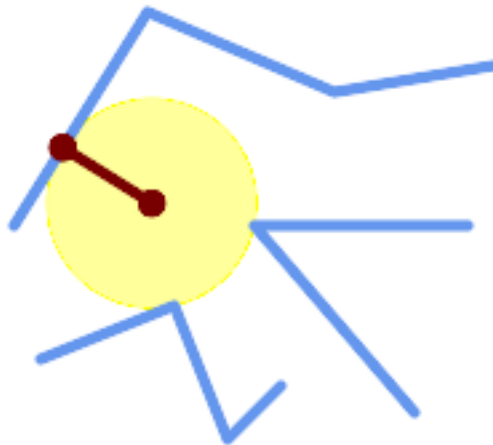
Requires GEOS >= 3.9.0.

☒☒

```

SELECT radius,
       center,
       nearest
FROM ST_LargestEmptyCircle(
  'MULTILINESTRING (
    (10 100, 60 180, 130 150, 190 160),
    (20 50, 70 70, 90 20, 110 40),
    (160 30, 100 100, 180 100))');

```

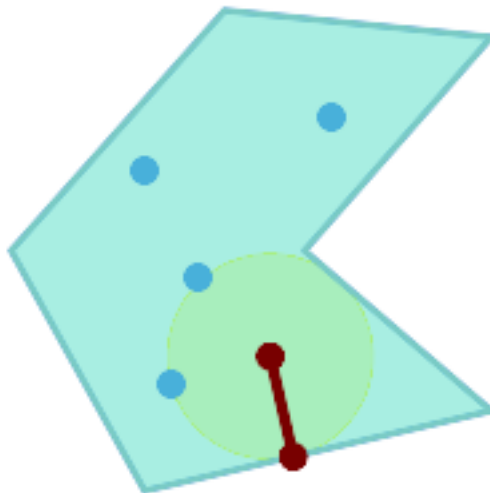


Largest Empty Circle within a set of lines.

```

SELECT radius,
       center,
       nearest
FROM ST_LargestEmptyCircle(
  ST_Collect(
    'MULTIPOINT ((70 50), (60 130), (130 150), (80 90))'::geometry,
    'POLYGON ((90 190, 10 100, 60 10, 190 40, 120 100, 190 180, 90 190))'::geometry) ←
    ,
    'POLYGON ((90 190, 10 100, 60 10, 190 40, 120 100, 190 180, 90 190))'::geometry
  );

```



Largest Empty Circle within a set of points, constrained to lie in a polygon. The constraint polygon boundary must be included as an obstacle, as well as specified as the constraint for the circle center.

ST_MinimumBoundingRadius

7.14.14 ST_MinimumBoundingCircle

`ST_MinimumBoundingCircle` — Returns the smallest circle polygon that contains a geometry.

Synopsis

geometry **ST_MinimumBoundingCircle**(geometry geomA, integer num_segs_per_qt_circ=48);

Returns the smallest circle polygon that contains a geometry.



Note

48 segments per quarter circle. (minimum bounding circle) options, options. ST_MinimumBoundingRadius options.

Use with **ST_Collect** to get the minimum bounding circle of a set of geometries.

To compute two points lying on the minimum circle (the "maximum diameter") use **ST_LongestLine**.

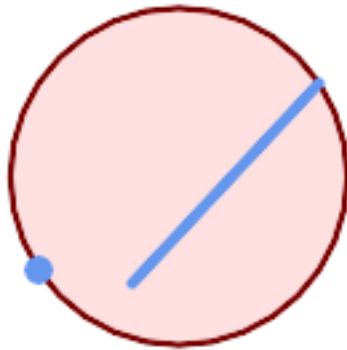
(Roeck)

GEOS

1.4.0

☒☒

```
SELECT d.disease_type,
       ST_MinimumBoundingCircle(ST_Collect(d.geom)) As geom
FROM disease_obs As d
GROUP BY d.disease_type;
```



☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒. ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒ 8 ☒☒☒☒☒☒☒☒.

```
SELECT ST_AsText(ST_MinimumBoundingCircle(
    ST_Collect(
        ST_GeomFromText('LINESTRING(55 75,125 150)'),
        ST_Point(20, 80)), 8
    )) As wktmbc;
wktmbc
-----
POLYGON((135.59714732062 115,134.384753327498 102.690357210921,130.79416296937 ←
90.8537670908995,124.963360620072 79.9451031602111,117.116420743937 ←
70.3835792560632,107.554896839789 62.5366393799277,96.6462329091006 ←
56.70583703063,84.8096427890789 53.115246672502,72.5000000000001 ←
51.9028526793802,60.1903572109213 53.1152466725019,48.3537670908996 ←
56.7058370306299,37.4451031602112 62.5366393799276,27.8835792560632 ←
70.383579256063,20.0366393799278 79.9451031602109,14.20583703063 ←
90.8537670908993,10.615246672502 102.690357210921,9.40285267938019 115,10.6152466725019 ←
127.309642789079,14.2058370306299 139.1462329091,20.0366393799275 ←
150.054896839789,27.883579256063 159.616420743937,
37.4451031602108 167.463360620072,48.3537670908992 173.29416296937,60.190357210921 ←
176.884753327498,
72.4999999999998 178.09714732062,84.8096427890786 176.884753327498,96.6462329091003 ←
173.29416296937,107.554896839789 167.463360620072,
117.116420743937 159.616420743937,124.963360620072 150.054896839789,130.79416296937 ←
139.146232909101,134.384753327498 127.309642789079,135.59714732062 115))
```

☒☒

ST_Collect, ST_MinimumBoundingRadius, ST_LargestEmptyCircle, ST_LongestLine

7.14.15 ST_MinimumBoundingRadius

`ST_MinimumBoundingRadius` — Returns the center point and radius of the smallest circle that contains a geometry.

Synopsis

(geometry, double precision) `ST_MinimumBoundingRadius`(geometry geom);

☒☒

Computes the center point and radius of the smallest circle that contains a geometry. Returns a record with fields:

- center - center point of the circle
- radius - radius of the circle

Use with `ST_Collect` to get the minimum bounding circle of a set of geometries.

To compute two points lying on the minimum circle (the "maximum diameter") use `ST_LongestLine`.

2.3.0 ☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
SELECT ST_AsText(center), radius FROM ST_MinimumBoundingRadius('POLYGON((26426 65078,26531 65242,26075 65136,26096 65427,26426 65078))');
```

st_astext	radius
POINT(26284.8418027133 65267.1145090825)	247.436045591407

☒☒

[ST_Collect](#), [ST_MinimumBoundingCircle](#), [ST_LongestLine](#)

7.14.16 ST_OrientedEnvelope

`ST_OrientedEnvelope` — Returns a minimum-area rectangle containing a geometry.

Synopsis

geometry `ST_OrientedEnvelope`(geometry geom);

☒☒

Returns the minimum-area rotated rectangle enclosing a geometry. Note that more than one such rectangle may exist. May return a Point or LineString in the case of degenerate inputs.

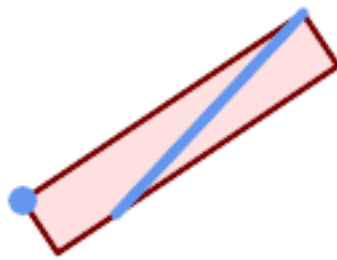
Availability: 2.5.0.

Requires GEOS >= 3.6.0.

☒☒

```
SELECT ST_AsText(ST_OrientedEnvelope('MULTIPOINT ((0 0), (-1 -1), (3 2))'));

      st_astext
-----
POLYGON((3 2,2.88 2.16,-1.12 -0.84,-1 -1,3 2))
```



Oriented envelope of a point and linestring.

```
SELECT ST_AsText(ST_OrientedEnvelope(
  ST_Collect(
    ST_GeomFromText('LINESTRING(55 75,125 150)'),
    ST_Point(20, 80))
  ) As wktenv;

wktenv
-----
POLYGON((19.9999999999997 79.9999999999999,33.0769230769229 ↔
  60.3846153846152,138.076923076924 130.384615384616,125.000000000001 ↔
  150.000000000001,19.9999999999997 79.9999999999999))
```

☒☒

ST_Envelope **ST_MinimumBoundingCircle**

7.14.17 ST_OffsetCurve

ST_OffsetCurve — Returns an offset line at a given distance and side from an input line.

Synopsis

geometry **ST_OffsetCurve**(geometry line, float signed_distance, text style_parameters=“);

ST_OffsetCurve

Return an offset line at a given distance and side from an input line. All points of the returned geometries are not further than the given distance from the input geometry. Useful for computing parallel lines about a center line.

For positive distance the offset is on the left side of the input line and retains the same direction. For a negative distance it is on the right side and in the opposite direction.

ST_OffsetCurve(geometry, float, text)

Note that output may be a MULTILINESTRING or EMPTY for some jigsaw-shaped input geometries.

ST_OffsetCurve(geometry, float, text) = ST_OffsetCurve(geometry, float, text, text):

- 'quad_segs=#' : # (quarter circle) (default 8)
- 'join=round|mitre|bevel' : 'round' (round), 'mitre' (miter), 'bevel' (bevel)
- 'mitre limit=#.#' : #.# (mitre limit) (default 2.0). 'mitre_limit' 'miter_limit'

GEOS 3.11

Behavior changed in GEOS 3.11 so offset curves now have the same direction as the input line, for both positive and negative offsets.

2.0

Enhanced: 2.5 - added support for GEOMETRYCOLLECTION and MULTILINESTRING




Note

This function ignores the Z dimension. It always gives a 2D result even when used on a 3D geometry.

ST_Union

ST_Union(geometry, geometry)

```
SELECT ST_Union(
  ST_OffsetCurve(f.geom, f.width/2, 'quad_segs=4 join=round'),
  ST_OffsetCurve(f.geom, -f.width/2, 'quad_segs=4 join=round')
) as track
FROM someroadstable;
```




☒☒ 15, ☒☒☒☒☒☒'quad_segs=4 join=round'
☒☒☒☒☒ 15 ☒☒

```
SELECT ST_AsText(ST_OffsetCurve( ↵
  ST_GeomFromText(
'LINESTRING(164 16,144 16,124 16,104 ↵
  16,84 16,64 16,
  44 16,24 16,20 16,18 16,17 17,
  16 18,16 20,16 40,16 60,16 80,16 100,
  16 120,16 140,16 160,16 180,16 195)') ↵
  ,
  15, 'quad_segs=4 join=round'));
```

output

```
LINESTRING(164 1,18 1,12.2597485145237 ↵
  2.1418070123307,
  7.39339828220179 5.39339828220179,
  5.39339828220179 7.39339828220179,
  2.14180701233067 12.2597485145237,1 ↵
  18,1 195)
```

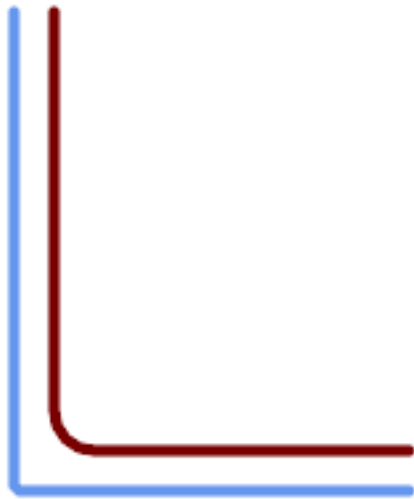


☒☒ -15, ☒☒☒☒☒☒'quad_segs=4
join=round' ☒☒☒☒☒ -15 ☒☒

```
SELECT ST_AsText(ST_OffsetCurve(geom, ↵
  -15, 'quad_segs=4 join=round')) As ↵
  notsocurvy
FROM ST_GeomFromText(
'LINESTRING(164 16,144 16,124 16,104 ↵
  16,84 16,64 16,
  44 16,24 16,20 16,18 16,17 17,
  16 18,16 20,16 40,16 60,16 80,16 100,
  16 120,16 140,16 160,16 180,16 195)') ↵
  As geom;
```

notsocurvy

```
LINESTRING(31 195,31 31,164 31)
```

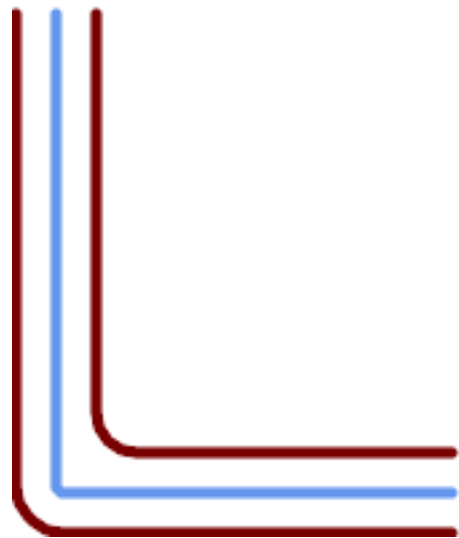


ST_OffsetCurve(ST_OffsetCurve(ST_GeomFromText('LINESTRING(164 16,144 16,124 16,104 16,84 16,64 16,44 16,24 16,20 16,18 16,17 17,16 18,16 20,16 40,16 60,16 80,16 100,16 120,16 140,16 160,16 180,16 195)') As geom, -30, 'quad_segs=4 join=round'), -15, 'quad_segs=4 join=round')) As morecurvy

```
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)
```



ST_OffsetCurve(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)') As geom, -30, 'quad_segs=4 join=round'), -15, 'quad_segs=4 join=round')) As parallel_curves

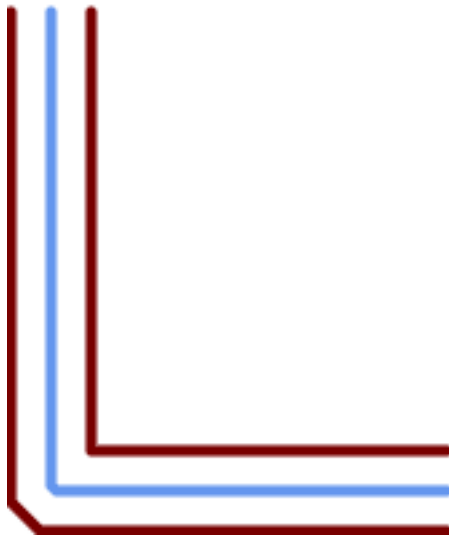
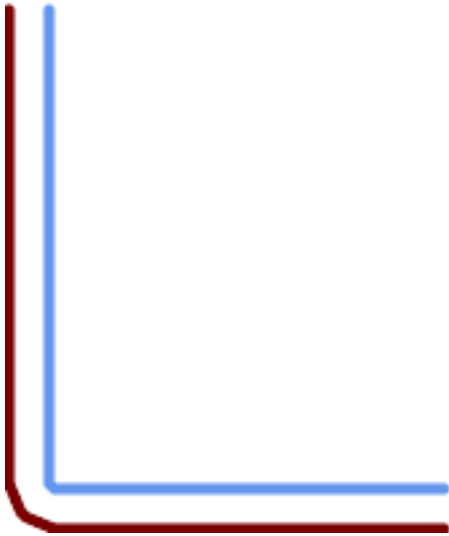
```
SELECT ST_AsText(ST_Collect(
  ST_OffsetCurve(geom, 15, 'quad_segs=4
  join=round'),
  ST_OffsetCurve(ST_OffsetCurve(geom,
    -30, 'quad_segs=4 join=round'), -15,
    'quad_segs=4 join=round')
  )
```

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))
```



ST_OffsetCurve(
geom, 15, 'quad_segs=4
join=round')

ST_OffsetCurve(
geom, 15, -15, join=mitre mitre_limit=2.1

```
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'));
```

```
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

output

```
LINESTRING(164 1,18 1,7.39339828220179  
5.39339828220179,  
5.39339828220179 7.39339828220179,1  
18,1 195)
```

```
MULTILINESTRING((164 1,11.7867965644036  
1,1 11.7867965644036,1 195),  
(31 195,31 31,164 31))
```

ST_Buffer

ST_Buffer

7.14.18 ST_PointOnSurface

ST_PointOnSurface — Computes a point guaranteed to lie in a polygon, or on a geometry.

Synopsis

geometry ST_PointOnSurface(geometry g1);

☒☒

Returns a POINT which is guaranteed to lie in the interior of a surface (POLYGON, MULTIPOLYGON, and CURVEPOLYGON). In PostGIS this function also works on line and point geometries.



This method implements the [OGC Simple Features Implementation Specification for SQL 1.1. s3.2.14.2 // s3.2.18.2](#)

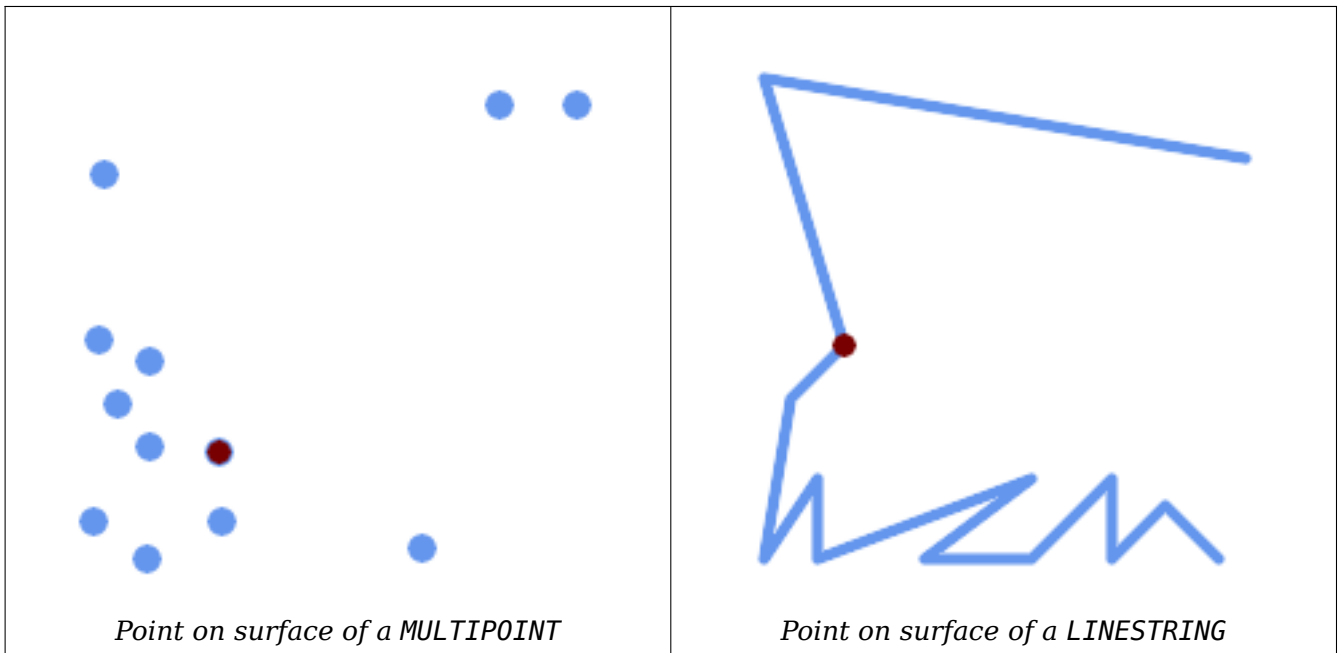


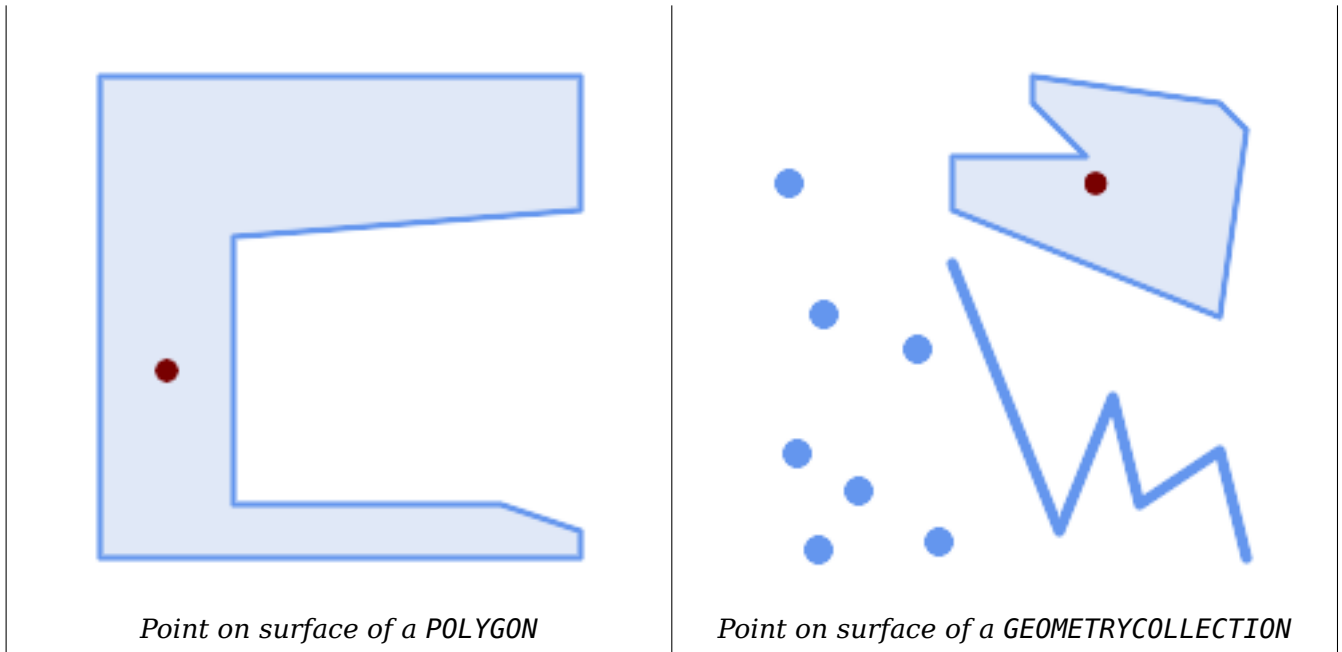
This method implements the SQL/MM specification. SQL-MM 3: 8.1.5, 9.5.6. The specifications define ST_PointOnSurface for surface geometries only. PostGIS extends the function to support all common geometry types. Other databases (Oracle, DB2, ArcSDE) seem to support this function only for surfaces. SQL Server 2008 supports all common geometry types.



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

☒☒





```

SELECT ST_AsText(ST_PointOnSurface('POINT(0 5)')::geometry);
-----
POINT(0 5)

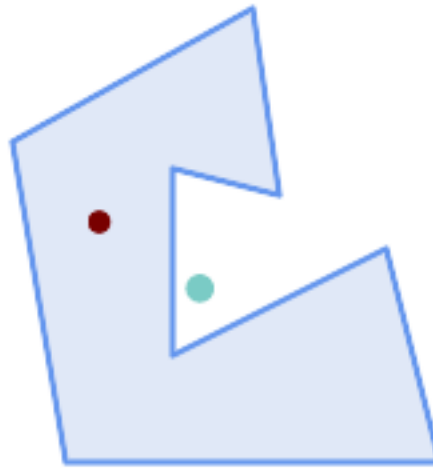
SELECT ST_AsText(ST_PointOnSurface('LINESTRING(0 5, 0 10)')::geometry);
-----
POINT(0 5)

SELECT ST_AsText(ST_PointOnSurface('POLYGON((0 0, 0 5, 5 5, 5 0, 0 0))')::geometry);
-----
POINT(2.5 2.5)

SELECT ST_AsEWKT(ST_PointOnSurface(ST_GeomFromEWKT('LINESTRING(0 5 1, 0 0 1, 0 10 2)')));
-----
POINT(0 0 1)

```

Example: The result of `ST_PointOnSurface` is guaranteed to lie within polygons, whereas the point computed by `ST_Centroid` may be outside.



Red: point on surface; Green: centroid

```
SELECT ST_AsText(ST_PointOnSurface(geom)) AS pt_on_surf,
       ST_AsText(ST_Centroid(geom)) AS centroid
FROM (SELECT 'POLYGON ((130 120, 120 190, 30 140, 50 20, 190 20,
                       170 100, 90 60, 90 130, 130 120))'::geometry AS geom) AS t;
```

pt_on_surf	centroid
POINT(62.5 110)	POINT(100.18264840182648 85.11415525114155)

☒☒

[ST_Centroid](#), [ST_MaximumInscribedCircle](#)

7.14.19 ST_Polygonize

ST_Polygonize — Computes a collection of polygons formed from the linework of a set of geometries.

Synopsis

```
geometry ST_Polygonize(geometry set geomfield);
geometry ST_Polygonize(geometry[] geom_array);
```

☒☒

Creates a GeometryCollection containing the polygons formed by the linework of a set of geometries. If the input linework does not form any polygons, an empty GeometryCollection is returned.

This function creates polygons covering all delimited areas. If the result is intended to form a valid polygonal geometry, use [ST_BuildArea](#) to prevent holes being filled.



Note

The input linework must be correctly noded for this function to work properly. To ensure input is noded use [ST_Node](#) on the input geometry before polygonizing.



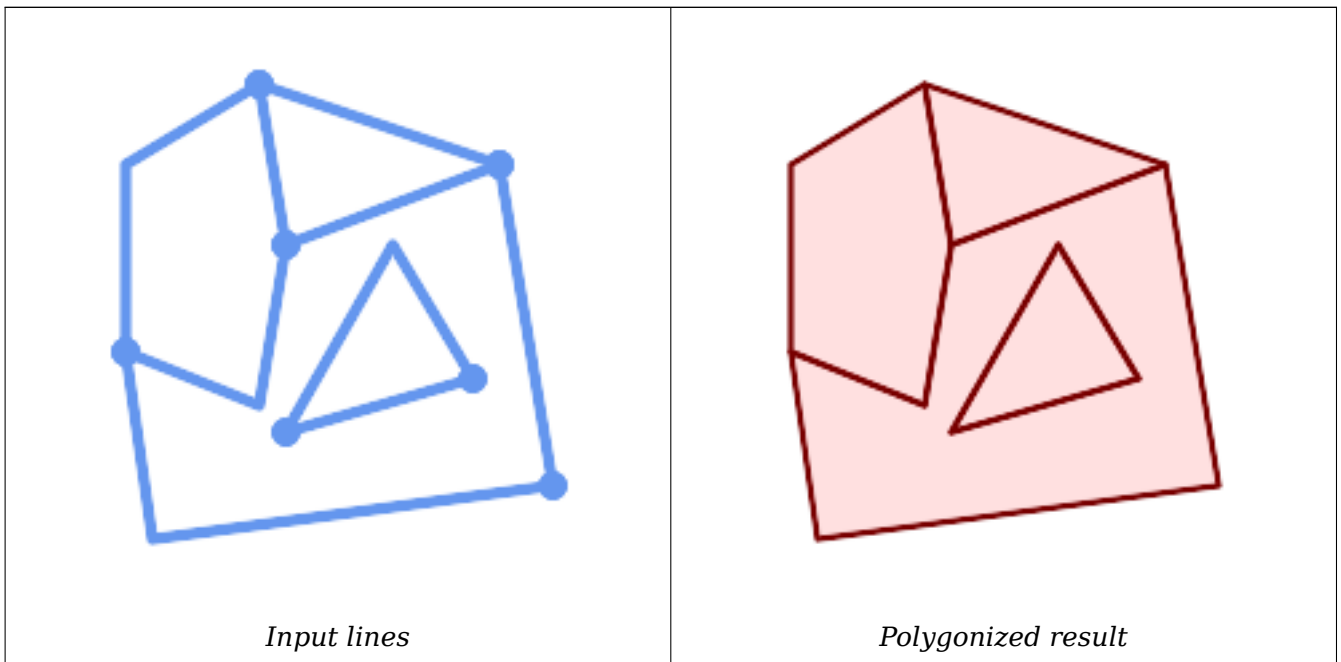
Note

GeometryCollections can be difficult to handle with external tools. Use **ST_Dump** to convert the polygonized result into separate polygons.

GEOS ☒☒☒☒☒

1.0.0RC1 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒



```

WITH data(geom) AS (VALUES
  ('LINESTRING (180 40, 30 20, 20 90)::geometry')
  ,('LINESTRING (180 40, 160 160)::geometry')
  ,('LINESTRING (80 60, 120 130, 150 80)::geometry')
  ,('LINESTRING (80 60, 150 80)::geometry')
  ,('LINESTRING (20 90, 70 70, 80 130)::geometry')
  ,('LINESTRING (80 130, 160 160)::geometry')
  ,('LINESTRING (20 90, 20 160, 70 190)::geometry')
  ,('LINESTRING (70 190, 80 130)::geometry')
  ,('LINESTRING (70 190, 160 160)::geometry')
)
SELECT ST_AsText( ST_Polygonize( geom ) )
FROM data;
-----
GEOMETRYCOLLECTION (POLYGON ((180 40, 30 20, 20 90, 70 70, 80 130, 160 160, 180 40)), (150 ←
  80, 120 130, 80 60, 150 80)),
  POLYGON ((20 90, 20 160, 70 190, 80 130, 70 70, 20 90)),
  POLYGON ((160 160, 80 130, 70 190, 160 160)),
  POLYGON ((80 60, 120 130, 150 80, 80 60)))
    
```

Polygonizing a table of linestrings:

```

SELECT ST_AsEWKT(ST_Polygonize(geom_4269)) As geomtextrep
FROM (SELECT geom_4269 FROM ma.suffolk_edges) As foo;

-----
SRID=4269;GEOMETRYCOLLECTION(POLYGON((-71.040878 42.285678,-71.040943 42.2856,-71.04096  ←
  42.285752,-71.040878 42.285678)),
POLYGON((-71.17166 42.353675,-71.172026 42.354044,-71.17239 42.354358,-71.171794  ←
  42.354971,-71.170511 42.354855,
-71.17112 42.354238,-71.17166 42.353675)))

--Use ST_Dump to dump out the polygonize geoms into individual polygons
SELECT ST_AsEWKT((ST_Dump(t.polycoll)).geom) AS geomtextrep
FROM (SELECT ST_Polygonize(geom_4269) AS polycoll
      FROM (SELECT geom_4269 FROM ma.suffolk_edges)
           As foo) AS t;

-----
SRID=4269;POLYGON((-71.040878 42.285678,-71.040943 42.2856,-71.04096 42.285752,
-71.040878 42.285678))
SRID=4269;POLYGON((-71.17166 42.353675,-71.172026 42.354044,-71.17239 42.354358
,-71.171794 42.354971,-71.170511 42.354855,-71.17112 42.354238,-71.17166 42.353675))

```

☒☒

[ST_BuildArea](#), [ST_Dump](#), [ST_Node](#)

7.14.20 ST_ReducePrecision

`ST_ReducePrecision` — Returns a valid geometry with points rounded to a grid tolerance.

Synopsis

geometry **ST_ReducePrecision**(geometry g, float8 gridsize);

☒☒

Returns a valid geometry with all points rounded to the provided grid tolerance, and features below the tolerance removed.

Unlike [ST_SnapToGrid](#) the returned geometry will be valid, with no ring self-intersections or collapsed components.

Precision reduction can be used to:

- match coordinate precision to the data accuracy
- reduce the number of coordinates needed to represent a geometry
- ensure valid geometry output to formats which use lower precision (e.g. text formats such as WKT, GeoJSON or KML when the number of output decimal places is limited).
- export valid geometry to systems which use lower or limited precision (e.g. SDE, Oracle tolerance value)

Availability: 3.1.0.

Requires GEOS >= 3.9.0.

☒☒

```
SELECT ST_AsText(ST_ReducePrecision('POINT(1.412 19.323)', 0.1));
      st_astext
-----
POINT(1.4 19.3)

SELECT ST_AsText(ST_ReducePrecision('POINT(1.412 19.323)', 1.0));
      st_astext
-----
POINT(1 19)

SELECT ST_AsText(ST_ReducePrecision('POINT(1.412 19.323)', 10));
      st_astext
-----
POINT(0 20)
```

Precision reduction can reduce number of vertices

```
SELECT ST_AsText(ST_ReducePrecision('LINESTRING (10 10, 19.6 30.1, 20 30, 20.3 30, 40 40)', 1));
      st_astext
-----
LINESTRING (10 10, 20 30, 40 40)
```

Precision reduction splits polygons if needed to ensure validity

```
SELECT ST_AsText(ST_ReducePrecision('POLYGON ((10 10, 60 60.1, 70 30, 40 40, 50 10, 10 10))', 10));
      st_astext
-----
MULTIPOLYGON (((60 60, 70 30, 40 40, 60 60)), ((40 40, 50 10, 10 10, 40 40)))
```

☒☒

[ST_SnapToGrid](#), [ST_Simplify](#), [ST_SimplifyVW](#)

7.14.21 ST_SharedPaths

`ST_SharedPaths` — [PostGIS 3.5.0alpha2/ST_SharedPaths\(geometry lineal1, geometry lineal2\)](#).

Synopsis

geometry **ST_SharedPaths**(geometry lineal1, geometry lineal2);

☒☒

[PostGIS 3.5.0alpha2/ST_SharedPaths\(geometry lineal1, geometry lineal2\)](#). [PostGIS 3.5.0alpha2/ST_SharedPaths\(geometry lineal1, geometry lineal2\)](#). [PostGIS 3.5.0alpha2/ST_SharedPaths\(geometry lineal1, geometry lineal2\)](#).

GEOS [PostGIS 3.5.0alpha2/ST_SharedPaths\(geometry lineal1, geometry lineal2\)](#)

2.0.0 [PostGIS 3.5.0alpha2/ST_SharedPaths\(geometry lineal1, geometry lineal2\)](#).

☒☒: [PostGIS 3.5.0alpha2/ST_SharedPaths\(geometry lineal1, geometry lineal2\)](#)




Diagram illustrating the input geometry for the ST_SharedPaths function. It shows a blue square and a green triangle. The triangle is positioned such that its bottom-right vertex coincides with the bottom-right vertex of the square. A line segment extends from the triangle's bottom-right vertex to the right and slightly downwards.

`ST_SharedPaths`




Diagram illustrating the output of the ST_SharedPaths function. The overlapping area between the square and triangle is highlighted in dark red, showing a smaller triangle. The shared line segment is also highlighted in dark red, appearing as a vertical line segment.

```
SELECT ST_AsText(
  ST_SharedPaths(
    ST_GeomFromText('MULTILINESTRING((26 125,26 200,126 200,126 125,26 125),
      (51 150,101 150,76 175,51 150))'),
    ST_GeomFromText('LINESTRING(151 100,126 156.25,126 125,90 161, 76 175)')
  )
) As wkt

-----
wkt
-----
GEOMETRYCOLLECTION(MULTILINESTRING((126 156.25,126 125),
  (101 150,90 161),(90 161,76 175)),MULTILINESTRING EMPTY)
```

same example but linestring orientation flipped

```
SELECT ST_AsText(
  ST_SharedPaths(
    ST_GeomFromText('LINESTRING(76 175,90 161,126 125,126 156.25,151 100)'),
    ST_GeomFromText('MULTILINESTRING((26 125,26 200,126 200,126 125,26 125),
      (51 150,101 150,76 175,51 150))')
  )
) As wkt
```

wkt

```
-----
GEOMETRYCOLLECTION(MULTILINESTRING EMPTY,
MULTILINESTRING((76 175,90 161),(90 161,101 150),(126 125,126 156.25)))
```

☒☒

[ST_Dump](#), [ST_GeometryN](#), [ST_NumGeometries](#)

7.14.22 ST_Simplify

`ST_Simplify` — Returns a simplified representation of a geometry, using the Douglas-Peucker algorithm.

Synopsis

```
geometry ST_Simplify(geometry geom, float tolerance);
geometry ST_Simplify(geometry geom, float tolerance, boolean preserveCollapsed);
```

☒☒

Computes a simplified representation of a geometry using the [Douglas-Peucker algorithm](#). The simplification tolerance is a distance value, in the units of the input SRS. Simplification removes vertices which are within the tolerance distance of the simplified linework. The result may not be valid even if the input is.

The function can be called with any kind of geometry (including GeometryCollections), but only line and polygon elements are simplified. Endpoints of linear geometry are preserved.

The `preserveCollapsed` flag retains small geometries that would otherwise be removed at the given tolerance. For example, if a 1m long line is simplified with a 10m tolerance, when `preserveCollapsed` is true the line will not disappear. This flag is useful for rendering purposes, to prevent very small features disappearing from a map.



Note

The returned geometry may lose its simplicity (see [ST_IsSimple](#)), topology may not be preserved, and polygonal results may be invalid (see [ST_IsValid](#)). Use [ST_SimplifyPreserveTopology](#) to preserve topology and ensure validity.



Note

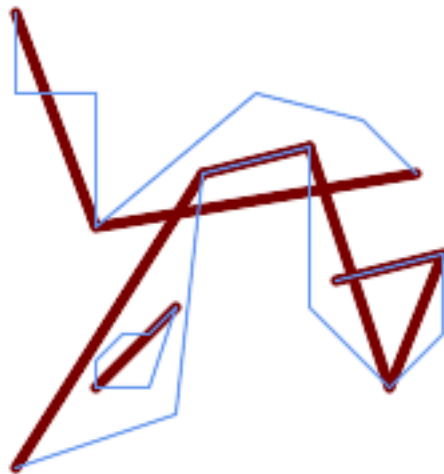
This function does not preserve boundaries shared between polygons. Use `ST_CoverageSimplify` if this is required.

1.2.2

```
SELECT ST_Npoints(geom) AS np_before,
       ST_NPoints(ST_Simplify(geom, 0.1)) AS np01_notbadcircle,
       ST_NPoints(ST_Simplify(geom, 0.5)) AS np05_notquitecircle,
       ST_NPoints(ST_Simplify(geom, 1)) AS np1_octagon,
       ST_NPoints(ST_Simplify(geom, 10)) AS np10_triangle,
       (ST_Simplify(geom, 100) is null) AS np100_geometrygoesaway
FROM (SELECT ST_Buffer('POINT(1 3)', 10,12) As geom) AS t;
```

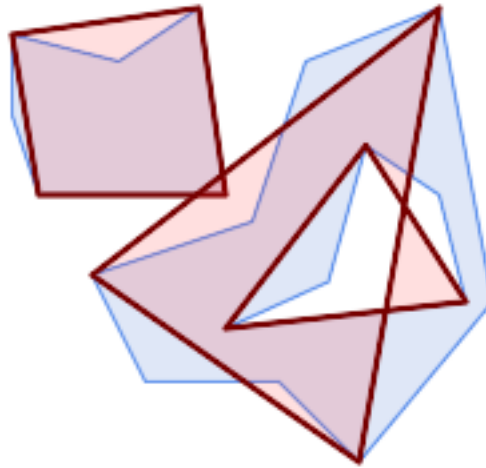
np_before	np01_notbadcircle	np05_notquitecircle	np1_octagon	np10_triangle	np100_geometrygoesaway
49	33	17	9	4	t

Simplifying a set of lines. Lines may intersect after simplification.



```
SELECT ST_Simplify(
'MULTILINESTRING ((20 180, 20 150, 50 150, 50 100, 110 150, 150 140, 170 120), (20 10, 80 30, 90 120), (90 120, 130 130), (130 130, 130 70, 160 40, 180 60, 180 90, 140 80), (50 40, 70 40, 80 70, 70 60, 60 60, 50 50, 50 40))',
40);
```

Simplifying a MultiPolygon. Polygonal results may be invalid.



```
SELECT ST_Simplify(
  'MULTIPOLYGON (((90 110, 80 180, 50 160, 10 170, 10 140, 20 110, 90 110)), ((40 80, 100 ←
    100, 120 160, 170 180, 190 70, 140 10, 110 40, 60 40, 40 80)), (180 70, 170 110, 142.5 ←
    128.5, 128.5 77.5, 90 60, 180 70)))',
  40);
```

☒☒

[ST_IsSimple](#), [ST_SimplifyPreserveTopology](#), [ST_SimplifyVW](#), [ST_CoverageSimplify](#), [Topology ST_Simplify](#)

7.14.23 ST_SimplifyPreserveTopology

`ST_SimplifyPreserveTopology` — Returns a simplified and valid representation of a geometry, using the Douglas-Peucker algorithm.

Synopsis

geometry **ST_SimplifyPreserveTopology**(geometry geom, float tolerance);

☒☒

Computes a simplified representation of a geometry using a variant of the [Douglas-Peucker algorithm](#) which limits simplification to ensure the result has the same topology as the input. The simplification tolerance is a distance value, in the units of the input SRS. Simplification removes vertices which are within the tolerance distance of the simplified linework, as long as topology is preserved. The result will be valid and simple if the input is.

The function can be called with any kind of geometry (including `GeometryCollections`), but only line and polygon elements are simplified. For polygonal inputs, the result will have the same number of rings (shells and holes), and the rings will not cross. Ring endpoints may be simplified. For linear inputs, the result will have the same number of lines, and lines will not intersect if they did not do so in the original geometry. Endpoints of linear geometry are preserved.



Note

This function does not preserve boundaries shared between polygons. Use `ST_CoverageSimplify` if this is required.

GEOS

1.3.3

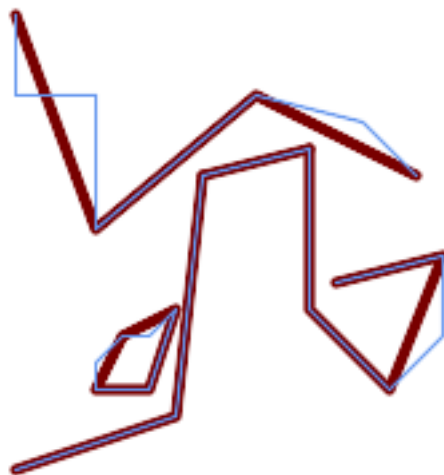


For the same example as `ST_Simplify`, `ST_SimplifyPreserveTopology` prevents oversimplification. The circle can at most become a square.

```
SELECT ST_Npoints(geom) AS np_before,
       ST_NPoints(ST_SimplifyPreserveTopology(geom, 0.1)) AS np01_notbadcircle,
       ST_NPoints(ST_SimplifyPreserveTopology(geom, 0.5)) AS np05_notquitecircle,
       ST_NPoints(ST_SimplifyPreserveTopology(geom, 1)) AS np1_octagon,
       ST_NPoints(ST_SimplifyPreserveTopology(geom, 10)) AS np10_square,
       ST_NPoints(ST_SimplifyPreserveTopology(geom, 100)) AS np100_stillsquare
FROM (SELECT ST_Buffer('POINT(1 3)', 10,12) AS geom) AS t;
```

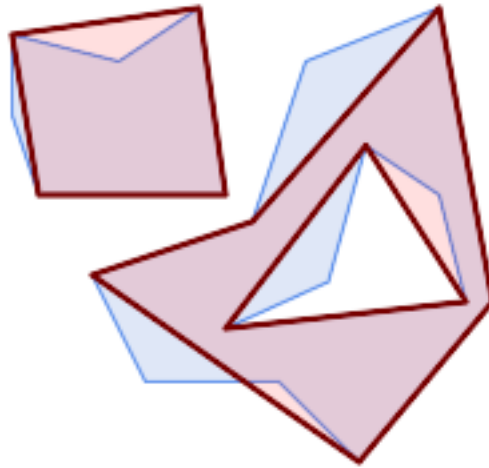
np_before	np01_notbadcircle	np05_notquitecircle	np1_octagon	np10_square	
49	33	17	9	5	↔
	5				↔

Simplifying a set of lines, preserving topology of non-intersecting lines.



```
SELECT ST_SimplifyPreserveTopology(
  'MULTILINESTRING ((20 180, 20 150, 50 150, 50 100, 110 150, 150 140, 170 120), (20 10, 80 30, 90 120), (90 120, 130 130), (130 130, 130 70), 160 40, 180 60, 180 90, 140 80), (50 40, 70 40, 80 70, 70 60, 60 60, 50 50, 50 40))',
  40);
```

Simplifying a MultiPolygon, preserving topology of shells and holes.



```
SELECT ST_SimplifyPreserveTopology(
  'MULTIPOLYGON (((90 110, 80 180, 50 160, 10 170, 10 140, 20 110, 90 110)), ((40 80, 100 ←
    100, 120 160, 170 180, 190 70, 140 10, 110 40, 60 40, 40 80), (180 70, 170 110, 142.5 ←
    128.5, 128.5 77.5, 90 60, 180 70)))',
  40);
```

☒☒

[ST_Simplify](#), [ST_SimplifyVW](#), [ST_CoverageSimplify](#)

7.14.24 ST_SimplifyPolygonHull

`ST_SimplifyPolygonHull` — Computes a simplified topology-preserving outer or inner hull of a polygonal geometry.

Synopsis

```
geometry ST_SimplifyPolygonHull(geometry param_geom, float vertex_fraction, boolean is_outer = true);
```

☒☒

Computes a simplified topology-preserving outer or inner hull of a polygonal geometry. An outer hull completely covers the input geometry. An inner hull is completely covered by the input geometry. The result is a polygonal geometry formed by a subset of the input vertices. MultiPolygons and holes are handled and produce a result with the same structure as the input.

The reduction in vertex count is controlled by the `vertex_fraction` parameter, which is a number in the range 0 to 1. Lower values produce simpler results, with smaller vertex count and less concaveness. For both outer and inner hulls a vertex fraction of 1.0 produces the original geometry. For outer hulls a value of 0.0 produces the convex hull (for a single polygon); for inner hulls it produces a triangle.

The simplification process operates by progressively removing concave corners that contain the least amount of area, until the vertex count target is reached. It prevents edges from crossing, so the result is always a valid polygonal geometry.

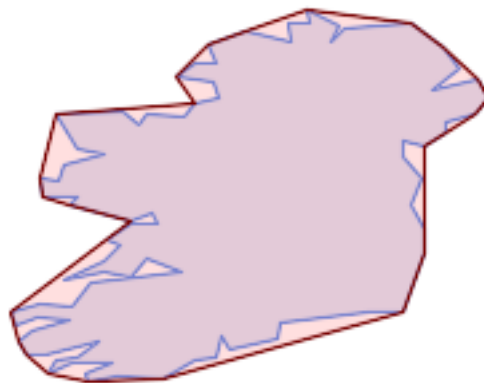
To get better results with geometries that contain relatively long line segments, it might be necessary to "segmentize" the input, as shown below.

GEOS ☒☒☒☒☒

Availability: 3.3.0.

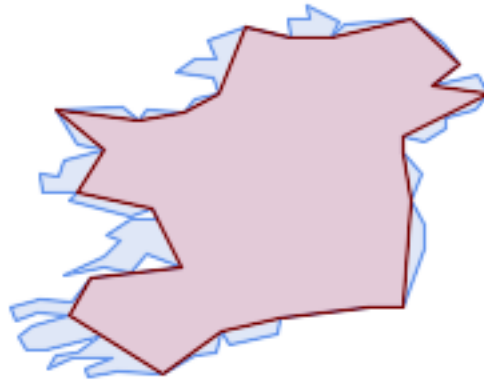
Requires GEOS >= 3.11.0.

☒☒



Outer hull of a Polygon

```
SELECT ST_SimplifyPolygonHull(  
  'POLYGON ((131 158, 136 163, 161 165, 173 156, 179 148, 169 140, 186 144, 190 137, 185 ↵  
    131, 174 128, 174 124, 166 119, 158 121, 158 115, 165 107, 161 97, 166 88, 166 79, 158 ↵  
    57, 145 57, 112 53, 111 47, 93 43, 90 48, 88 40, 80 39, 68 32, 51 33, 40 31, 39 34, ↵  
    49 38, 34 38, 25 34, 28 39, 36 40, 44 46, 24 41, 17 41, 14 46, 19 50, 33 54, 21 55, 13 ↵  
    52, 11 57, 22 60, 34 59, 41 68, 75 72, 62 77, 56 70, 46 72, 31 69, 46 76, 52 82, 47 ↵  
    84, 56 90, 66 90, 64 94, 56 91, 33 97, 36 100, 23 100, 22 107, 29 106, 31 112, 46 116, ↵  
    36 118, 28 131, 53 132, 59 127, 62 131, 76 130, 80 135, 89 137, 87 143, 73 145, 80 ↵  
    150, 88 150, 85 157, 99 162, 116 158, 115 165, 123 165, 122 170, 134 164, 131 158))',  
  0.3);
```



Inner hull of a Polygon

```
SELECT ST_SimplifyPolygonHull(
  'POLYGON ((131 158, 136 163, 161 165, 173 156, 179 148, 169 140, 186 144, 190 137, 185 ↵
    131, 174 128, 174 124, 166 119, 158 121, 158 115, 165 107, 161 97, 166 88, 166 79, 158 ↵
    57, 145 57, 112 53, 111 47, 93 43, 90 48, 88 40, 80 39, 68 32, 51 33, 40 31, 39 34, ↵
    49 38, 34 38, 25 34, 28 39, 36 40, 44 46, 24 41, 17 41, 14 46, 19 50, 33 54, 21 55, 13 ↵
    52, 11 57, 22 60, 34 59, 41 68, 75 72, 62 77, 56 70, 46 72, 31 69, 46 76, 52 82, 47 ↵
    84, 56 90, 66 90, 64 94, 56 91, 33 97, 36 100, 23 100, 22 107, 29 106, 31 112, 46 116, ↵
    36 118, 28 131, 53 132, 59 127, 62 131, 76 130, 80 135, 89 137, 87 143, 73 145, 80 ↵
    150, 88 150, 85 157, 99 162, 116 158, 115 165, 123 165, 122 170, 134 164, 131 158))',
  0.3, false);
```



Outer hull simplification of a MultiPolygon, with segmentization

```
SELECT ST_SimplifyPolygonHull(
  ST_Segmentize(ST_Letters('xt'), 2.0),
  0.1);
```

☒☒

[ST_ConvexHull](#), [ST_SimplifyVW](#), [ST_ConcaveHull](#), [ST_Segmentize](#)

7.14.25 ST_SimplifyVW


ST_SimplifyVW — Returns a simplified representation of a geometry, using the Visvalingam-Whyatt algorithm


Synopsis

geometry ST_SimplifyVW(geometry geom, float tolerance);

Returns a simplified representation of a geometry using the **Visvalingam-Whyatt algorithm**. The simplification tolerance is an area value, in the units of the input SRS. Simplification removes vertices which form "corners" with area less than the tolerance. The result may not be valid even if the input is.

The function can be called with any kind of geometry (including GeometryCollections), but only line and polygon elements are simplified. Endpoints of linear geometry are preserved.

Note  The returned geometry may lose its simplicity (see [ST_IsSimple](#)), topology may not be preserved, and polygonal results may be invalid (see [ST_IsValid](#)). Use [ST_SimplifyPreserveTopology](#) to preserve topology and ensure validity. [ST_CoverageSimplify](#) also preserves topology and validity.

Note  This function does not preserve boundaries shared between polygons. Use [ST_CoverageSimplify](#) if this is required.

Note  `ST_SimplifyVW(geom, tolerance)` is deprecated. Use `ST_Simplify(geom, tolerance)` instead.

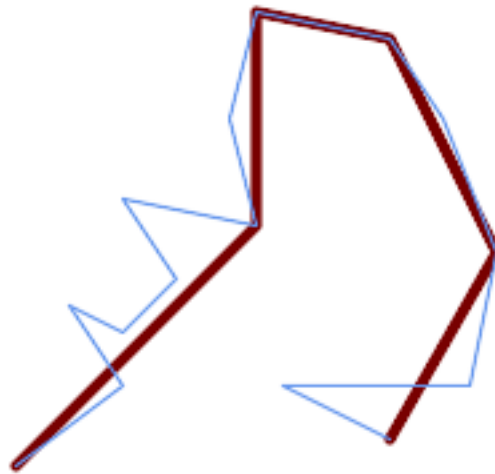
2.2.0 `ST_SimplifyVW(geom, tolerance)`.

A LineString is simplified with a minimum-area tolerance of 30.

```
SELECT ST_AsText(ST_SimplifyVW(geom,30)) simplified
FROM (SELECT 'LINESTRING(5 2, 3 8, 6 20, 7 25, 10 10)::geometry AS geom) AS t;

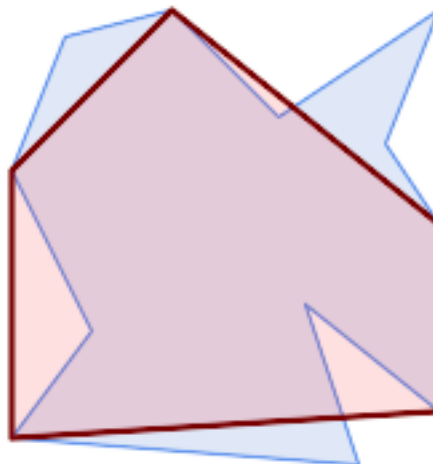
simplified
-----
LINESTRING(5 2,7 25,10 10)
```

Simplifying a line.



```
SELECT ST_SimplifyVW(
  'LINESTRING (10 10, 50 40, 30 70, 50 60, 70 80, 50 110, 100 100, 90 140, 100 180, 150 ←
    170, 170 140, 190 90, 180 40, 110 40, 150 20)',
  1600);
```

Simplifying a polygon.



```
SELECT ST_SimplifyVW(
  'MULTIPOLYGON (((90 110, 80 180, 50 160, 10 170, 10 140, 20 110, 90 110)), ((40 80, 100 ←
    100, 120 160, 170 180, 190 70, 140 10, 110 40, 60 40, 40 80), (180 70, 170 110, 142.5 ←
    128.5, 128.5 77.5, 90 60, 180 70))))',
  40);
```

☒☒

[ST_SetEffectiveArea](#), [ST_Simplify](#), [ST_SimplifyPreserveTopology](#), [ST_CoverageSimplify](#), [Topology ST_Simpl](#)

7.14.26 ST_SetEffectiveArea

`ST_SetEffectiveArea` — Sets the effective area for each vertex, using the Visvalingam-Whyatt algorithm.

Synopsis

geometry **ST_SetEffectiveArea**(geometry geom, float threshold = 0, integer set_area = 1);

Geometry

Removes the area of a geometry that is smaller than the specified threshold. If the set_area parameter is set to 1, the geometry is returned as a single point. If set_area is 0, the geometry is returned as a multi-point. If set_area is 2, the geometry is returned as a multi-line. If set_area is 3, the geometry is returned as a multi-polygon.

The threshold parameter is a float value representing the area of the geometry. The default value is 0. The set_area parameter is an integer value representing the type of geometry to return. The default value is 1.

Examples: ST_SetEffectiveArea('POINT(1 1)', 0.5, 1) returns POINT(1 1). ST_SetEffectiveArea('POINT(1 1)', 0.5, 0) returns MULTIPOINT(1 1). ST_SetEffectiveArea('POINT(1 1)', 0.5, 2) returns MULTIPOINT(1 1). ST_SetEffectiveArea('POINT(1 1)', 0.5, 3) returns MULTIPOINT(1 1).



Note

ST_IsSimple is used to check if the geometry is simple.



Note

ST_SimplifyPreserveTopology is used to simplify the geometry while preserving topology.



Note

The M parameter is used to specify the multi-point geometry.



Note

The threshold parameter is a float value representing the area of the geometry.

2.2.0 Examples

Geometry

Removes the area of a geometry that is smaller than the specified threshold. If the set_area parameter is set to 1, the geometry is returned as a single point. If set_area is 0, the geometry is returned as a multi-point. If set_area is 2, the geometry is returned as a multi-line. If set_area is 3, the geometry is returned as a multi-polygon.

```
select ST_AsText(ST_SetEffectiveArea(geom)) all_pts, ST_AsText(ST_SetEffectiveArea(geom,30) ←
) thrshld_30
FROM (SELECT 'LINESTRING(5 2, 3 8, 6 20, 7 25, 10 10)::geometry geom) As foo;
-result
all_pts | thrshld_30
-----+-----
LINESTRING M (5 2 3.40282346638529e+38,3 8 29,6 20 1.5,7 25 49.5,10 10 3.40282346638529e ←
+38) | LINESTRING M (5 2 3.40282346638529e+38,7 25 49.5,10 10 3.40282346638529e+38)
```


☒☒

[ST_SimplifyVW](#)

7.14.27 ST_TriangulatePolygon

ST_TriangulatePolygon — Computes the constrained Delaunay triangulation of polygons

Synopsis

geometry **ST_TriangulatePolygon**(geometry geom);

☒☒

Computes the constrained Delaunay triangulation of polygons. Holes and Multipolygons are supported.

The “constrained Delaunay triangulation” of a polygon is a set of triangles formed from the vertices of the polygon, and covering it exactly, with the maximum total interior angle over all possible triangulations. It provides the “best quality” triangulation of the polygon.

Availability: 3.3.0.

Requires GEOS >= 3.11.0.

☒☒

Triangulation of a square.

```
SELECT ST_AsText(
  ST_TriangulatePolygon('POLYGON((0 0, 0 1, 1 1, 1 0, 0 0))');

```

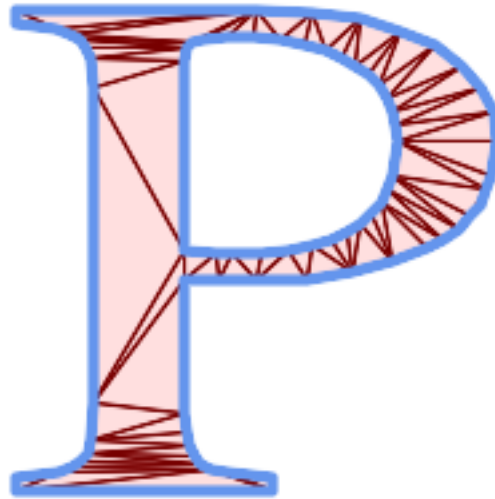
st_astext

GEOMETRYCOLLECTION(POLYGON((0 0,0 1,1 1,0 0)),POLYGON((1 1,1 0,0 0,1 1)))

☒☒

Triangulation of the letter P.

```
SELECT ST_AsText(ST_TriangulatePolygon(
  'POLYGON ((26 17, 31 19, 34 21, 37 24, 38 29, 39 43, 39 161, 38 172, 36 176, 34 179, 30 ←
    181, 25 183, 10 185, 10 190, 100 190, 121 189, 139 187, 154 182, 167 177, 177 169, ←
    184 161, 189 152, 190 141, 188 128, 186 123, 184 117, 180 113, 176 108, 170 104, 164 ←
    101, 151 96, 136 92, 119 89, 100 89, 86 89, 73 89, 73 39, 74 32, 75 27, 77 23, 79 ←
    20, 83 18, 89 17, 106 15, 106 10, 10 10, 10 15, 26 17), (152 147, 151 152, 149 157, ←
    146 162, 142 166, 137 169, 132 172, 126 175, 118 177, 109 179, 99 180, 89 180, 80 ←
    179, 76 178, 74 176, 73 171, 73 100, 85 99, 91 99, 102 99, 112 100, 121 102, 128 ←
    104, 134 107, 139 110, 143 114, 147 118, 149 123, 151 128, 153 141, 152 147))'
));
```



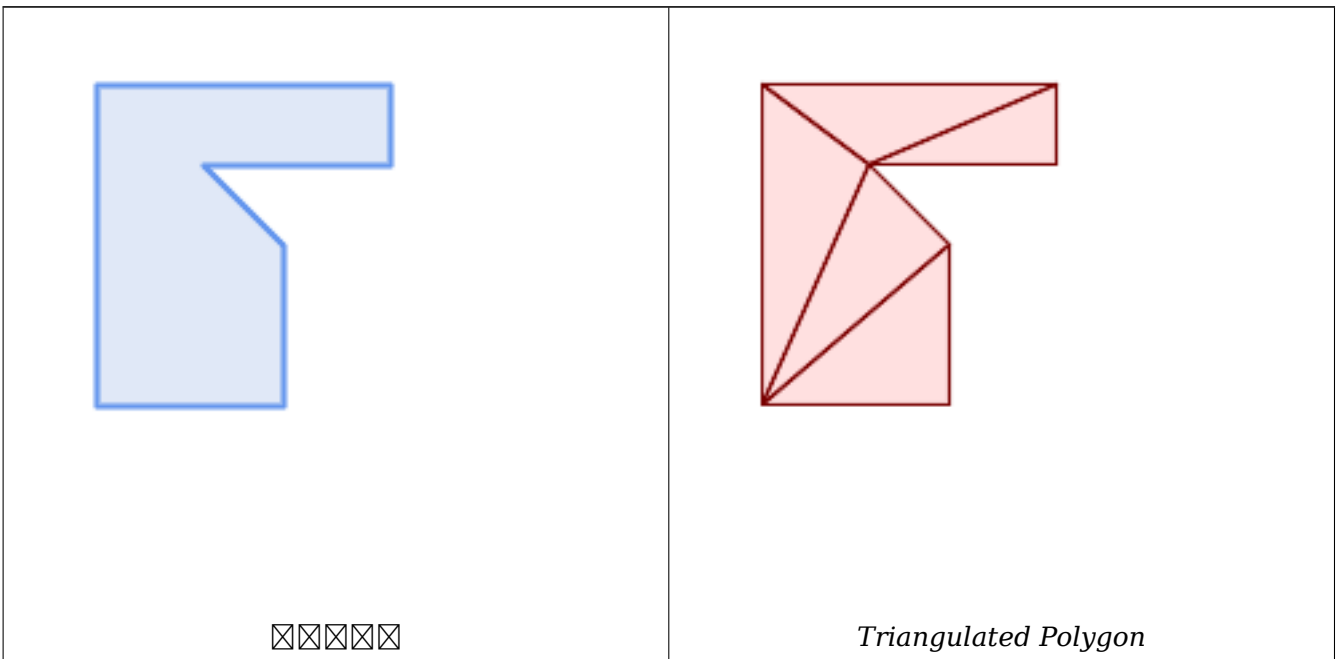
Polygon Triangulation

Same example as ST_Tessellate

```
SELECT ST_TriangulatePolygon(
    'POLYGON (( 10 190, 10 70, 80 70, 80 130, 50 160, 120 160, 120 190, 10 190 ←
    ))'::geometry
);
```

ST_AsText ☒☒☒:

```
GEOMETRYCOLLECTION(POLYGON((50 160,120 190,120 160,50 160))
, POLYGON((10 70,80 130,80 70,10 70))
, POLYGON((50 160,10 70,10 190,50 160))
, POLYGON((120 190,50 160,10 190,120 190))
, POLYGON((80 130,10 70,50 160,80 130)))
```



☒☒

[ST_ConstrainedDelaunayTriangles](#), [ST_DelaunayTriangles](#), [ST_Tessellate](#)

7.14.28 ST_VoronoiLines

ST_VoronoiLines — Returns the boundaries of the Voronoi diagram of the vertices of a geometry.

Synopsis

geometry **ST_VoronoiLines**(geometry geom , float8 tolerance = 0.0 , geometry extend_to = NULL);

☒☒

Computes a two-dimensional **Voronoi diagram** from the vertices of the supplied geometry and returns the boundaries between cells in the diagram as a MultiLineString. Returns null if input geometry is null. Returns an empty geometry collection if the input geometry contains only one vertex. Returns an empty geometry collection if the extend_to envelope has zero area.

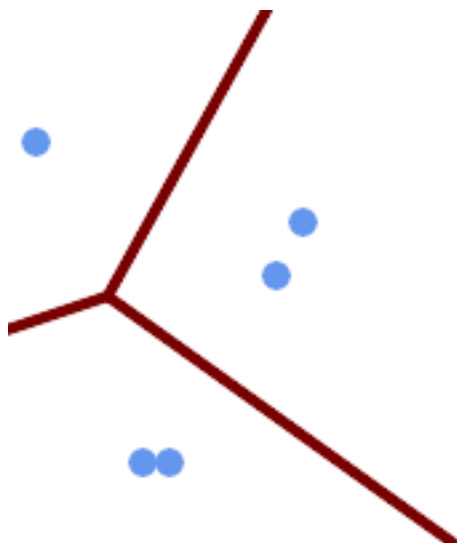
☒☒☒☒☒☒☒☒☒☒:

- **tolerance**: The distance within which vertices will be considered equivalent. Robustness of the algorithm can be improved by supplying a nonzero tolerance distance. (default = 0.0)
- **extend_to**: If present, the diagram is extended to cover the envelope of the supplied geometry, unless smaller than the default envelope (default = NULL, default envelope is the bounding box of the input expanded by about 50%).

GEOS ☒☒☒☒☒

2.3.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒



Voronoi diagram lines, with tolerance of 30 units

```
SELECT ST_VoronoiLines(
  'MULTIPOINT (50 30, 60 30, 100 100,10 150, 110 120)::geometry,
  30) AS geom;
```

ST_AsText output

```
MULTILINESTRING((135.555555555556 270,36.8181818181818 92.2727272727273),(36.8181818181818 92.2727272727273,-110 43.3333333333333),(230 -45.7142857142858,36.8181818181818 92.2727272727273))
```

☒☒

[ST_DelaunayTriangles](#), [ST_VoronoiPolygons](#)

7.14.29 ST_VoronoiPolygons

`ST_VoronoiPolygons` — Returns the cells of the Voronoi diagram of the vertices of a geometry.

Synopsis

```
geometry ST_VoronoiPolygons( geometry geom , float8 tolerance = 0.0 , geometry extend_to = NULL );
```

☒☒

Computes a two-dimensional **Voronoi diagram** from the vertices of the supplied geometry. The result is a `GEOMETRYCOLLECTION` of `POLYGON`s that covers an envelope larger than the extent of the input vertices. Returns null if input geometry is null. Returns an empty geometry collection if the input geometry contains only one vertex. Returns an empty geometry collection if the `extend_to` envelope has zero area.

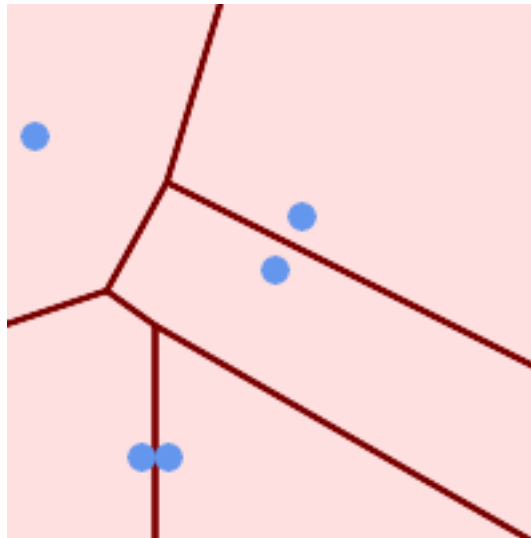
☒☒☒☒☒☒☒☒☒☒:

- **tolerance**: The distance within which vertices will be considered equivalent. Robustness of the algorithm can be improved by supplying a nonzero tolerance distance. (default = 0.0)
- **extend_to**: If present, the diagram is extended to cover the envelope of the supplied geometry, unless smaller than the default envelope (default = NULL, default envelope is the bounding box of the input expanded by about 50%).

GEOS ☒☒☒☒☒

2.3.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

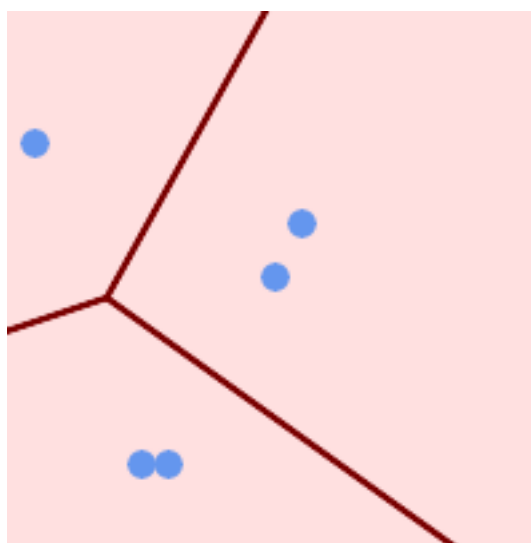


Points overlaid on top of Voronoi diagram

```
SELECT ST_VoronoiPolygons(
    'MULTIPOINT (50 30, 60 30, 100 100,10 150, 110 120)>::geometry
) AS geom;
```

ST_AsText output

```
GEOMETRYCOLLECTION(POLYGON((-110 43.33333333333333, -110 270,100.5 270,59.3478260869565 ↔
    132.826086956522,36.8181818181818 92.2727272727273, -110 43.3333333333333)),
POLYGON((55 -90, -110 -90, -110 43.3333333333333,36.8181818181818 92.2727272727273,55 ↔
    79.2857142857143,55 -90)),
POLYGON((230 47.5,230 -20.7142857142857,55 79.2857142857143,36.8181818181818 ↔
    92.2727272727273,59.3478260869565 132.826086956522,230 47.5)),POLYGON((230 ↔
    -20.7142857142857,230 -90,55 -90,55 79.2857142857143,230 -20.7142857142857)),
POLYGON((100.5 270,230 270,230 47.5,59.3478260869565 132.826086956522,100.5 270)))
```



Voronoi diagram, with tolerance of 30 units

```
SELECT ST_VoronoiPolygons(
  'MULTIPOINT (50 30, 60 30, 100 100,10 150, 110 120)::geometry,
  30) AS geom;
```

ST_AsText output

```
GEOMETRYCOLLECTION(POLYGON((-110 43.3333333333333, -110 270,100.5 270,59.3478260869565 ↔
  132.826086956522,36.8181818181818 92.2727272727273, -110 43.3333333333333)),
POLYGON((230 47.5,230 -45.7142857142858,36.8181818181818 92.2727272727273,59.3478260869565 ↔
  132.826086956522,230 47.5)),POLYGON((230 -45.7142857142858,230 -90,-110 -90,-110 ↔
  43.3333333333333,36.8181818181818 92.2727272727273,230 -45.7142857142858)),
POLYGON((100.5 270,230 270,230 47.5,59.3478260869565 132.826086956522,100.5 270)))
```

☒☒

[ST_DelaunayTriangles](#), [ST_VoronoiLines](#)

7.15 Coverages

7.15.1 ST_CoverageInvalidEdges

`ST_CoverageInvalidEdges` — Window function that finds locations where polygons fail to form a valid coverage.

Synopsis

geometry **ST_CoverageInvalidEdges**(geometry winset geom, float8 tolerance = 0);

☒☒

A window function which checks if the polygons in the window partition form a valid polygonal coverage. It returns linear indicators showing the location of invalid edges (if any) in each polygon.

A set of valid polygons is a valid coverage if the following conditions hold:

- **Non-overlapping** - polygons do not overlap (their interiors do not intersect)
- **Edge-Matched** - vertices along shared edges are identical

As a window function a value is returned for every input polygon. For polygons which violate one or more of the validity conditions the return value is a MULTILINESTRING containing the problematic edges. Coverage-valid polygons return the value NULL. Non-polygonal or empty geometries also produce NULL values.

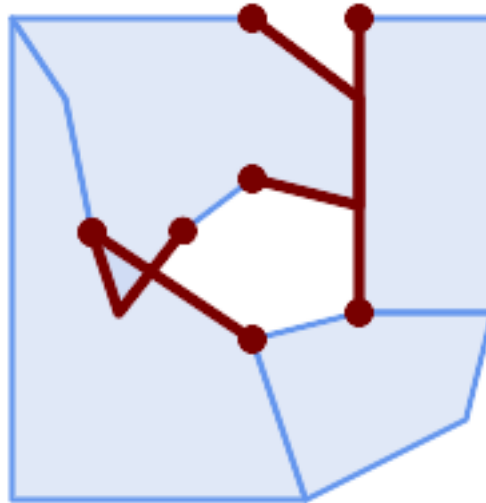
The conditions allow a valid coverage to contain holes (gaps between polygons), as long as the surrounding polygons are edge-matched. However, very narrow gaps are often undesirable. If the *tolerance* parameter is specified with a non-zero distance, edges forming narrower gaps will also be returned as invalid.

The polygons being checked for coverage validity must also be valid geometries. This can be checked with [ST_IsValid](#).

Availability: 3.4.0

Requires GEOS >= 3.12.0

☒☒



Invalid edges caused by overlap and non-matching vertices

```
WITH coverage(id, geom) AS (VALUES
  (1, 'POLYGON ((10 190, 30 160, 40 110, 100 70, 120 10, 10 10, 10 190))'::geometry),
  (2, 'POLYGON ((100 190, 10 190, 30 160, 40 110, 50 80, 74 110.5, 100 130, 140 120, 140 160, 100 190))'::geometry),
  (3, 'POLYGON ((140 190, 190 190, 190 80, 140 80, 140 190))'::geometry),
  (4, 'POLYGON ((180 40, 120 10, 100 70, 140 80, 190 80, 180 40))'::geometry)
)
SELECT id, ST_AsText(ST_CoverageInvalidEdges(geom) OVER ())
FROM coverage;
```

id	st_astext
1	LINestring (40 110, 100 70)
2	MULTILINestring ((100 130, 140 120, 140 160, 100 190), (40 110, 50 80, 74 110.5))
3	LINestring (140 80, 140 190)
4	null

```
-- Test entire table for coverage validity
SELECT true = ALL (
  SELECT ST_CoverageInvalidEdges(geom) OVER () IS NULL
  FROM coverage
);
```

☒☒

[ST_IsValid](#), [ST_CoverageUnion](#), [ST_CoverageSimplify](#)

7.15.2 ST_CoverageSimplify

ST_CoverageSimplify — Window function that simplifies the edges of a polygonal coverage.

Synopsis

geometry **ST_CoverageSimplify**(geometry winset geom, float8 tolerance, boolean simplifyBoundary = true);

☒☒

A window function which simplifies the edges of polygons in a polygonal coverage. The simplification preserves the coverage topology. This means the simplified output polygons are consistent along shared edges, and still form a valid coverage.

The simplification uses a variant of the **Visvalingam-Whyatt algorithm**. The *tolerance* parameter has units of distance, and is roughly equal to the square root of triangular areas to be simplified.

To simplify only the "internal" edges of the coverage (those that are shared by two polygons) set the *simplifyBoundary* parameter to false.



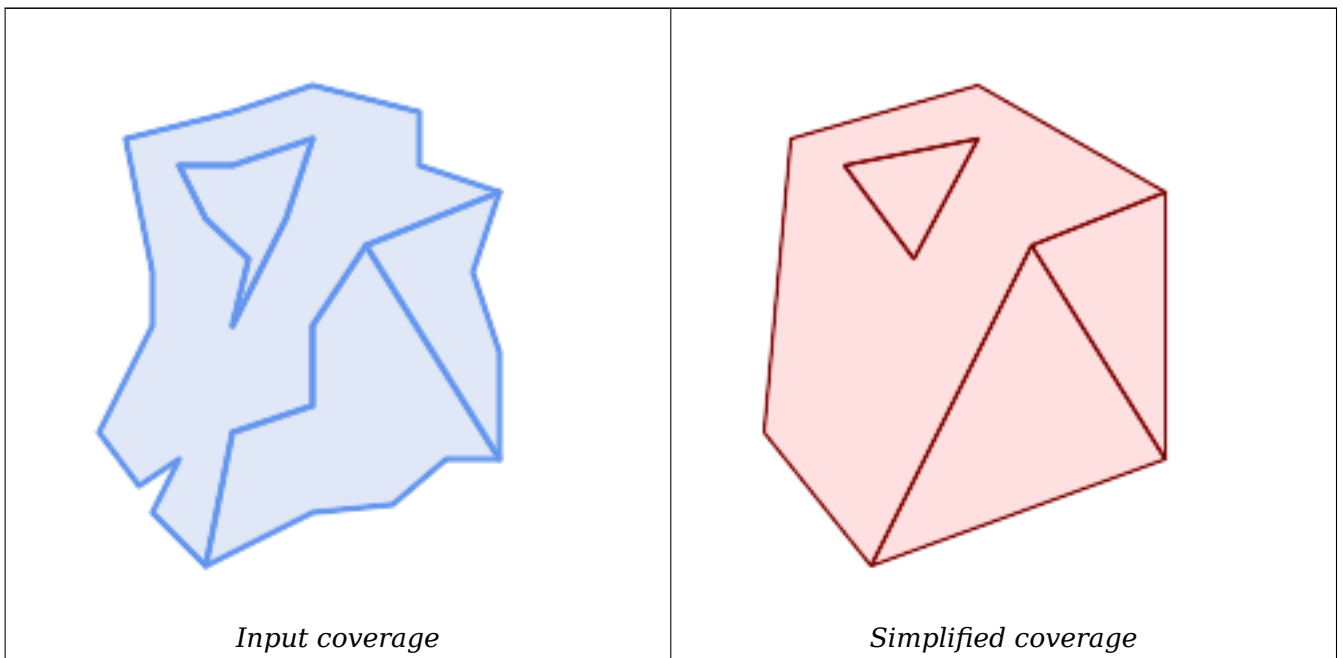
Note

If the input is not a valid coverage there may be unexpected artifacts in the output (such as boundary intersections, or separated boundaries which appeared to be shared). Use **ST_CoverageInvalidEdges** to determine if a coverage is valid.

Availability: 3.4.0

Requires GEOS >= 3.12.0

☒☒



```
WITH coverage(id, geom) AS (VALUES
(1, 'POLYGON ((160 150, 110 130, 90 100, 90 70, 60 60, 50 10, 30 30, 40 50, 25 40, 10 60, ←
30 100, 30 120, 20 170, 60 180, 90 190, 130 180, 130 160, 160 150), (40 160, 50 140, ←
66 125, 60 100, 80 140, 90 170, 60 160, 40 160))'::geometry),
```



```

(2, 'POLYGON ((40 160, 60 160, 90 170, 80 140, 60 100, 66 125, 50 140, 40 160))':: geometry),
(3, 'POLYGON ((110 130, 160 50, 140 50, 120 33, 90 30, 50 10, 60 60, 90 70, 90 100, 110 130))'::geometry),
(4, 'POLYGON ((160 150, 150 120, 160 90, 160 50, 110 130, 160 150))'::geometry)
)
SELECT id, ST_AsText(ST_CoverageSimplify(geom, 30) OVER ())
FROM coverage;

id | st_astext
---+-----
 1 | POLYGON ((160 150, 110 130, 50 10, 10 60, 20 170, 90 190, 160 150), (40 160, 66 125, 90 170, 40 160))
 2 | POLYGON ((40 160, 66 125, 90 170, 40 160))
 3 | POLYGON ((110 130, 160 50, 50 10, 110 130))
 4 | POLYGON ((160 150, 160 50, 110 130, 160 150))

```



ST_CoverageInvalidEdges

7.15.3 ST_CoverageUnion


ST_CoverageUnion — Computes the union of a set of polygons forming a coverage by removing shared edges.

Synopsis

geometry **ST_CoverageUnion**(geometry set geom);



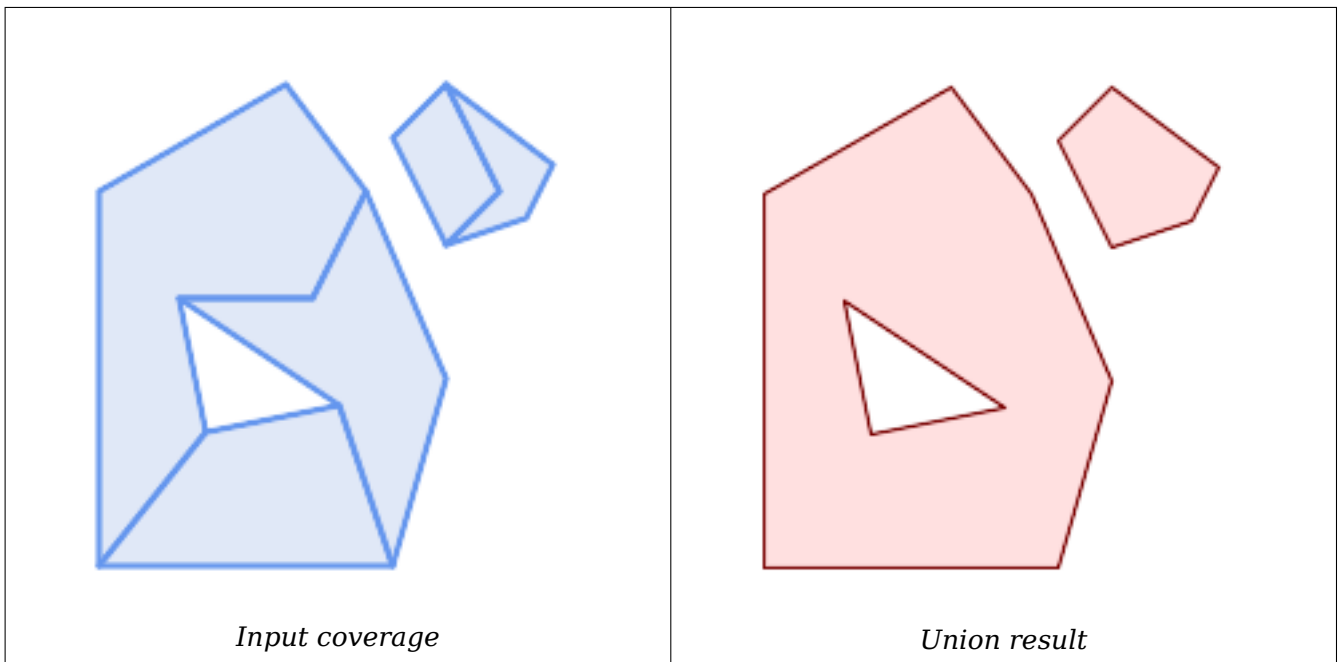
An aggregate function which unions a set of polygons forming a polygonal coverage. The result is a polygonal geometry covering the same area as the coverage. This function produces the same result as **ST_Union**, but uses the coverage structure to compute the union much faster.

 **Note** If the input is not a valid coverage there may be unexpected artifacts in the output (such as unmerged or overlapping polygons). Use **ST_CoverageInvalidEdges** to determine if a coverage is valid.

Availability: 3.4.0 - requires GEOS >= 3.8.0



--	--



```
WITH coverage(id, geom) AS (VALUES
  (1, 'POLYGON ((10 10, 10 150, 80 190, 110 150, 90 110, 40 110, 50 60, 10 10))'::geometry) ←
  (2, 'POLYGON ((120 10, 10 10, 50 60, 100 70, 120 10))'::geometry),
  (3, 'POLYGON ((140 80, 120 10, 100 70, 40 110, 90 110, 110 150, 140 80))'::geometry),
  (4, 'POLYGON ((140 190, 120 170, 140 130, 160 150, 140 190))'::geometry),
  (5, 'POLYGON ((180 160, 170 140, 140 130, 160 150, 140 190, 180 160))'::geometry)
)
SELECT ST_AsText(ST_CoverageUnion(geom))
FROM coverage;

-----
MULTIPOLYGON (((10 150, 80 190, 110 150, 140 80, 120 10, 10 10, 10 150), (50 60, 100 70, 40 ←
  110, 50 60)), ((120 170, 140 190, 180 160, 170 140, 140 130, 120 170)))
```

☒☒

[ST_CoverageInvalidEdges](#), [ST_AsBinary](#)

7.16 Affine Transformations

7.16.1 ST_Affine

ST_Affine — Apply a 3D affine transformation to a geometry.

Synopsis

geometry **ST_Affine**(geometry geomA, float a, float b, float c, float d, float e, float f, float g, float h, float i, float xoff, float yoff, float zoff);
 geometry **ST_Affine**(geometry geomA, float a, float b, float d, float e, float xoff, float yoff);

ST_Affine

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.

ST_Affine: 2.0.0 **ST_Affine**, **ST_Affine** TIN **ST_Affine**.

Availability: 1.1.2. Name changed from **Affine** to **ST_Affine** in 1.2.2



Note

1.3.4 **ST_Affine** (curve) **ST_Affine**. 1.3.4 **ST_Affine**.

- This function supports Polyhedral surfaces.
- This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).
- This function supports 3d and will not drop the z-index.
- This method supports Circular Strings and Curves.

☒☒

```
--Rotate a 3d line 180 degrees about the z axis. Note this is long-hand for doing ↵
ST_Rotate();
SELECT ST_AsEWKT(ST_Affine(geom, cos(pi()), -sin(pi()), 0, sin(pi()), cos(pi()), 0, 0, ↵
    0, 1, 0, 0, 0)) As using_affine,
    ST_AsEWKT(ST_Rotate(geom, pi())) As using_rotate
FROM (SELECT ST_GeomFromEWKT('LINESTRING(1 2 3, 1 4 3)') As geom) As foo;
-----+-----
LINESTRING(-1 -2 3,-1 -4 3) | LINESTRING(-1 -2 3,-1 -4 3)
(1 row)

--Rotate a 3d line 180 degrees in both the x and z axis
SELECT ST_AsEWKT(ST_Affine(geom, cos(pi()), -sin(pi()), 0, sin(pi()), cos(pi()), -sin(pi()) ↵
    , 0, sin(pi()), cos(pi()), 0, 0, 0))
FROM (SELECT ST_GeomFromEWKT('LINESTRING(1 2 3, 1 4 3)') As geom) As foo;
    st_asewkt
-----
LINESTRING(-1 -2 -3,-1 -4 -3)
(1 row)
```

☒☒

[ST_Rotate](#), [ST_Scale](#), [ST_Translate](#), [ST_TransScale](#)

7.16.2 ST_Rotate

`ST_Rotate` — Rotates a geometry about an origin point.

Synopsis

```
geometry ST_Rotate(geometry geomA, float rotRadians);
geometry ST_Rotate(geometry geomA, float rotRadians, float x0, float y0);
geometry ST_Rotate(geometry geomA, float rotRadians, geometry pointOrigin);
```

☒☒

Rotates geometry `rotRadians` counter-clockwise about the origin point. The rotation origin can be specified either as a POINT geometry, or as x and y coordinates. If the origin is not specified, the geometry is rotated about POINT(0 0).

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒, ☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒.

Enhanced: 2.0.0 additional parameters for specifying the origin of rotation were added.

Availability: 1.1.2. Name changed from `Rotate` to `ST_Rotate` in 1.2.2



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



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
--Rotate 180 degrees
SELECT ST_AsEWKT(ST_Rotate('LINESTRING (50 160, 50 50, 100 50)', pi()));
           st_asewkt
-----
LINESTRING(-50 -160,-50 -50,-100 -50)
(1 row)

--Rotate 30 degrees counter-clockwise at x=50, y=160
SELECT ST_AsEWKT(ST_Rotate('LINESTRING (50 160, 50 50, 100 50)', pi()/6, 50, 160));
           st_asewkt
-----
LINESTRING(50 160,105 64.7372055837117,148.301270189222 89.7372055837117)
(1 row)

--Rotate 60 degrees clockwise from centroid
SELECT ST_AsEWKT(ST_Rotate(geom, -pi()/3, ST_Centroid(geom)))
FROM (SELECT 'LINESTRING (50 160, 50 50, 100 50)::geometry AS geom) AS foo;
           st_asewkt
-----
LINESTRING(116.4225 130.6721,21.1597 75.6721,46.1597 32.3708)
(1 row)
```

☒☒

[ST_Affine](#), [ST_RotateX](#), [ST_RotateY](#), [ST_RotateZ](#)

7.16.3 ST_RotateX

ST_RotateX — Rotates a geometry about the X axis.

Synopsis

geometry **ST_RotateX**(geometry geomA, float rotRadians);

☒☒

Rotates a geometry geomA - rotRadians about the X axis.



Note

ST_RotateX(geomA, rotRadians) is short-hand for ST_Affine(geomA, 1, 0, 0, 0, cos(rotRadians), -sin(rotRadians), 0, sin(rotRadians), cos(rotRadians), 0, 0, 0).

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒, ☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒.

Availability: 1.1.2. Name changed from RotateX to ST_RotateX in 1.2.2



This function supports Polyhedral surfaces.



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



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
--Rotate a line 90 degrees along x-axis
SELECT ST_AsEWKT(ST_RotateX(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), pi()/2));
           st_asewkt
-----
LINESTRING(1 -3 2,1 -1 1)
```

☒☒

[ST_Affine](#), [ST_RotateY](#), [ST_RotateZ](#)

7.16.4 ST_RotateY

ST_RotateY — Rotates a geometry about the Y axis.

Synopsis

geometry **ST_RotateY**(geometry geomA, float rotRadians);

☒☒

Rotates a geometry geomA - rotRadians about the y axis.



Note

ST_RotateY(geomA, rotRadians) is short-hand for ST_Affine(geomA, cos(rotRadians), 0, sin(rotRadians), 0, 1, 0, -sin(rotRadians), 0, cos(rotRadians), 0, 0, 0).

Availability: 1.1.2. Name changed from RotateY to ST_RotateY in 1.2.2

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒, ☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒.



This function supports Polyhedral surfaces.



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



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
--Rotate a line 90 degrees along y-axis
SELECT ST_AsEWKT(ST_RotateY(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), pi()/2));
           st_asewkt
-----
LINESTRING(3 2 -1,1 1 -1)
```

☒☒

[ST_Affine](#), [ST_RotateX](#), [ST_RotateZ](#)

7.16.5 ST_RotateZ

ST_RotateZ — Rotates a geometry about the Z axis.

Synopsis

geometry **ST_RotateZ**(geometry geomA, float rotRadians);

⊠

Rotates a geometry geomA - rotRadians about the Z axis.



Note

This is a synonym for ST_Rotate



Note

ST_RotateZ(geomA, rotRadians) is short-hand for SELECT ST_Affine(geomA, cos(rotRadians), -sin(rotRadians), 0, sin(rotRadians), cos(rotRadians), 0, 0, 0, 1, 0, 0, 0).

⊠: 2.0.0 ⊠, ⊠ TIN ⊠.

Availability: 1.1.2. Name changed from RotateZ to ST_RotateZ in 1.2.2



Note

1.3.4 ⊠ (curve) ⊠. 1.3.4 ⊠.

- ✔ This function supports 3d and will not drop the z-index.
- ✔ This method supports Circular Strings and Curves.
- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

⊠

```
--Rotate a line 90 degrees along z-axis
SELECT ST_AsEWKT(ST_RotateZ(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), pi()/2));
           st_asewkt
-----
LINESTRING(-2 1 3,-1 1 1)

--Rotate a curved circle around z-axis
SELECT ST_AsEWKT(ST_RotateZ(geom, pi()/2))
FROM (SELECT ST_LineToCurve(ST_Buffer(ST_GeomFromText('POINT(234 567)'), 3)) As geom) As foo;
```

```
CURVEPOLYGON(CIRCULARSTRING(-567 237,-564.87867965644 236.12132034356,-564 234,-569.12132034356 231.87867965644,-567 237))
```



[ST_Affine](#), [ST_RotateX](#), [ST_RotateY](#)

7.16.6 ST_Scale

ST_Scale — Scales a geometry by given factors.

Synopsis

```
geometry ST_Scale(geometry geomA, float XFactor, float YFactor, float ZFactor);
geometry ST_Scale(geometry geomA, float XFactor, float YFactor);
geometry ST_Scale(geometry geom, geometry factor);
geometry ST_Scale(geometry geom, geometry factor, geometry origin);
```



Scales the geometry to a new size by multiplying the ordinates with the corresponding factor parameters.

The version taking a geometry as the factor parameter allows passing a 2d, 3dm, 3dz or 4d point to set scaling factor for all supported dimensions. Missing dimensions in the factor point are equivalent to no scaling the corresponding dimension.

The three-geometry variant allows a "false origin" for the scaling to be passed in. This allows "scaling in place", for example using the centroid of the geometry as the false origin. Without a false origin, scaling takes place relative to the actual origin, so all coordinates are just multiplied by the scale factor.



Note

1.3.4 (curve) . 1.3.4

Availability: 1.1.0.

: 2.0.0 , TIN

Enhanced: 2.2.0 support for scaling all dimension (factor parameter) was introduced.

Enhanced: 2.5.0 support for scaling relative to a local origin (origin parameter) was introduced.



This function supports Polyhedral surfaces.



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

- ☑ This method supports Circular Strings and Curves.
- ☑ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).
- ☑ This function supports M coordinates.

☒☒

```

--Version 1: scale X, Y, Z
SELECT ST_AsEWKT(ST_Scale(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), 0.5, 0.75, 0.8));
           st_asewkt
-----
LINESTRING(0.5 1.5 2.4,0.5 0.75 0.8)

--Version 2: Scale X Y
SELECT ST_AsEWKT(ST_Scale(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), 0.5, 0.75));
           st_asewkt
-----
LINESTRING(0.5 1.5 3,0.5 0.75 1)

--Version 3: Scale X Y Z M
SELECT ST_AsEWKT(ST_Scale(ST_GeomFromEWKT('LINESTRING(1 2 3 4, 1 1 1 1)'),
  ST_MakePoint(0.5, 0.75, 2, -1)));
           st_asewkt
-----
LINESTRING(0.5 1.5 6 -4,0.5 0.75 2 -1)

--Version 4: Scale X Y using false origin
SELECT ST_AsText(ST_Scale('LINESTRING(1 1, 2 2)', 'POINT(2 2)', 'POINT(1 1)::geometry'));
           st_astext
-----
LINESTRING(1 1,3 3)

```

☒☒

ST_Affine, ST_TransScale

7.16.7 ST_Translate

ST_Translate — Translates a geometry by given offsets.

Synopsis

```

geometry ST_Translate(geometry g1, float deltax, float deltax);
geometry ST_Translate(geometry g1, float deltax, float deltax, float deltax);

```

☒☒

Returns a new geometry whose coordinates are translated delta x,delta y,delta z units. Units are based on the units defined in spatial reference (SRID) for this geometry.

**Note**

1.3.4 `ST_Translate` (curve) `ST_Translate`. 1.3.4 `ST_Translate`.

1.2.2 `ST_Translate`.

- This function supports 3d and will not drop the z-index.
- This method supports Circular Strings and Curves.

`ST`

Move a point 1 degree longitude

```
SELECT ST_AsText(ST_Translate(ST_GeomFromText('POINT(-71.01 42.37)',4326),1,0)) As
  wgs_transgeomtxt;

  wgs_transgeomtxt
  -----
  POINT(-70.01 42.37)
```

Move a linestring 1 degree longitude and 1/2 degree latitude

```
SELECT ST_AsText(ST_Translate(ST_GeomFromText('LINESTRING(-71.01 42.37,-71.11 42.38)',4326)
  ,1,0.5)) As wgs_transgeomtxt;
  wgs_transgeomtxt
  -----
  LINESTRING(-70.01 42.87,-70.11 42.88)
```

Move a 3d point

```
SELECT ST_AsEWKT(ST_Translate(CAST('POINT(0 0 0)' As geometry), 5, 12,3));
  st_asewkt
  -----
  POINT(5 12 3)
```

Move a curve and a point

```
SELECT ST_AsText(ST_Translate(ST_Collect('CURVEPOLYGON(CIRCULARSTRING(4 3,3.12 0.878,1
  0,-1.121 5.1213,6 7, 8 9,4 3))','POINT(1 3)'),1,2));

-----

GEOMETRYCOLLECTION(CURVEPOLYGON(CIRCULARSTRING(5 5,4.12 2.878,2 2,-0.121 7.1213,7 9,9 11,5
  5)),POINT(2 5))
```

`ST`

[ST_Affine](#), [ST_AsText](#), [ST_GeomFromText](#)

7.16.8 ST_TransScale

`ST_TransScale` — Translates and scales a geometry by given offsets and factors.

Synopsis

geometry **ST_TransScale**(geometry geomA, float deltaX, float deltaY, float XFactor, float YFactor);

Translates the geometry using the deltaX and deltaY args, then scales it using the XFactor, YFactor args, working in 2D only.



Note

ST_TransScale(geomA, deltaX, deltaY, XFactor, YFactor) is short-hand for ST_Affine(geomA, XFactor, 0, 0, 0, YFactor, 0, 0, 0, 1, deltaX*XFactor, deltaY*YFactor, 0).



Note

1.3.4 (curve) 1.3.4

Availability: 1.1.0.



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



This method supports Circular Strings and Curves.

```
SELECT ST_AsEWKT(ST_TransScale(ST_GeomFromEWKT('LINESTRING(1 2 3, 1 1 1)'), 0.5, 1, 1, 2));
           st_asewkt
```

```
-----
LINESTRING(1.5 6 3,1.5 4 1)
```

```
--Buffer a point to get an approximation of a circle, convert to curve and then translate ↔
1,2 and scale it 3,4
```

```
SELECT ST_AsText(ST_Transscale(ST_LineToCurve(ST_Buffer('POINT(234 567)', 3)),1,2,3,4));
```

```
-----
CURVEPOLYGON(CIRCULARSTRING(714 2276,711.363961030679 2267.51471862576,705 ↔
2264,698.636038969321 2284.48528137424,714 2276))
```

ST_Affine, ST_Translate

7.17 Clustering Functions

7.17.1 ST_ClusterDBSCAN

ST_ClusterDBSCAN — Window function that returns a cluster id for each input geometry using the DBSCAN algorithm.

Synopsis

integer **ST_ClusterDBSCAN**(geometry winset geom, float8 eps, integer minpoints);

A window function that returns a cluster number for each input geometry, using the 2D **Density-based spatial clustering of applications with noise (DBSCAN)** algorithm. Unlike **ST_ClusterKMeans**, it does not require the number of clusters to be specified, but instead uses the desired **distance** (eps) and density (minpoints) parameters to determine each cluster.

An input geometry is added to a cluster if it is either:

- A "core" geometry, that is within eps **distance** of at least minpoints input geometries (including itself); or
- A "border" geometry, that is within eps **distance** of a core geometry.

Note that border geometries may be within eps distance of core geometries in more than one cluster. Either assignment would be correct, so the border geometry will be arbitrarily assigned to one of the available clusters. In this situation it is possible for a correct cluster to be generated with fewer than minpoints geometries. To ensure deterministic assignment of border geometries (so that repeated calls to ST_ClusterDBSCAN will produce identical results) use an ORDER BY clause in the window definition. Ambiguous cluster assignments may differ from other DBSCAN implementations.



Note

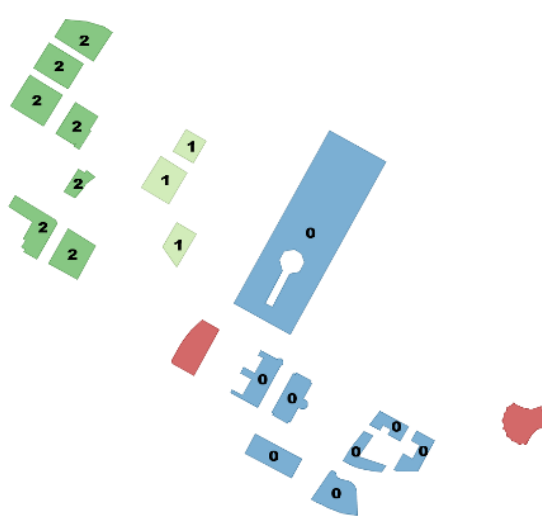
Geometries that do not meet the criteria to join any cluster are assigned a cluster number of NULL.

2.3.0



This method supports Circular Strings and Curves.

Clustering polygon within 50 meters of each other, and requiring at least 2 polygons per cluster.



Clusters within 50 meters with at least 2 items per cluster. Singletons have NULL for cid

```

SELECT name, ST_ClusterDBSCAN(geom, eps = > 50, minpoints = > 2) over () AS cid
FROM boston_polys
WHERE name
> '' AND building
> ''
      AND ST_DWithin(geom,
      ST_Transform(
        ST_GeomFromText('POINT ↵
        (-71.04054 42.35141)', 4326), 26986),
        500);
        
```

bucket	name	↵
Manulife Tower		↵
0		
Park Lane Seaport I		↵
0		
Park Lane Seaport II		↵
0		
Renaissance Boston Waterfront Hotel		↵
0		
Seaport Boston Hotel		↵
0		
Seaport Hotel & World Trade Center		↵
0		
Waterside Place		↵
0		
World Trade Center East		↵
0		
100 Northern Avenue		↵
1		
100 Pier 4		↵
1		
The Institute of Contemporary Art		↵
1		
101 Seaport		↵
2		
District Hall		↵
2		
One Marina Park Drive		↵
2		
Twenty Two Liberty		↵
2		
Vertex		↵
2		
Vertex		↵
2		
Watermark Seaport		↵
2		
Blue Hills Bank Pavilion		↵
NULL		
World Trade Center West		↵
NULL		
(20 rows)		

A example showing combining parcels with the same cluster number into geometry collections.

```

SELECT cid, ST_Collect(geom) AS cluster_geom, array_agg(parcel_id) AS ids_in_cluster FROM (
  SELECT parcel_id, ST_ClusterDBSCAN(geom, eps => 0.5, minpoints => 5) over () AS cid, ↵
  geom
  FROM parcels) sq
GROUP BY cid;
    
```



[ST_DWithin](#), [ST_ClusterKMeans](#), [ST_ClusterIntersecting](#), [ST_ClusterIntersectingWin](#), [ST_ClusterWithin](#), [ST_ClusterWithinWin](#)

7.17.2 ST_ClusterIntersecting

`ST_ClusterIntersecting` — Aggregate function that clusters input geometries into connected sets.

Synopsis

```
geometry[] ST_ClusterIntersecting(geometry set g);
```

☒☒

An aggregate function that returns an array of `GeometryCollections` partitioning the input geometries into connected clusters that are disjoint. Each geometry in a cluster intersects at least one other geometry in the cluster, and does not intersect any geometry in other clusters.

2.2.0 ☒☒☒☒☒☒☒☒☒☒.

☒☒

```
WITH testdata AS
  (SELECT unnest(ARRAY['LINESTRING (0 0, 1 1)::geometry',
    'LINESTRING (5 5, 4 4)::geometry',
    'LINESTRING (6 6, 7 7)::geometry',
    'LINESTRING (0 0, -1 -1)::geometry',
    'POLYGON ((0 0, 4 0, 4 4, 0 4, 0 0))::geometry']) AS geom)

SELECT ST_AsText(unnest(ST_ClusterIntersecting(geom))) FROM testdata;

-- result

st_astext
-----
GEOMETRYCOLLECTION(LINESTRING(0 0,1 1),LINESTRING(5 5,4 4),LINESTRING(0 0,-1 -1),POLYGON((0 ←
  0,4 0,4 4,0 4,0 0)))
GEOMETRYCOLLECTION(LINESTRING(6 6,7 7))
```

☒☒

[ST_ClusterIntersectingWin](#), [ST_ClusterWithin](#), [ST_ClusterWithinWin](#)

7.17.3 ST_ClusterIntersectingWin

`ST_ClusterIntersectingWin` — Window function that returns a cluster id for each input geometry, clustering input geometries into connected sets.

Synopsis

```
integer ST_ClusterIntersectingWin(geometry winset geom);
```

☒☒

A window function that builds connected clusters of geometries that intersect. It is possible to traverse all geometries in a cluster without leaving the cluster. The return value is the cluster number that the geometry argument participates in, or null for null inputs.

Availability: 3.4.0

☒☒

```
WITH testdata AS (
  SELECT id, geom::geometry FROM (
    VALUES (1, 'LINESTRING (0 0, 1 1)'),
           (2, 'LINESTRING (5 5, 4 4)'),
           (3, 'LINESTRING (6 6, 7 7)'),
           (4, 'LINESTRING (0 0, -1 -1)'),
           (5, 'POLYGON ((0 0, 4 0, 4 4, 0 4, 0 0))')) AS t(id, geom)
)
SELECT id,
       ST_AsText(geom),
       ST_ClusterIntersectingWin(geom) OVER () AS cluster
FROM testdata;
```

id	st_astext	cluster
1	LINESTRING(0 0,1 1)	0
2	LINESTRING(5 5,4 4)	0
3	LINESTRING(6 6,7 7)	1
4	LINESTRING(0 0,-1 -1)	0
5	POLYGON((0 0,4 0,4 4,0 4,0 0))	0

☒☒

[ST_ClusterIntersecting](#), [ST_ClusterWithin](#), [ST_ClusterWithinWin](#)

7.17.4 ST_ClusterKMeans

`ST_ClusterKMeans` — Window function that returns a cluster id for each input geometry using the K-means algorithm.

Synopsis

integer **ST_ClusterKMeans**(geometry winset geom, integer number_of_clusters, float max_radius);

☒☒

Returns **K-means** cluster number for each input geometry. The distance used for clustering is the distance between the centroids for 2D geometries, and distance between bounding box centers for 3D geometries. For POINT inputs, M coordinate will be treated as weight of input and has to be larger than 0.

`max_radius`, if set, will cause `ST_ClusterKMeans` to generate more clusters than `k` ensuring that no cluster in output has radius larger than `max_radius`. This is useful in reachability analysis.

Enhanced: 3.2.0 Support for max_radius

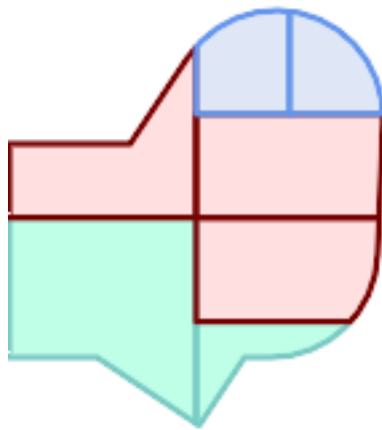
Enhanced: 3.1.0 Support for 3D geometries and weights

2.3.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

Generate dummy set of parcels for examples:

```
CREATE TABLE parcels AS
SELECT lpad((row_number() over())::text,3,'0') As parcel_id, geom,
('{residential, commercial}'::text[])[1 + mod(row_number()OVER(),2)] As type
FROM
  ST_Subdivide(ST_Buffer('SRID=3857;LINESTRING(40 100, 98 100, 100 150, 60 90)'::geometry ←
  40, 'endcap=square'),12) As geom;
```



Parcels color-coded by cluster number (cid)

```
SELECT ST_ClusterKMeans(geom, 3) OVER() AS cid, parcel_id, geom
FROM parcels;
```

cid	parcel_id	geom
0	001	0103000000...
0	002	0103000000...
1	003	0103000000...
0	004	0103000000...
1	005	0103000000...
2	006	0103000000...
2	007	0103000000...

Partitioning parcel clusters by type:

```
SELECT ST_ClusterKMeans(geom, 3) over (PARTITION BY type) AS cid, parcel_id, type
FROM parcels;
```


cid	parcel_id	type
1	005	commercial
1	003	commercial
2	007	commercial
0	001	commercial
1	004	residential
0	002	residential
2	006	residential

Example: Clustering a preaggregated planetary-scale data population dataset using 3D clustering and weighting. Identify at least 20 regions based on [Kontur Population Data](#) that do not span more than 3000 km from their center:

```
create table kontur_population_3000km_clusters as
select
  geom,
  ST_ClusterKMeans(
    ST_Force4D(
      ST_Transform(ST_Force3D(geom), 4978), -- cluster in 3D XYZ CRS
      mvalue => population -- set clustering to be weighed by population
    ),
    20, -- aim to generate at least 20 clusters
    max_radius => 3000000 -- but generate more to make each under 3000 km radius
  ) over ( ) as cid
from
  kontur_population;
```



World population clustered to above specs produces 46 clusters. Clusters are centered at well-populated regions (New York, Moscow). Greenland is one cluster. There are island clusters that span across the antimeridian. Cluster edges follow Earth's curvature.

☒☒

[ST_ClusterDBSCAN](#), [ST_ClusterIntersectingWin](#), [ST_ClusterWithinWin](#), [ST_ClusterIntersecting](#), [ST_ClusterWithin](#), [ST_Subdivide](#), [ST_Force3D](#), [ST_Force4D](#),

7.17.5 ST_ClusterWithin

`ST_ClusterWithin` — Aggregate function that clusters geometries by separation distance.

Synopsis

```
geometry[] ST_ClusterWithin(geometry set g, float8 distance);
```

☒☒

An aggregate function that returns an array of GeometryCollections, where each collection is a cluster containing some input geometries. Clustering partitions the input geometries into sets in which each geometry is within the specified *distance* of at least one other geometry in the same cluster. Distances are Cartesian distances in the units of the SRID.

ST_ClusterWithin is equivalent to running **ST_ClusterDBSCAN** with `minpoints => 0`.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



This method supports Circular Strings and Curves.

☒☒

```
WITH testdata AS
  (SELECT unnest(ARRAY['LINESTRING (0 0, 1 1)::geometry,
                      'LINESTRING (5 5, 4 4)::geometry,
                      'LINESTRING (6 6, 7 7)::geometry,
                      'LINESTRING (0 0, -1 -1)::geometry,
                      'POLYGON ((0 0, 4 0, 4 4, 0 4, 0 0))::geometry']) AS geom)

SELECT ST_AsText(unnest(ST_ClusterWithin(geom, 1.4))) FROM testdata;

--result

st_astext
-----
GEOMETRYCOLLECTION(LINESTRING(0 0,1 1),LINESTRING(5 5,4 4),LINESTRING(0 0,-1 -1),POLYGON((0 ←
  0,4 0,4 4,0 4,0 0)))
GEOMETRYCOLLECTION(LINESTRING(6 6,7 7))
```

☒☒

ST_ClusterWithinWin, **ST_ClusterDBSCAN**, **ST_ClusterIntersecting**, **ST_ClusterIntersectingWin**

7.17.6 ST_ClusterWithinWin

ST_ClusterWithinWin — Window function that returns a cluster id for each input geometry, clustering using separation distance.

Synopsis

integer **ST_ClusterWithinWin**(geometry winset geom, float8 distance);

☒☒

A window function that returns a cluster number for each input geometry. Clustering partitions the geometries into sets in which each geometry is within the specified distance of at least one other geometry in the same cluster. Distances are Cartesian distances in the units of the SRID.

ST_ClusterWithinWin is equivalent to running **ST_ClusterDBSCAN** with `minpoints => 0`.

Availability: 3.4.0



This method supports Circular Strings and Curves.

☒☒

```
WITH testdata AS (
  SELECT id, geom::geometry FROM (
  VALUES (1, 'LINESTRING (0 0, 1 1)'),
          (2, 'LINESTRING (5 5, 4 4)'),
          (3, 'LINESTRING (6 6, 7 7)'),
          (4, 'LINESTRING (0 0, -1 -1)'),
          (5, 'POLYGON ((0 0, 4 0, 4 4, 0 4, 0 0))) AS t(id, geom)
  )
)
SELECT id,
       ST_AsText(geom),
       ST_ClusterWithinWin(geom, 1.4) OVER () AS cluster
FROM testdata;
```

id	st_astext	cluster
1	LINESTRING(0 0,1 1)	0
2	LINESTRING(5 5,4 4)	0
3	LINESTRING(6 6,7 7)	1
4	LINESTRING(0 0,-1 -1)	0
5	POLYGON((0 0,4 0,4 4,0 4,0 0))	0

☒☒

[ST_ClusterWithin](#), [ST_ClusterDBSCAN](#), [ST_ClusterIntersecting](#), [ST_ClusterIntersectingWin](#),

7.18 Bounding Box Functions

7.18.1 Box2D

Box2D — Returns a BOX2D representing the 2D extent of a geometry.

Synopsis

box2d **Box2D**(geometry geom);

☒☒

Returns a **box2d** representing the 2D extent of the geometry.

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒, ☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒☒.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
SELECT Box2D(ST_GeomFromText('LINESTRING(1 2, 3 4, 5 6)'));
```

```
box2d
```

```
-----
```

```
BOX(1 2,5 6)
```

```
SELECT Box2D(ST_GeomFromText('CIRCULARSTRING(220268 150415,220227 150505,220227 150406)'));
```

```
box2d
```

```
-----
```

```
BOX(220186.984375 150406,220288.25 150506.140625)
```

☒☒

Box3D, ST_GeomFromText

7.18.2 Box3D

Box3D — Returns a BOX3D representing the 3D extent of a geometry.

Synopsis

```
box3d Box3D(geometry geom);
```

☒☒

Returns a **box3d** representing the 3D extent of the geometry.

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒, ☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒.



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).



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

☒☒

```
SELECT Box3D(ST_GeomFromEWKT('LINESTRING(1 2 3, 3 4 5, 5 6 5)'));
```

```
Box3d
```

```
-----
```

```
BOX3D(1 2 3,5 6 5)
```

```
SELECT Box3D(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 1,220227 150406 1)'));
```

```
Box3d
```

```
-----
```

```
BOX3D(220227 150406 1,220268 150415 1)
```

☒☒

[Box2D](#), [ST_GeomFromEWKT](#)

7.18.3 ST_EstimatedExtent

`ST_EstimatedExtent` — Returns the estimated extent of a spatial table.

Synopsis

```

box2d ST_EstimatedExtent(text schema_name, text table_name, text geocolumn_name, boolean parent_only);
box2d ST_EstimatedExtent(text schema_name, text table_name, text geocolumn_name);
box2d ST_EstimatedExtent(text table_name, text geocolumn_name);

```

☒☒

Returns the estimated extent of a spatial table as a [box2d](#). The current schema is used if not specified. The estimated extent is taken from the geometry column's statistics. This is usually much faster than computing the exact extent of the table using [ST_Extent](#) or [ST_3DExtent](#).

The default behavior is to also use statistics collected from child tables (tables with INHERITS) if available. If `parent_only` is set to `TRUE`, only statistics for the given table are used and child tables are ignored.

For PostgreSQL $\geq 8.0.0$ statistics are gathered by `VACUUM ANALYZE` and the result extent will be about 95% of the actual one. For PostgreSQL $< 8.0.0$ statistics are gathered by running `update_geometry_stats` and the result extent is exact.

**Note**

In the absence of statistics (empty table or no `ANALYZE` called) this function returns `NULL`. Prior to version 1.5.4 an exception was thrown instead.

1.0.0 [☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒](#).

Changed: 2.1.0. Up to 2.0.x this was called `ST_Estimated_Extent`.



This method supports Circular Strings and Curves.

☒☒

```

SELECT ST_EstimatedExtent('ny', 'edges', 'geom');
--result--
BOX(-8877653 4912316,-8010225.5 5589284)

SELECT ST_EstimatedExtent('feature_poly', 'geom');
--result--
BOX(-124.659652709961 24.6830825805664,-67.7798080444336 49.0012092590332)

```

☒☒

[ST_Extent](#), [ST_3DExtent](#)

7.18.4 ST_Expand

ST_Expand — Returns a bounding box expanded from another bounding box or a geometry.

Synopsis

```
geometry ST_Expand(geometry geom, float units_to_expand);
geometry ST_Expand(geometry geom, float dx, float dy, float dz=0, float dm=0);
box2d ST_Expand(box2d box, float units_to_expand);
box2d ST_Expand(box2d box, float dx, float dy);
box3d ST_Expand(box3d box, float units_to_expand);
box3d ST_Expand(box3d box, float dx, float dy, float dz=0);
```

☒☒

Returns a bounding box expanded from the bounding box of the input, either by specifying a single distance with which the box should be expanded on both axes, or by specifying an expansion distance for each axis. Uses double-precision. Can be used for distance queries, or to add a bounding box filter to a query to take advantage of a spatial index.

In addition to the version of ST_Expand accepting and returning a geometry, variants are provided that accept and return **box2d** and **box3d** data types.

Distances are in the units of the spatial reference system of the input.

ST_Expand is similar to **ST_Buffer**, except while buffering expands a geometry in all directions, ST_Expand expands the bounding box along each axis.



Note

Pre version 1.3, ST_Expand was used in conjunction with **ST_Distance** to do indexable distance queries. For example, `geom && ST_Expand('POINT(10 20)', 10) AND ST_Distance(geom, 'POINT(10 20)') < 10`. This has been replaced by the simpler and more efficient **ST_DWithin** function.

Availability: 1.5.0 behavior changed to output double precision instead of float4 coordinates.

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒, ☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒.

Enhanced: 2.3.0 support was added to expand a box by different amounts in different dimensions.



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒



Note

Examples below use US National Atlas Equal Area (SRID=2163) which is a meter projection

```

--10 meter expanded box around bbox of a linestring
SELECT CAST(ST_Expand(ST_GeomFromText('LINESTRING(2312980 110676,2312923 110701,2312892  ←
  110714)', 2163),10) As box2d);
                                st_expand
-----
BOX(2312882 110666,2312990 110724)

--10 meter expanded 3D box of a 3D box
SELECT ST_Expand(CAST('BOX3D(778783 2951741 1,794875 2970042.61545891 10)' As box3d),10)
                                st_expand
-----
BOX3D(778773 2951731 -9,794885 2970052.61545891 20)

--10 meter geometry astext rep of a expand box around a point geometry
SELECT ST_AsEWKT(ST_Expand(ST_GeomFromEWKT('SRID=2163;POINT(2312980 110676)'),10));
                                                                st_asewkt ←
-----
SRID=2163;POLYGON((2312970 110666,2312970 110686,2312990 110686,2312990 110666,2312970  ←
  110666))

```

☒☒

[ST_Buffer](#), [ST_DWithin](#), [ST_SRID](#)

7.18.5 ST_Extent

`ST_Extent` — Aggregate function that returns the bounding box of geometries.

Synopsis

`box2d ST_Extent(geometry set geomfield);`

☒☒

An aggregate function that returns a `box2d` bounding box that bounds a set of geometries. The bounding box coordinates are in the spatial reference system of the input geometries. `ST_Extent` is similar in concept to Oracle Spatial/Locator's `SDO_AGGR_MBR`.

**Note**

`ST_Extent` returns boxes with only X and Y ordinates even with 3D geometries. To return XYZ ordinates use [ST_3DExtent](#).

**Note**

The returned `box3d` value does not include a SRID. Use [ST_SetSRID](#) to convert it into a geometry with SRID metadata. The SRID is the same as the input geometries.

2.0.0 supports Polyhedral surfaces, TIN and Triangulated Irregular Network Surfaces (TIN).

- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒



Note

Examples below use Massachusetts State Plane ft (SRID=2249)

```
SELECT ST_Extent(geom) as bextent FROM sometable;
                st_bextent
-----
BOX(739651.875 2908247.25,794875.8125 2970042.75)

--Return extent of each category of geometries
SELECT ST_Extent(geom) as bextent
FROM sometable
GROUP BY category ORDER BY category;

                bextent | name
-----+-----
BOX(778783.5625 2951741.25,794875.8125 2970042.75) | A
BOX(751315.8125 2919164.75,765202.6875 2935417.25) | B
BOX(739651.875 2917394.75,756688.375 2935866)      | C

--Force back into a geometry
-- and render the extended text representation of that geometry
SELECT ST_SetSRID(ST_Extent(geom),2249) as bextent FROM sometable;

                bextent
-----
SRID=2249;POLYGON((739651.875 2908247.25,739651.875 2970042.75,794875.8125 2970042.75,
794875.8125 2908247.25,739651.875 2908247.25))
```

☒

[ST_EstimatedExtent](#), [ST_3DExtent](#), [ST_SetSRID](#)

7.18.6 ST_3DExtent

`ST_3DExtent` — Aggregate function that returns the 3D bounding box of geometries.

Synopsis

`box3d ST_3DExtent(geometry set geomfield);`

☒☒

An aggregate function that returns a **box3d** (includes Z ordinate) bounding box that bounds a set of geometries.

The bounding box coordinates are in the spatial reference system of the input geometries.



Note

The returned box3d value does not include a SRID. Use **ST_SetSRID** to convert it into a geometry with SRID metadata. The SRID is the same as the input geometries.

☒☒☒☒: 2.0.0 ☒☒☒☒☒☒☒☒☒, ☒☒☒☒ TIN ☒☒☒☒☒☒☒☒☒☒☒.

Changed: 2.0.0 In prior versions this used to be called ST_Extent3D



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



This method supports Circular Strings and Curves.



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
SELECT ST_3DExtent(foo.geom) As b3extent
FROM (SELECT ST_MakePoint(x,y,z) As geom
      FROM generate_series(1,3) As x
      CROSS JOIN generate_series(1,2) As y
      CROSS JOIN generate_series(0,2) As Z) As foo;
      b3extent
-----
BOX3D(1 1 0,3 2 2)

--Get the extent of various elevated circular strings
SELECT ST_3DExtent(foo.geom) As b3extent
FROM (SELECT ST_Translate(ST_Force_3DZ(ST_LineToCurve(ST_Buffer(ST_Point(x,y),1))),0,0,z) ←
      As geom
      FROM generate_series(1,3) As x
      CROSS JOIN generate_series(1,2) As y
      CROSS JOIN generate_series(0,2) As Z) As foo;
      b3extent
-----
BOX3D(1 0 0,4 2 2)
```

☒☒

ST_Extent, **ST_Force3DZ**, **ST_SetSRID**

7.18.7 ST_MakeBox2D

ST_MakeBox2D — Creates a BOX2D defined by two 2D point geometries.

Synopsis

box2d **ST_MakeBox2D**(geometry pointLowLeft, geometry pointUpRight);

☒☒

Creates a **box2d** defined by two Point geometries. This is useful for doing range queries.

☒☒

```
--Return all features that fall reside or partly reside in a US national atlas coordinate ←
  bounding box
--It is assumed here that the geometries are stored with SRID = 2163 (US National atlas ←
  equal area)
SELECT feature_id, feature_name, geom
FROM features
WHERE geom && ST_SetSRID(ST_MakeBox2D(ST_Point(-989502.1875, 528439.5625),
  ST_Point(-987121.375 ,529933.1875)),2163)
```

☒☒

ST_Point, **ST_SetSRID**, **ST_SRID**

7.18.8 ST_3DMakeBox

ST_3DMakeBox — Creates a BOX3D defined by two 3D point geometries.

Synopsis

box3d **ST_3DMakeBox**(geometry point3DLowLeftBottom, geometry point3DUpRightTop);

☒☒

Creates a **box3d** defined by two 3D Point geometries.



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

Changed: 2.0.0 In prior versions this used to be called ST_MakeBox3D

☒☒

```
SELECT ST_3DMakeBox(ST_MakePoint(-989502.1875, 528439.5625, 10),
  ST_MakePoint(-987121.375 ,529933.1875, 10)) As abb3d

-- bb3d --
-----
BOX3D(-989502.1875 528439.5625 10, -987121.375 529933.1875 10)
```

☒☒

[ST_MakePoint](#), [ST_SetSRID](#), [ST_SRID](#)

7.18.9 ST_XMax

ST_XMax — Returns the X maxima of a 2D or 3D bounding box or a geometry.

Synopsis

```
float ST_XMax(box3d aGeomorBox2DorBox3D);
```

☒☒

Returns the X maxima of a 2D or 3D bounding box or a geometry.

**Note**

Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However, it will not accept a geometry or box2d text representation, since those do not auto-cast.



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



This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_XMax('BOX3D(1 2 3, 4 5 6)');
```

```
st_xmax
```

```
-----
```

```
4
```

```
SELECT ST_XMax(ST_GeomFromText('LINESTRING(1 3 4, 5 6 7)'));
```

```
st_xmax
```

```
-----
```

```
5
```

```
SELECT ST_XMax(CAST('BOX(-3 2, 3 4)' As box2d));
```

```
st_xmax
```

```
-----
```

```
3
```

--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to a BOX3D ↔

```
SELECT ST_XMax('LINESTRING(1 3, 5 6)');
```

```
--ERROR: BOX3D parser - doesn't start with BOX3D(
```

```
SELECT ST_XMax(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)'));
```

```
st_xmax
```

```
-----
```

```
220288.248780547
```

☒☒

`ST_XMin, ST_YMax, ST_YMin, ST_ZMax, ST_ZMin`

7.18.10 ST_XMin

`ST_XMin` — Returns the X minima of a 2D or 3D bounding box or a geometry.

Synopsis

```
float ST_XMin(box3d aGeomorBox2DorBox3D);
```

☒☒

Returns the X minima of a 2D or 3D bounding box or a geometry.

**Note**

Although this function is only defined for `box3d`, it also works for `box2d` and geometry values due to automatic casting. However it will not accept a geometry or `box2d` text representation, since those do not auto-cast.



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



This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_XMin('BOX3D(1 2 3, 4 5 6)');
```

```
st_xmin
```

```
-----
```

```
1
```

```
SELECT ST_XMin(ST_GeomFromText('LINESTRING(1 3 4, 5 6 7)'));
```

```
st_xmin
```

```
-----
```

```
1
```

```
SELECT ST_XMin(CAST('BOX(-3 2, 3 4)' As box2d));
```

```
st_xmin
```

```
-----
```

```
-3
```

--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to a `BOX3D` ↔

```
SELECT ST_XMin('LINESTRING(1 3, 5 6)');
```

```
--ERROR: BOX3D parser - doesn't start with BOX3D(
```

```
SELECT ST_XMin(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)'));
```

```
st_xmin
```

```
-----
```

```
220186.995121892
```

☒☒

ST_XMax, ST_YMax, ST_YMin, ST_ZMax, ST_ZMin

7.18.11 ST_YMax

ST_YMax — Returns the Y maxima of a 2D or 3D bounding box or a geometry.

Synopsis

```
float ST_YMax(box3d aGeomorBox2DorBox3D);
```

☒☒

Returns the Y maxima of a 2D or 3D bounding box or a geometry.

**Note**

Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However it will not accept a geometry or box2d text representation, since those do not auto-cast.



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



This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_YMax('BOX3D(1 2 3, 4 5 6)');
```

```
st_ymax
```

```
-----
```

```
5
```

```
SELECT ST_YMax(ST_GeomFromText('LINESTRING(1 3 4, 5 6 7)'));
```

```
st_ymax
```

```
-----
```

```
6
```

```
SELECT ST_YMax(CAST('BOX(-3 2, 3 4)' As box2d));
```

```
st_ymax
```

```
-----
```

```
4
```

--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to a BOX3D ↔

```
SELECT ST_YMax('LINESTRING(1 3, 5 6)');
```

```
--ERROR: BOX3D parser - doesn't start with BOX3D(
```

```
SELECT ST_YMax(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)'));
```

```
st_ymax
```

```
-----
```

```
150506.126829327
```

☒☒

`ST_XMin, ST_XMax, ST_YMin, ST_ZMax, ST_ZMin`

7.18.12 ST_YMin

ST_YMin — Returns the Y minima of a 2D or 3D bounding box or a geometry.

Synopsis

```
float ST_YMin(box3d aGeomorBox2DorBox3D);
```

☒☒

Returns the Y minima of a 2D or 3D bounding box or a geometry.

**Note**

Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However it will not accept a geometry or box2d text representation, since those do not auto-cast.



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



This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_YMin('BOX3D(1 2 3, 4 5 6)');
```

```
st_ymin
```

```
-----
```

```
2
```

```
SELECT ST_YMin(ST_GeomFromText('LINESTRING(1 3 4, 5 6 7)'));
```

```
st_ymin
```

```
-----
```

```
3
```

```
SELECT ST_YMin(CAST('BOX(-3 2, 3 4)' As box2d));
```

```
st_ymin
```

```
-----
```

```
2
```

--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to a BOX3D ↔

```
SELECT ST_YMin('LINESTRING(1 3, 5 6)');
```

```
--ERROR: BOX3D parser - doesn't start with BOX3D(
```

```
SELECT ST_YMin(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)'));
```

```
st_ymin
```

```
-----
```

```
150406
```

☒☒

[ST_GeomFromEWKT](#), [ST_XMin](#), [ST_XMax](#), [ST_YMax](#), [ST_ZMax](#), [ST_ZMin](#)

7.18.13 ST_ZMax

`ST_ZMax` — Returns the Z maxima of a 2D or 3D bounding box or a geometry.

Synopsis

```
float ST_ZMax(box3d aGeomorBox2DorBox3D);
```

☒☒

Returns the Z maxima of a 2D or 3D bounding box or a geometry.



Note

Although this function is only defined for `box3d`, it also works for `box2d` and geometry values due to automatic casting. However it will not accept a geometry or `box2d` text representation, since those do not auto-cast.



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



This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_ZMax('BOX3D(1 2 3, 4 5 6)');
st_zmax
-----
6

SELECT ST_ZMax(ST_GeomFromEWKT('LINESTRING(1 3 4, 5 6 7)'));
st_zmax
-----
7

SELECT ST_ZMax('BOX3D(-3 2 1, 3 4 1) ');
st_zmax
-----
1
--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to a BOX3D
SELECT ST_ZMax('LINESTRING(1 3 4, 5 6 7)');
--ERROR: BOX3D parser - doesn't start with BOX3D(

SELECT ST_ZMax(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)'));
st_zmax
-----
3
```

☒☒

[ST_GeomFromEWKT](#), [ST_XMin](#), [ST_XMax](#), [ST_YMax](#), [ST_YMin](#), [ST_ZMax](#)

7.18.14 ST_ZMin

ST_ZMin — Returns the Z minima of a 2D or 3D bounding box or a geometry.

Synopsis

```
float ST_ZMin(box3d aGeomorBox2DorBox3D);
```

☒☒

Returns the Z minima of a 2D or 3D bounding box or a geometry.

**Note**

Although this function is only defined for box3d, it also works for box2d and geometry values due to automatic casting. However it will not accept a geometry or box2d text representation, since those do not auto-cast.



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



This method supports Circular Strings and Curves.

☒☒

```
SELECT ST_ZMin('BOX3D(1 2 3, 4 5 6)');
```

```
st_zmin
```

```
-----
```

```
3
```

```
SELECT ST_ZMin(ST_GeomFromEWKT('LINESTRING(1 3 4, 5 6 7)'));
```

```
st_zmin
```

```
-----
```

```
4
```

```
SELECT ST_ZMin('BOX3D(-3 2 1, 3 4 1)');
```

```
st_zmin
```

```
-----
```

```
1
```

--Observe THIS DOES NOT WORK because it will try to auto-cast the string representation to a BOX3D ↔

```
SELECT ST_ZMin('LINESTRING(1 3 4, 5 6 7)');
```

```
--ERROR: BOX3D parser - doesn't start with BOX3D(
```

```
SELECT ST_ZMin(ST_GeomFromEWKT('CIRCULARSTRING(220268 150415 1,220227 150505 2,220227 150406 3)'));
```

```
st_zmin
```

```
-----
```

```
1
```




Note

This only works with LINESTRINGs. To use on contiguous MULTILINESTRINGs first join them with **ST_LineMerge**.



Note

1.1.1 **M** **Z** (**M**) **Z**. **M**. **M**.

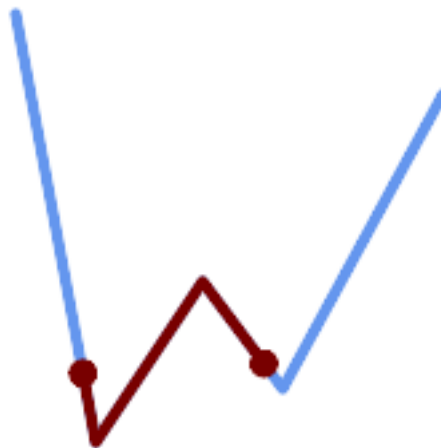
Enhanced: 3.4.0 - Support for geography was introduced.

2.1.0 **ST_Line_Substring**.

1.1.0 **ST_Line_Substring**. 1.1.1 **Z** **M**.



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



1/3 (0.333, 0.666)

```
SELECT ST_AsText(ST_LineSubstring( 'LINESTRING (20 180, 50 20, 90 80, 120 40, 180 150)',
    0.333, 0.666));
```

```
LINESTRING (45.17311810399485 45.74337011202746, 50 20, 90 80, 112.97593050157862
    49.36542599789519)
```

If start and end locations are the same, the result is a POINT.

```
SELECT ST_AsText(ST_LineSubstring( 'LINESTRING(25 50, 100 125, 150 190)', 0.333, 0.333));
```

```
POINT(69.2846934853974 94.2846934853974)
```

A query to cut a LineString into sections of length 100 or shorter. It uses `generate_series()` with a `CROSS JOIN LATERAL` to produce the equivalent of a FOR loop.

```

WITH data(id, geom) AS (VALUES
  ( 'A', 'LINESTRING( 0 0, 200 0)::geometry ),
  ( 'B', 'LINESTRING( 0 100, 350 100)::geometry ),
  ( 'C', 'LINESTRING( 0 200, 50 200)::geometry )
)
SELECT id, i,
       ST_AsText( ST_LineSubstring( geom, startfrac, LEAST( endfrac, 1 ) ) ) AS geom
FROM (
  SELECT id, geom, ST_Length(geom) len, 100 sublen FROM data
) AS d
CROSS JOIN LATERAL (
  SELECT i, (sublen * i) / len AS startfrac,
         (sublen * (i+1)) / len AS endfrac
  FROM generate_series(0, floor( len / sublen )::integer ) AS t(i)
  -- skip last i if line length is exact multiple of sublen
  WHERE (sublen * i) / len <
> 1.0
) AS d2;

```

id	i	geom
A	0	LINESTRING(0 0,100 0)
A	1	LINESTRING(100 0,200 0)
B	0	LINESTRING(0 100,100 100)
B	1	LINESTRING(100 100,200 100)
B	2	LINESTRING(200 100,300 100)
B	3	LINESTRING(300 100,350 100)
C	0	LINESTRING(0 200,50 200)

Geography implementation measures along a spheroid, geometry along a line

```

SELECT ST_AsText(ST_LineSubstring( 'LINESTRING(-118.2436 34.0522, -71.0570 42.3611)::':: ↵
  geography, 0.333, 0.666),6) AS geog_sub
, ST_AsText(ST_LineSubstring('LINESTRING(-118.2436 34.0522, -71.0570 42.3611)::'::geometry, ↵
  0.333, 0.666),6) AS geom_sub;
-----
geog_sub | LINESTRING(-104.167064 38.854691,-87.674646 41.849854)
geom_sub | LINESTRING(-102.530462 36.819064,-86.817324 39.585927)

```

☒☒

[ST_Length](#), [ST_LineExtend](#), [ST_LineInterpolatePoint](#), [ST_LineMerge](#)

7.19.6 ST_LocateAlong

`ST_LocateAlong` — Returns the point(s) on a geometry that match a measure value.

Synopsis

geometry **ST_LocateAlong**(geometry geom_with_measure, float8 measure, float8 offset = 0);


```
MULTILINESTRING((54.49835019899045 104.53426957938231,58.70056060327303 ←
82.12248075654186,69.16695286779743 103.05526528559065,82.11145618000168 ←
128.94427190999915,84.24893681714357 132.32493442618113,87.01636951231555 ←
135.21267035596549,90.30307285299679 137.49198684843182,93.97759758337769 ←
139.07172433557758,97.89298381958797 139.8887023914453,101.89263860095893 ←
139.9102465862721,105.81659870902816 139.13549527600819,109.50792827749828 ←
137.5954340631298,112.81899532549731 135.351656550512,115.6173761888606 ←
132.49390095108848,145.31017306064817 95.37790486135405))
```

☒☒

[ST_LocateAlong](#), [ST_LocateAlong](#), [ST_LocateBetween](#)

7.19.8 ST_LocateBetweenElevations

`ST_LocateBetweenElevations` — Returns the portions of a geometry that lie in an elevation (Z) range.

Synopsis

geometry **ST_LocateBetweenElevations**(geometry geom, float8 elevation_start, float8 elevation_end);

☒☒

Returns a geometry (collection) with the portions of a geometry that lie in an elevation (Z) range.

Clipping a non-convex POLYGON may produce invalid geometry.

1.4.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Enhanced: 3.0.0 - added support for POLYGON, TIN, TRIANGLE.



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

☒☒

```
SELECT ST_AsText(
  ST_LocateBetweenElevations(
    'LINESTRING(1 2 3, 4 5 6)::geometry,
    2, 4 ));
```

st_astext


MULTILINESTRING Z ((1 2 3,2 3 4))

```
SELECT ST_AsText(
  ST_LocateBetweenElevations(
    'LINESTRING(1 2 6, 4 5 -1, 7 8 9)',
    6, 9)) As ewelev;
```

ewelev

GEOMETRYCOLLECTION Z (POINT Z (1 2 6),LINESTRING Z (6.1 7.1 6,7 8 9))

2.2.0

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



```
-- A valid trajectory
SELECT ST_IsValidTrajectory(ST_MakeLine(
  ST_MakePointM(0,0,1),
  ST_MakePointM(0,1,2)
));
t

-- An invalid trajectory
SELECT ST_IsValidTrajectory(ST_MakeLine(ST_MakePointM(0,0,1), ST_MakePointM(0,1,0)));
NOTICE: Measure of vertex 1 (0) not bigger than measure of vertex 0 (1)
st_isvalidtrajectory
-----
f
```



ST_ClosestPointOfApproach

7.20.2 ST_ClosestPointOfApproach

ST_ClosestPointOfApproach — Returns a measure at the closest point of approach of two trajectories.

Synopsis

float8 **ST_ClosestPointOfApproach**(geometry track1, geometry track2);




Returns the smallest measure at which points interpolated along the given trajectories are the least distance apart.

Inputs must be valid trajectories as checked by **ST_IsValidTrajectory**. Null is returned if the trajectories do not overlap in their M ranges.

To obtain the actual points at the computed measure use **ST_LocateAlong** .

2.2.0

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



```

-- Return the time in which two objects moving between 10:00 and 11:00
-- are closest to each other and their distance at that point
WITH inp AS ( SELECT
  ST_AddMeasure('LINESTRING Z (0 0 0, 10 0 5)::geometry,
    extract(epoch from '2015-05-26 10:00'::timestampz),
    extract(epoch from '2015-05-26 11:00'::timestampz)
  ) a,
  ST_AddMeasure('LINESTRING Z (0 2 10, 12 1 2)::geometry,
    extract(epoch from '2015-05-26 10:00'::timestampz),
    extract(epoch from '2015-05-26 11:00'::timestampz)
  ) b
), cpa AS (
  SELECT ST_ClosestPointOfApproach(a,b) m FROM inp
), points AS (
  SELECT ST_GeometryN(ST_LocateAlong(a,m),1) pa,
    ST_GeometryN(ST_LocateAlong(b,m),1) pb
  FROM inp, cpa
)
SELECT to_timestamp(m) t,
  ST_Distance(pa,pb) distance,
  ST_AsText(pa, 2) AS pa, ST_AsText(pb, 2) AS pb
FROM points, cpa;

```

t	distance	pa	
	pb		
2015-05-26 10:45:31.034483-07	1.9603683315139542	POINT ZM (7.59 0 3.79 1432662331.03)	←
POINT ZM (9.1 1.24 3.93 1432662331.03)			

☒☒

[ST_IsValidTrajectory](#), [ST_DistanceCPA](#), [ST_LocateAlong](#), [ST_AddMeasure](#)

7.20.3 ST_DistanceCPA

`ST_DistanceCPA` — Returns the distance between the closest point of approach of two trajectories.

Synopsis

float8 `ST_DistanceCPA`(geometry track1, geometry track2);

☒☒

Returns the distance (in 2D) between two trajectories at their closest point of approach.

Inputs must be valid trajectories as checked by [ST_IsValidTrajectory](#). Null is returned if the trajectories do not overlap in their M ranges.

2.2.0 ☒☒☒☒☒☒☒☒☒☒.



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

☒☒

```
-- Return the minimum distance of two objects moving between 10:00 and 11:00
WITH inp AS ( SELECT
  ST_AddMeasure('LINESTRING Z (0 0 0, 10 0 5)::geometry,
    extract(epoch from '2015-05-26 10:00'::timestampz),
    extract(epoch from '2015-05-26 11:00'::timestampz)
  ) a,
  ST_AddMeasure('LINESTRING Z (0 2 10, 12 1 2)::geometry,
    extract(epoch from '2015-05-26 10:00'::timestampz),
    extract(epoch from '2015-05-26 11:00'::timestampz)
  ) b
)
SELECT ST_DistanceCPA(a,b) distance FROM inp;

    distance
-----
1.96036833151395
```

☒☒

[ST_IsValidTrajectory](#), [ST_ClosestPointOfApproach](#), [ST_AddMeasure](#), [|](#)

7.20.4 ST_CPAWithin

`ST_CPAWithin` — Tests if the closest point of approach of two trajectories is within the specified distance.

Synopsis

boolean `ST_CPAWithin`(geometry track1, geometry track2, float8 dist);

☒☒

Tests whether two moving objects have ever been closer than the specified distance.

Inputs must be valid trajectories as checked by [ST_IsValidTrajectory](#). False is returned if the trajectories do not overlap in their M ranges.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.



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

☒☒

```
WITH inp AS ( SELECT
  ST_AddMeasure('LINESTRING Z (0 0 0, 10 0 5)::geometry,
    extract(epoch from '2015-05-26 10:00'::timestampz),
    extract(epoch from '2015-05-26 11:00'::timestampz)
  ) a,
  ST_AddMeasure('LINESTRING Z (0 2 10, 12 1 2)::geometry,
    extract(epoch from '2015-05-26 10:00'::timestampz),
    extract(epoch from '2015-05-26 11:00'::timestampz)
  ) b
```

```
)
SELECT ST_CPAWithin(a,b,2), ST_DistanceCPA(a,b) distance FROM inp;

 st_cpawithin |      distance
-----+-----
 t             | 1.96521473776207
```

☒☒

[ST_IsValidTrajectory](#), [ST_ClosestPointOfApproach](#), [ST_DistanceCPA](#), [|](#) [=](#)

7.21 Version Functions

7.21.1 PostGIS_Extensions_Upgrade

PostGIS_Extensions_Upgrade — Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.

Synopsis

```
text PostGIS_Extensions_Upgrade(text target_version=null);
```

☒☒

Packages and upgrades PostGIS extensions to given or latest version. Only extensions you have installed in the database will be packaged and upgraded if needed. Reports full PostGIS version and build configuration infos after. This is short-hand for doing multiple CREATE EXTENSION .. FROM un-packaged and ALTER EXTENSION .. UPDATE for each PostGIS extension. Currently only tries to upgrade extensions postgis, postgis_raster, postgis_sfcgal, postgis_topology, and postgis_tiger_geocoder.

Availability: 2.5.0



Note

Changed: 3.4.0 to add target_version argument.

Changed: 3.3.0 support for upgrades from any PostGIS version. Does not work on all systems.

Changed: 3.0.0 to repackage loose extensions and support postgis_raster.

☒☒

```
SELECT PostGIS_Extensions_Upgrade();
```

```
NOTICE: Packaging extension postgis
NOTICE: Packaging extension postgis_raster
NOTICE: Packaging extension postgis_sfcgal
NOTICE: Extension postgis_topology is not available or not packagable for some reason
NOTICE: Extension postgis_tiger_geocoder is not available or not packagable for some reason
      reason

      postgis_extensions_upgrade
-----+-----
 Upgrade completed, run SELECT postgis_full_version(); for details
(1 row)
```


☒☒

Section [3.4](#), [PostGIS_GEOS_Version](#), [PostGIS_Lib_Version](#), [PostGIS_LibXML_Version](#), [PostGIS_PROJ_Version](#), [PostGIS_Version](#)

7.21.2 PostGIS_Full_Version

`PostGIS_Full_Version` — Reports full PostGIS version and build configuration infos.

Synopsis

text `PostGIS_Full_Version()`;

☒☒

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

Enhanced: 3.4.0 now includes extra PROJ configurations `NETWORK_ENABLED`, `URL_ENDPOINT` and `DATABASE_PATH` of `proj.db` location

☒☒

```
SELECT PostGIS_Full_Version();
                                     postgis_full_version
-----
POSTGIS="3.4.0dev 3.3.0rc2-993-g61bdf43a7" [EXTENSION] PGSQL="160" GEOS="3.12.0dev-CAPI ↔
-1.18.0" SFCGAL="1.3.8" PROJ="7.2.1 NETWORK_ENABLED=OFF URL_ENDPOINT=https://cdn.proj. ↔
org USER_WRITABLE_DIRECTORY=/tmp/proj DATABASE_PATH=/usr/share/proj/proj.db" GDAL="GDAL ↔
3.2.2, released 2021/03/05" LIBXML="2.9.10" LIBJSON="0.15" LIBPROTOBUF="1.3.3" WAGYU ↔
="0.5.0 (Internal)" TOPOLOGY RASTER
(1 row)
```

☒☒

Section [3.4](#), [PostGIS_GEOS_Version](#), [PostGIS_Lib_Version](#), [PostGIS_LibXML_Version](#), [PostGIS_PROJ_Version](#), [PostGIS_Wagyu_Version](#), [PostGIS_Version](#)

7.21.3 PostGIS_GEOS_Version

`PostGIS_GEOS_Version` — Returns the version number of the GEOS library.

Synopsis

text `PostGIS_GEOS_Version()`;

☒☒

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

☒☒

```
SELECT PostGIS_GEOS_Version();
   postgis_geos_version
-----
3.12.0dev-CAPI-1.18.0
(1 row)
```

☒☒

[PostGIS_Full_Version](#), [PostGIS_Lib_Version](#), [PostGIS_LibXML_Version](#), [PostGIS_PROJ_Version](#), [PostGIS_Version](#)

7.21.4 PostGIS_GEOS_Compiled_Version

`PostGIS_GEOS_Compiled_Version` — Returns the version number of the GEOS library against which PostGIS was built.

Synopsis

text `PostGIS_GEOS_Compiled_Version()`;

☒☒

Returns the version number of the GEOS library, or against which PostGIS was built.

Availability: 3.4.0

☒☒

```
SELECT PostGIS_GEOS_Compiled_Version();
   postgis_geos_compiled_version
-----
3.12.0
(1 row)
```

☒☒

[PostGIS_GEOS_Version](#), [PostGIS_Full_Version](#)

7.21.5 PostGIS_Liblwgeom_Version

`PostGIS_Liblwgeom_Version` — Returns the version number of the liblwgeom library. This should match the version of PostGIS.

Synopsis

text `PostGIS_Liblwgeom_Version()`;

☒☒

Returns the version number of the liblwgeom library/

☒☒

```
SELECT PostGIS_Liblwgeom_Version();
postgis_liblwgeom_version
-----
3.4.0dev 3.3.0rc2-993-g61bdf43a7
(1 row)
```

☒☒

[PostGIS_Full_Version](#), [PostGIS_Lib_Version](#), [PostGIS_LibXML_Version](#), [PostGIS_PROJ_Version](#), [PostGIS_Version](#)

7.21.6 PostGIS_LibXML_Version

`PostGIS_LibXML_Version` — Returns the version number of the libxml2 library.

Synopsis

text `PostGIS_LibXML_Version()`;

☒☒

Returns the version number of the LibXML2 library.

1.5 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
SELECT PostGIS_LibXML_Version();
postgis_libxml_version
-----
2.9.10
(1 row)
```

☒☒

[PostGIS_Full_Version](#), [PostGIS_Lib_Version](#), [PostGIS_PROJ_Version](#), [PostGIS_GEOS_Version](#), [PostGIS_Version](#)

7.21.7 PostGIS_Lib_Build_Date

`PostGIS_Lib_Build_Date` — Returns build date of the PostGIS library.

Synopsis

text **PostGIS_Lib_Build_Date()**;

☒☒

Returns build date of the PostGIS library.

☒☒

```
SELECT PostGIS_Lib_Build_Date();
 postgis_lib_build_date
-----
2023-06-22 03:56:11
(1 row)
```

7.21.8 PostGIS_Lib_Version

PostGIS_Lib_Version — Returns the version number of the PostGIS library.

Synopsis

text **PostGIS_Lib_Version()**;

☒☒

Returns the version number of the PostGIS library.

☒☒

```
SELECT PostGIS_Lib_Version();
 postgis_lib_version
-----
3.4.0dev
(1 row)
```

☒☒

[PostGIS_Full_Version](#), [PostGIS_GEOS_Version](#), [PostGIS_LibXML_Version](#), [PostGIS_PROJ_Version](#), [PostGIS_Version](#)

7.21.9 PostGIS_PROJ_Version

PostGIS_PROJ_Version — Returns the version number of the PROJ4 library.

Synopsis

text **PostGIS_PROJ_Version()**;

☒☒

Returns the version number of the PROJ library and some configuration options of proj.

Enhanced: 3.4.0 now includes NETWORK_ENABLED, URL_ENDPOINT and DATABASE_PATH of proj.db location

☒☒

```
SELECT PostGIS_PROJ_Version();
   postgis_proj_version
-----
7.2.1 NETWORK_ENABLED=OFF URL_ENDPOINT=https://cdn.proj.org USER_WRITABLE_DIRECTORY=/tmp/ ↔
   proj DATABASE_PATH=/usr/share/proj/proj.db
(1 row)
```

☒☒

[PostGIS_PROJ_Compiled_Version](#), [PostGIS_Full_Version](#), [PostGIS_GEOS_Version](#), [PostGIS_Lib_Version](#), [PostGIS_LibXML_Version](#), [PostGIS_Version](#)

7.21.10 PostGIS_PROJ_Compiled_Version

`PostGIS_PROJ_Compiled_Version` — Returns the version number of the PROJ library against which PostGIS was built.

Synopsis

text `PostGIS_PROJ_Compiled_Version()`;

☒☒

Returns the version number of the PROJ library, or against which PostGIS was built.

Availability: 3.5.0

☒☒

```
SELECT PostGIS_PROJ_Compiled_Version();
   postgis_proj_compiled_version
-----
9.1.1
(1 row)
```

☒☒

[PostGIS_PROJ_Version](#), [PostGIS_Full_Version](#)

7.21.11 PostGIS_Wagyu_Version

PostGIS_Wagyu_Version — Returns the version number of the internal Wagyu library.

Synopsis

text **PostGIS_Wagyu_Version()**;

☒☒

Returns the version number of the internal Wagyu library, or NULL if Wagyu support is not enabled.

☒☒

```
SELECT PostGIS_Wagyu_Version();
 postgis_wagyu_version
-----
0.5.0 (Internal)
(1 row)
```

☒☒

[PostGIS_Full_Version](#), [PostGIS_GEOS_Version](#), [PostGIS_PROJ_Version](#), [PostGIS_Lib_Version](#), [PostGIS_LibXML2_Version](#), [PostGIS_Version](#)

7.21.12 PostGIS_Scripts_Build_Date

PostGIS_Scripts_Build_Date — Returns build date of the PostGIS scripts.

Synopsis

text **PostGIS_Scripts_Build_Date()**;

☒☒

Returns build date of the PostGIS scripts.

1.0.0RC1 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
SELECT PostGIS_Scripts_Build_Date();
 postgis_scripts_build_date
-----
2023-06-22 03:56:11
(1 row)
```

☒☒

[PostGIS_Full_Version](#), [PostGIS_GEOS_Version](#), [PostGIS_Lib_Version](#), [PostGIS_LibXML_Version](#), [PostGIS_Version](#)

7.21.13 PostGIS_Scripts_Installed

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

Synopsis

text `PostGIS_Scripts_Installed()`;

☒☒

Returns version of the PostGIS scripts installed in this database.



Note

If the output of this function doesn't match the output of [PostGIS_Scripts_Released](#) you probably missed to properly upgrade an existing database. See the [Upgrading](#) section for more info.

Availability: 0.9.0

☒☒

```
SELECT PostGIS_Scripts_Installed();
 postgis_scripts_installed
-----
 3.4.0dev 3.3.0rc2-993-g61bdf43a7
(1 row)
```

☒☒

[PostGIS_Full_Version](#), [PostGIS_Scripts_Released](#), [PostGIS_Version](#)

7.21.14 PostGIS_Scripts_Released

`PostGIS_Scripts_Released` — Returns the version number of the `postgis.sql` script released with the installed PostGIS lib.

Synopsis

text `PostGIS_Scripts_Released()`;

☒☒

Returns the version number of the postgis.sql script released with the installed PostGIS lib.



Note

Starting with version 1.1.0 this function returns the same value of `PostGIS_Lib_Version`. Kept for backward compatibility.

Availability: 0.9.0

☒☒

```
SELECT PostGIS_Scripts_Released();
       postgis_scripts_released
-----
3.4.0dev 3.3.0rc2-993-g61bdf43a7
(1 row)
```

☒☒

`PostGIS_Full_Version`, `PostGIS_Scripts_Installed`, `PostGIS_Lib_Version`

7.21.15 PostGIS_Version

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

Synopsis

text `PostGIS_Version()`;

☒☒

Returns PostGIS version number and compile-time options.

☒☒

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

☒☒

`PostGIS_Full_Version`, `PostGIS_GEOS_Version`, `PostGIS_Lib_Version`, `PostGIS_LibXML_Version`, `PostGIS_PROJ_Version`

7.22 PostGIS GUC(Grand Unified Custom Variable)

7.22.1 postgis.backend

`postgis.backend` — GEOS or SFCGAL. `geos` or `sfcgal`.

PostGIS `sfcgal` GUC. GEOS or SFCGAL `geos` or `sfcgal`.

2.1.0

```
set postgis.backend = sfcgal;
```

```
ALTER DATABASE mygisdb SET postgis.backend = sfcgal;
```

Chapter 8

7.22.2 postgis.gdal_datapath

`postgis.gdal datapath` — GDAL `GDAL_DATA`. `GDAL_DATA`.

GDAL `GDAL_DATA` PostgreSQL GUC. `postgis.gdal_datapath` `GDAL`.

GDAL (hard-coded) `GDAL`.



Note

PostgreSQL `postgresql.conf`.

2.2.0



Note

GDAL `GDAL_DATA`.

¶¶

postgis.gdal_datapath 简体中文。

```
SET postgis.gdal_datapath TO '/usr/local/share/gdal.hidden';
SET postgis.gdal_datapath TO default;
```

简体中文。

```
ALTER DATABASE gisdb
SET postgis.gdal_datapath = 'C:/Program Files/PostgreSQL/9.3/gdal-data';
```

¶¶

PostGIS_GDAL_Version, ST_Transform

7.22.3 postgis.gdal_enabled_drivers

postgis.gdal_enabled_drivers — PostGIS 简体中文 GDAL 简体中文。 GDAL 简体中文 GDAL_SKIP 简体中文。

¶¶

PostGIS 简体中文 GDAL 简体中文。 GDAL 简体中文 GDAL_SKIP 简体中文。 PostgreSQL 简体中文 postgresql.conf 简体中文。 简体中文

PostgreSQL 简体中文 POSTGIS_GDAL_ENABLED_DRIVERS 简体中文 (pass) 简体中文 postgis.gdal_enabled_drivers 简体中文。

简体中文 GDAL 简体中文。 简体中文 GDAL 简体中文 简体中文。

Note

postgis.gdal_enabled_drivers 简体中文。 简体中文



- DISABLE_ALL 简体中文 GDAL 简体中文。 DISABLE_ALL 简体中文, postgis.gdal_enabled_drivers 简体中文。
- ENABLE_ALL 简体中文 GDAL 简体中文。
- VSICURL 简体中文 GDAL 简体中文 /vsicurl/ 简体中文。

postgis.gdal_enabled_drivers 简体中文 DISABLE_ALL 简体中文, DB 简体中文, ST_FromGDALRaster(), ST_AsGDALRaster(), ST_AsTIFF(), ST_AsJPEG() 简体中文 ST_AsPNG() 简体中文。



Note

简体中文 PostGIS 简体中文, postgis.gdal_enabled_drivers 简体中文 DISABLE_ALL 简体中文。



Note

GDAL_SKIP GDAL [Configuration Options](#).

2.2.0

postgis.gdal_enabled_drivers

```
ALTER DATABASE mygisdb SET postgis.gdal_enabled_drivers TO 'GTiff PNG JPEG';
```

PostgreSQL 9.4

```
ALTER SYSTEM SET postgis.gdal_enabled_drivers TO 'GTiff PNG JPEG';
SELECT pg_reload_conf();
```

```
SET postgis.gdal_enabled_drivers TO 'GTiff PNG JPEG';
SET postgis.gdal_enabled_drivers = default;
```

GDAL

```
SET postgis.gdal_enabled_drivers = 'ENABLE_ALL';
```

GDAL

```
SET postgis.gdal_enabled_drivers = 'DISABLE_ALL';
```

[ST_FromGDALRaster](#), [ST_AsGDALRaster](#), [ST_AsTIFF](#), [ST_AsPNG](#), [ST_AsJPEG](#), [postgis.enable_outdb_raster](#)

7.22.4 postgis.enable_outdb_rasters

postgis.enable_outdb_rasters — DB

DB PostgreSQL postgresql.conf

PostgreSQL 0 POSTGIS_ENABLE_OUTDB_RASTERS (pass) postgis.enable_outdb_rasters



Note

postgis.enable_outdb_rasters, GUC postgis.enable_outdb_rasters



Note

PostGIS, `postgis.enable_outdb_rasters`.

2.2.0.

`postgis.enable_outdb_rasters`.

```
SET postgis.enable_outdb_rasters TO True;
SET postgis.enable_outdb_rasters = default;
SET postgis.enable_outdb_rasters = True;
SET postgis.enable_outdb_rasters = False;
```

Set for specific database

```
ALTER DATABASE gisdb SET postgis.enable_outdb_rasters = true;
```

Setting for whole database cluster. You need to reconnect to the database for changes to take effect.

```
--writes to postgres.auto.conf
ALTER SYSTEM postgis.enable_outdb_rasters = true;
--Reloads postgres conf
SELECT pg_reload_conf();
```

[postgis.gdal_enabled_drivers](#) [postgis.gdal_vsi_options](#)

7.22.5 postgis.gdal_vsi_options

`postgis.gdal_vsi_options` — DB

A string configuration to set options used when working with an out-db raster. [Configuration options](#) control things like how much space GDAL allocates to local data cache, whether to read overviews, and what access keys to use for remote out-db data sources.

Availability: 3.2.0

`postgis.enable_outdb_rasters`.

```
SET postgis.gdal_vsi_options = 'AWS_ACCESS_KEY_ID=xxxxxxxxxxxxxxxx AWS_SECRET_ACCESS_KEY=
yyyyyyyyyyyyyyyyyyyyyyyyyyyyyy';
```

Set `postgis.gdal_vsi_options` just for the *current transaction* using the LOCAL keyword:

```
SET LOCAL postgis.gdal_vsi_options = 'AWS_ACCESS_KEY_ID=xxxxxxxxxxxxxxxx ↔
AWS_SECRET_ACCESS_KEY=yyyyyyyyyyyyyyyyyyyyyyyyyyyyyy';
```


☒☒

```
SELECT geom
FROM sometable WHERE PostGIS_HasBBox(geom) = false;
```

☒☒

[PostGIS_AddBBox](#), [PostGIS_DropBBox](#)

Chapter 8

SFCGAL Functions Reference

SFCGAL is a 2D & 3D geometry engine based on CGAL, a C++ (wrapper) library. It is a fork of the SFCGAL library, which is a fork of the SFCGAL library.

SFCGAL is available at <http://www.sfcgal.org>. It is a fork of the SFCGAL library, which is a fork of the SFCGAL library. The SFCGAL library is a fork of the SFCGAL library.

8.1 SFCGAL Management Functions

8.1.1 postgis_sfcgal_version

`postgis_sfcgal_version` — Returns SFCGAL version.

Synopsis

```
text postgis_sfcgal_version(void);
```

⚠

⚠ SFCGAL version.

2.1.0 version.



This method needs SFCGAL backend.

⚠

`postgis_sfcgal_full_version`

8.1.2 postgis_sfcgal_full_version

`postgis_sfcgal_full_version` — Returns the full version of SFCGAL in use including CGAL and Boost versions

Synopsis

text **postgis_sfcgal_version**(void);



Returns the full version of SFCGAL in use including CGAL and Boost versions

Availability: 3.3.0



This method needs SFCGAL backend.



[postgis_sfcgal_version](#)

8.2 SFCGAL Accessors and Setters

8.2.1 CG_ForceLHR

CG_ForceLHR — LHR(Left Hand Reverse;  ).

Synopsis

geometry **CG_ForceLHR**(geometry geom);



Availability: 3.5.0



This method needs SFCGAL backend.



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



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.2.2 CG_IsPlanar

CG_IsPlanar —                  .

Synopsis

boolean **CG_IsPlanar**(geometry geom);

8.2.5 CG_Orientation



CG_Orientation — (orientation)

Synopsis

integer **CG_Orientation**(geometry geom);

. -1 , 1 .

Availability: 3.5.0

-  This method needs SFCGAL backend.
-  This function supports 3d and will not drop the z-index.

8.2.6 CG_Area

CG_Area — Calculates the area of a geometry

Synopsis

double precision **CG_Area**(geometry geom);


Calculates the area of a geometry.
Performed by the SFCGAL module



Note

NOTE: this function returns a double precision value representing the area.

Availability: 3.5.0

-  This method needs SFCGAL backend.

```
SELECT CG_Area('Polygon ((0 0, 0 5, 5 5, 5 0, 0 0), (1 1, 2 1, 2 2, 1 2, 1 1), (3 3, 4 3, 4 4, 3 4, 3 3))');
      cg_area
-----
      25
(1 row)
```


Synopsis

```
float CG_Volume(geometry geom1);
```

☒☒

Availability: 3.5.0

- ✔ This method needs SFCGAL backend.
- ✔ This function supports 3d and will not drop the z-index.
- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).
- ✔ This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 9.1 (same as CG_3DVolume)

☒☒

When closed surfaces are created with WKT, they are treated as areal rather than solid. To make them solid, you need to use [CG_MakeSolid](#). Areal geometries have no volume. Here is an example to demonstrate.

```
SELECT CG_Volume(geom) As cube_surface_vol,
       CG_Volume(CG_MakeSolid(geom)) As solid_surface_vol
FROM (SELECT 'POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
  ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
  ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
  ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
  ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
  ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )'::geometry) As f(geom);

cube_surface_vol | solid_surface_vol
-----+-----
0 | 1
```

☒☒

[CG_3DArea](#), [CG_MakeSolid](#), [CG_IsSolid](#)

8.2.9 ST_ForceLHR

ST_ForceLHR — LHR(Left Hand Reverse; ☒☒☒☒) ☒☒☒☒☒☒☒☒.

Synopsis

```
geometry ST_ForceLHR(geometry geom);
```



```

SELECT ST_Volume(geom) As cube_surface_vol,
       ST_Volume(ST_MakeSolid(geom)) As solid_surface_vol
FROM (SELECT 'POLYHEDRALSURFACE( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
  ((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)),
  ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
  ((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
  ((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)),
  ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )'::geometry) As f(geom);

cube_surface_vol | solid_surface_vol
-----+-----
0 | 1

```

☒☒

[ST_3DArea](#), [ST_MakeSolid](#), [ST_IsSolid](#)

8.3 SFCGAL Processing and Relationship Functions

8.3.1 CG_Intersection

CG_Intersection — Computes the intersection of two geometries

Synopsis

geometry **CG_Intersection**(geometry geomA , geometry geomB);

☒☒

Computes the intersection of two geometries.

Performed by the SFCGAL module



Note

NOTE: this function returns a geometry representing the intersection.

Availability: 3.5.0



This method needs SFCGAL backend.

☒☒☒☒

```

SELECT ST_AsText(CG_Intersection('LINESTRING(0 0, 5 5)', 'LINESTRING(5 0, 0 5)'));
       cg_intersection
-----
POINT(2.5 2.5)
(1 row)

```

 ☒☒

[ST_3DIntersection](#), [ST_Intersection](#)

8.3.2 CG_Intersects

CG_Intersects — Tests if two geometries intersect (they have at least one point in common)

Synopsis

boolean **CG_Intersects**(geometry geomA , geometry geomB);

☒☒

Returns true if two geometries intersect. Geometries intersect if they have any point in common.

Performed by the SFCGAL module



Note

NOTE: this is the "allowable" version that returns a boolean, not an integer.

Availability: 3.5.0



This method needs SFCGAL backend.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```
SELECT CG_Intersects('POINT(0 0)::geometry, 'LINESTRING ( 2 0, 0 2 ) '::geometry);
   cg_intersects
-----
f
(1 row)
SELECT CG_Intersects('POINT(0 0)::geometry, 'LINESTRING ( 0 0, 0 2 ) '::geometry);
   cg_intersects
-----
t
(1 row)
```

☒☒

[CG_3DIntersects](#), [ST_3DIntersects](#), [ST_Intersects](#), [ST_Disjoint](#)

8.3.3 CG_3DIntersects

CG_3DIntersects — Tests if two 3D geometries intersect

Synopsis

boolean **CG_3DIntersects**(geometry geomA , geometry geomB);

☒☒

Tests if two 3D geometries intersect. 3D geometries intersect if they have any point in common in the three-dimensional space.

Performed by the SFCGAL module



Note

NOTE: this is the "allowable" version that returns a boolean, not an integer.

Availability: 3.5.0



This method needs SFCGAL backend.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```
SELECT CG_3DIntersects('POINT(1.2 0.1 0)', 'POLYHEDRALSURFACE(((0 0 0,0.5 0.5 0,1 0 0,1 1 0,0 1 0,0 0 0)),((1 0 0,2 0 0,2 1 0,1 1 0,1 0 0),(1.2 0.2 0,1.2 0.8 0,1.8 0.8 0,1.8 0.2 0,1.2 0.2 0)))');
   cg_3dintersects
   -----
   t
   (1 row)
```

☒☒

[CG_Intersects](#), [ST_3DIntersects](#), [ST_Intersects](#), [ST_Disjoint](#)

8.3.4 CG_Difference

CG_Difference — Computes the geometric difference between two geometries

Synopsis

geometry **CG_Difference**(geometry geomA , geometry geomB);

☒☒

Computes the geometric difference between two geometries. The resulting geometry is a set of points that are present in geomA but not in geomB.

Performed by the SFCGAL module



Note

NOTE: this function returns a geometry.

Availability: 3.5.0



This method needs SFCGAL backend.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```
SELECT ST_AsText(CG_Difference('POLYGON((0 0, 0 1, 1 1, 1 0, 0 0))'::geometry, 'LINESTRING ↔
(0 0, 2 2)'::geometry));
cg_difference
-----
POLYGON((0 0,1 0,1 1,0 1,0 0))
(1 row)
```

☒☒

[ST_3DDifference](#), [ST_Difference](#)

8.3.5 ST_3DDifference

ST_3DDifference — 3 ☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_3DDifference**(geometry geom1, geometry geom2);

☒☒








Warning

[ST_3DDifference](#) is deprecated as of 3.5.0. Use [CG_3DDifference](#) instead.

geom2 ST_3DDifference(geom1).

2.2.0

-  This method needs SFCGAL backend.
-  This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1
-  This function supports 3d and will not drop the z-index.
-  This function supports Polyhedral surfaces.
-  This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.6 CG_3DDifference

CG_3DDifference — 3

Synopsis

geometry CG_3DDifference(geometry geom1, geometry geom2);








Warning

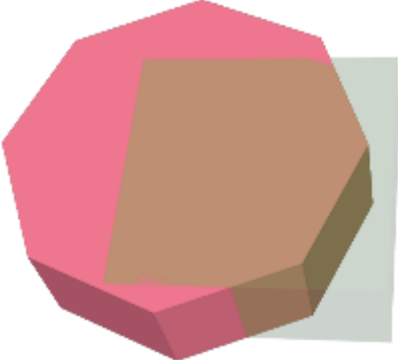
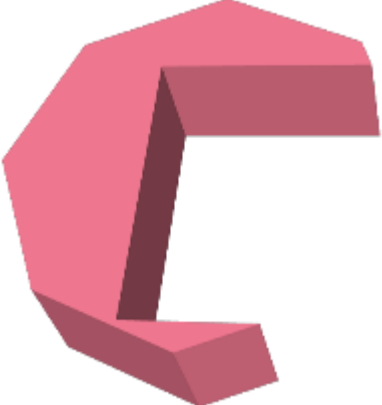
CG_3DDifference is deprecated as of 3.5.0. Use ST_3DDifference instead.

geom2 ST_3DDifference(geom1).

Availability: 3.5.0

-  This method needs SFCGAL backend.
-  This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1
-  This function supports 3d and will not drop the z-index.
-  This function supports Polyhedral surfaces.
-  This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

PostGIS ST_AsX3D 3 X3Dom HTML HTML

<pre>SELECT CG_Extrude(ST_Buffer(ST_GeomFromText('POINT(100 90)'), CG_Extrude(ST_Buffer(ST_GeomFromText('POINT(80 80)'), 50, 'quad_segs=1'),0,0,30) AS geom2;</pre>  <p>3 <i>geom2</i></p>	<pre>SELECT CG_3DDifference(geom1,geom2) AS geom1, CG_Extrude(ST_Buffer(ST_GeomFromText('POINT(80 80)'), 50, 'quad_segs=1'),0,0,30) AS geom2) As t;</pre>  <p><i>geom2</i></p>
--	--

[CG_Extrude](#), [ST_AsX3D](#), [CG_3DIntersection](#) [CG_3DUnion](#)

8.3.7 CG_Distance

CG_Distance — Computes the minimum distance between two geometries

Synopsis

double precision **CG_Distance**(geometry geomA , geometry geomB);

Computes the minimum distance between two geometries.

Performed by the SFCGAL module



Note

NOTE: this function returns a double precision value representing the distance.

Availability: 3.5.0

- ✔ This method needs SFCGAL backend.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```
SELECT CG_Distance('LINESTRING(0.0 0.0,-1.0 -1.0)', 'LINESTRING(3.0 4.0,4.0 5.0)');
   cg_distance
-----
      2.0
(1 row)
```

☒☒

[CG_3DDistance](#), [CG_Distance](#)

8.3.8 CG_3DDistance

CG_3DDistance — Computes the minimum 3D distance between two geometries

Synopsis

double precision **CG_3DDistance**(geometry geomA , geometry geomB);

☒☒

Computes the minimum 3D distance between two geometries.

Performed by the SFCGAL module



Note

NOTE: this function returns a double precision value representing the 3D distance.

Availability: 3.5.0

- ✔ This method needs SFCGAL backend.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒☒☒

```
SELECT CG_3DDistance('LINESTRING(-1.0 0.0 2.0,1.0 0.0 3.0)', 'TRIANGLE((-4.0 0.0 1.0,4.0 0.0 1.0,0.0 4.0 1.0,-4.0 0.0 1.0))');
   cg_3ddistance
-----
              1
(1 row)
```




[CG_Distance](#), [ST_3DDistance](#)

8.3.9 ST_3DConvexHull

ST_3DConvexHull — 

Synopsis





geometry **ST_3DConvexHull**(geometry geom1);



Warning

ST_3DConvexHull is deprecated as of 3.5.0. Use [CG_3DConvexHull](#) instead.

Availability: 3.3.0

-  This method needs SFCGAL backend.
-  This function supports 3d and will not drop the z-index.
-  This function supports Polyhedral surfaces.
-  This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.10 CG_3DConvexHull





CG_3DConvexHull — 

Synopsis

geometry **CG_3DConvexHull**(geometry geom1);



Availability: 3.5.0

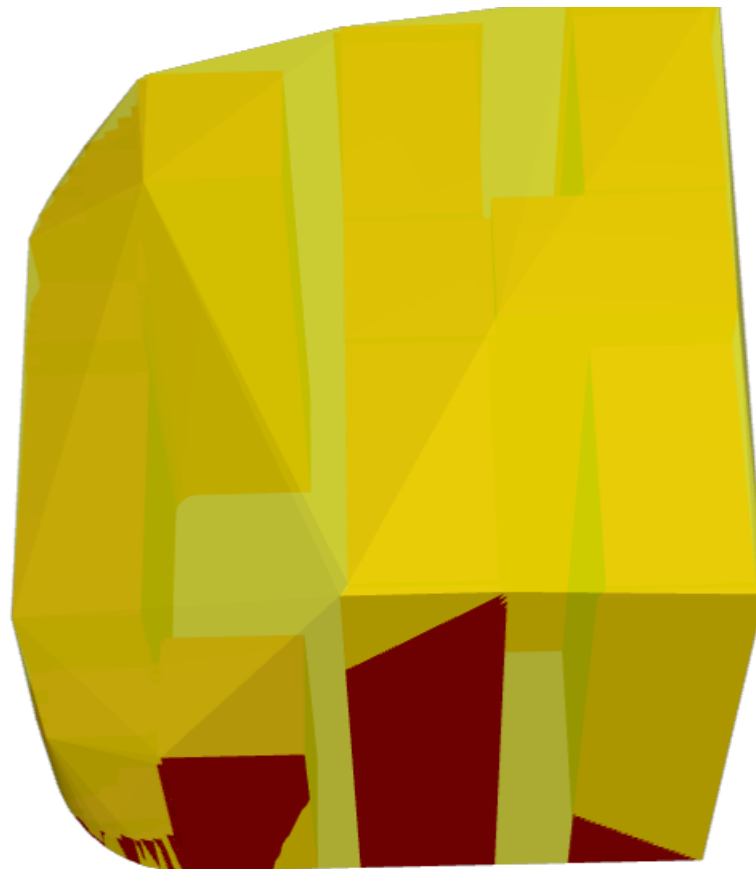
-  This method needs SFCGAL backend.
-  This function supports 3d and will not drop the z-index.
-  This function supports Polyhedral surfaces.
-  This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
SELECT ST_AsText(CG_3DConvexHull('LINESTRING Z(0 0 5, 1 5 3, 5 7 6, 9 5 3 , 5 7 5, 6 3 5) ←
  '::geometry));
```

```
POLYHEDRALSURFACE Z (((1 5 3,9 5 3,0 0 5,1 5 3)),((1 5 3,0 0 5,5 7 6,1 5 3)),((5 7 6,5 7 ←
  5,1 5 3,5 7 6)),((0 0 5,6 3 5,5 7 6,0 0 5)),((6 3 5,9 5 3,5 7 6,6 3 5)),((0 0 5,9 5 3,6 ←
  3 5,0 0 5)),((9 5 3,5 7 5,5 7 6,9 5 3)),((1 5 3,5 7 5,9 5 3,1 5 3)))
```

```
WITH f AS (SELECT i, CG_Extrude(geom, 0,0, i ) AS geom
  FROM ST_Subdivide(ST_Letters('CH'),5) WITH ORDINALITY AS sd(geom,i)
 )
SELECT CG_3DConvexHull(ST_Collect(f.geom) )
FROM f;
```



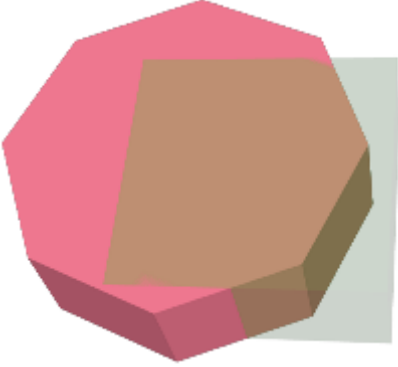
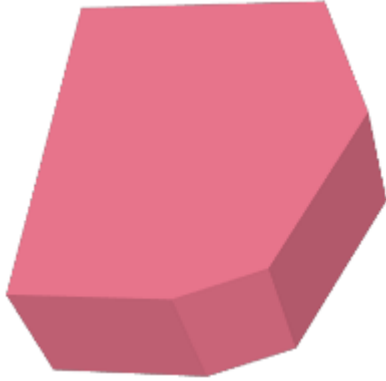
Original geometry overlaid with 3D convex hull

☒☒

[ST_Letters](#), [ST_AsX3D](#)

8.3.11 ST_3DIntersection

ST_3DIntersection — 3 ☒☒☒☒☒☒☒☒☒☒.

<pre>SELECT CG_Extrude(ST_Buffer(ST_GeomFromText('POINT(100 90)'), CG_Extrude(ST_Buffer(ST_GeomFromText('POINT(80 80)'), 50, ' quad_segs=1'),0,0,30) AS geom2;</pre>  <p>3 . geom2</p>	<pre>SELECT CG_3DIntersection(geom1,geom2) 50, ' quad_segs=2'),0,0,30) AS geom1, quad_segs=2'),0,0,30) AS geom1, CG_Extrude(ST_Buffer(ST_GeomFromText('PO 50, ' quad_segs=1'),0,0,30) AS geom2) As t;</pre>  <p>geom1 geom2</p>
--	--

3

```
SELECT ST_AsText(CG_3DIntersection(linestring, polygon)) As wkt
FROM ST_GeomFromText('LINESTRING Z (2 2 6,1.5 1.5 7,1 1 8,0.5 0.5 8,0 0 10)') AS
linestring
CROSS JOIN ST_GeomFromText('POLYGON((0 0 8, 0 1 8, 1 1 8, 1 0 8, 0 0 8))') AS polygon;

wkt
-----
LINESTRING Z (1 1 8,0.5 0.5 8)
```

() Z

```
SELECT ST_AsText(CG_3DIntersection(
ST_GeomFromText('POLYHEDRALSURFACE Z( ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)),
((0 0 0, 0 1 0, 1 1 0, 1 0 0, 0 0 0)), ((0 0 0, 1 0 0, 1 0 1, 0 0 1, 0 0 0)),
((1 1 0, 1 1 1, 1 0 1, 1 0 0, 1 1 0)),
((0 1 0, 0 1 1, 1 1 1, 1 1 0, 0 1 0)), ((0 0 1, 1 0 1, 1 1 1, 0 1 1, 0 0 1)) )'),
'POLYGON Z ((0 0 0, 0 0 0.5, 0 0.5 0.5, 0 0.5 0, 0 0 0))'::geometry))
```

TIN Z (((0 0 0,0 0 0.5,0 0.5 0.5,0 0 0)),((0 0.5 0,0 0 0,0 0.5 0.5,0 0.5 0)))

(ST_Dimension 3)

```
SELECT ST_AsText(CG_3DIntersection( CG_Extrude(ST_Buffer('POINT(10 20)'::geometry,10,1)
,0,0,30),
CG_Extrude(ST_Buffer('POINT(10 20)'::geometry,10,1),2,0,10) ));
```

POLYHEDRALSURFACE Z (((13.33333333333333 13.33333333333333 10,20 20 0,20 20
10,13.33333333333333 13.33333333333333 10)),
((20 20 10,16.66666666666667 23.33333333333333 10,13.33333333333333 13.33333333333333
10,20 20 10)),

```
((20 20 0,16.6666666666667 23.3333333333333 10,20 20 10,20 20 0)),
((13.3333333333333 13.3333333333333 10,10 10 0,20 20 0,13.3333333333333 ←
 13.3333333333333 10)),
((16.6666666666667 23.3333333333333 10,12 28 10,13.3333333333333 13.3333333333333 ←
 10,16.6666666666667 23.3333333333333 10)),
((20 20 0,9.99999999999995 30 0,16.6666666666667 23.3333333333333 10,20 20 0)),
((10 10 0,9.99999999999995 30 0,20 20 0,10 10 0)),((13.3333333333333 ←
 13.3333333333333 10,12 12 10,10 10 0,13.3333333333333 13.3333333333333 10)),
((12 28 10,12 12 10,13.3333333333333 13.3333333333333 10,12 28 10)),
((16.6666666666667 23.3333333333333 10,9.99999999999995 30 0,12 28 ←
 10,16.6666666666667 23.3333333333333 10)),
((10 10 0,0 20 0,9.99999999999995 30 0,10 10 0)),
((12 12 10,11 11 10,10 10 0,12 12 10)),((12 28 10,11 11 10,12 12 10,12 28 10)),
((9.99999999999995 30 0,11 29 10,12 28 10,9.99999999999995 30 0)),((0 20 0,2 20 ←
 10,9.99999999999995 30 0,0 20 0)),
((10 10 0,2 20 10,0 20 0,10 10 0)),((11 11 10,2 20 10,10 10 0,11 11 10)),((12 28 ←
 10,11 29 10,11 11 10,12 28 10)),
((9.99999999999995 30 0,2 20 10,11 29 10,9.99999999999995 30 0)),((11 11 10,11 29 ←
 10,2 20 10,11 11 10)))
```

8.3.13 CG_Union

CG_Union — Computes the union of two geometries

Synopsis

geometry **CG_Union**(geometry geomA , geometry geomB);

☒☒

Computes the union of two geometries.

Performed by the SFCGAL module



Note

NOTE: this function returns a geometry representing the union.

Availability: 3.5.0



This method needs SFCGAL backend.

☒☒☒☒

```
SELECT CG_Union('POINT(.5 0)', 'LINESTRING(-1 0,1 0)');
      cg_union
      -----
LINESTRING(-1 0,0.5 0,1 0)
(1 row)
```

 ☒☒

[ST_3DUnion](#), [ST_AsBinary](#)

8.3.14 ST_3DUnion

ST_3DUnion — Perform 3D union.

Synopsis

geometry **ST_3DUnion**(geometry geom1, geometry geom2);
 geometry **ST_3DUnion**(geometry set g1field);

 ☒☒



Warning

[ST_3DUnion](#) is deprecated as of 3.5.0. Use [CG_3DUnion](#) instead.

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Availability: 3.3.0 aggregate variant was added

- ✔ This method needs SFCGAL backend.
- ✔ This method implements the SQL/MM specification. SQL-MM IEC 13249-3: 5.1
- ✔ This function supports 3d and will not drop the z-index.
- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

Aggregate variant: returns a geometry that is the 3D union of a rowset of geometries. The ST_3DUnion() function is an “aggregate” function in the terminology of PostgreSQL. That means that it operates on rows of data, in the same way the SUM() and AVG() functions do and like most aggregates, it also ignores NULL geometries.

8.3.15 CG_3DUnion

CG_3DUnion — Perform 3D union.

Synopsis

geometry **CG_3DUnion**(geometry geom1, geometry geom2);
 geometry **CG_3DUnion**(geometry set g1field);

☒☒

[CG_Extrude](#), [ST_AsX3D](#), [CG_3DIntersection](#) [CG_3DDifference](#)

8.3.16 ST_AlphaShape

ST_AlphaShape — Computes an Alpha-shape enclosing a geometry

Synopsis

geometry **ST_AlphaShape**(geometry geom, float alpha, boolean allow_holes = false);

☒☒

**Warning**

[ST_AlphaShape](#) is deprecated as of 3.5.0. Use [CG_AlphaShape](#) instead.

Computes the [Alpha-Shape](#) of the points in a geometry. An alpha-shape is a (usually) concave polygonal geometry which contains all the vertices of the input, and whose vertices are a subset of the input vertices. An alpha-shape provides a closer fit to the shape of the input than the shape produced by the [convex hull](#).

8.3.17 CG_AlphaShape

CG_AlphaShape — Computes an Alpha-shape enclosing a geometry

Synopsis

geometry **CG_AlphaShape**(geometry geom, float alpha, boolean allow_holes = false);

☒☒

Computes the [Alpha-Shape](#) of the points in a geometry. An alpha-shape is a (usually) concave polygonal geometry which contains all the vertices of the input, and whose vertices are a subset of the input vertices. An alpha-shape provides a closer fit to the shape of the input than the shape produced by the [convex hull](#).

The “closeness of fit” is controlled by the alpha parameter, which can have values from 0 to infinity. Smaller alpha values produce more concave results. Alpha values greater than some data-dependent value produce the convex hull of the input.

Note

Following the CGAL implementation, the alpha value is the *square* of the radius of the disc used in the Alpha-Shape algorithm to “erode” the Delaunay Triangulation of the input points. See [CGAL Alpha-Shapes](#) for more information. This is different from the original definition of alpha-shapes, which defines alpha as the radius of the eroding disc.

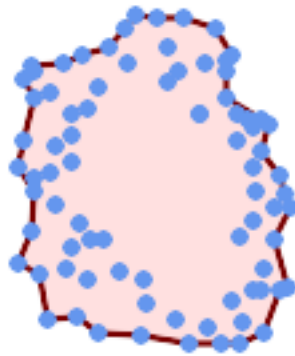
The computed shape does not contain holes unless the optional `allow_holes` argument is specified as `true`.

This function effectively computes a concave hull of a geometry in a similar way to `ST_ConcaveHull`, but uses CGAL and a different algorithm.

Availability: 3.5.0 - requires SFCGAL \geq 1.4.1.



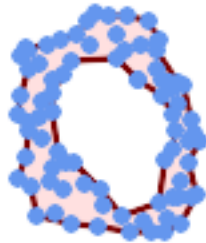
This method needs SFCGAL backend.



Alpha-shape of a MultiPoint (same example As `CG_OptimalAlphaShape`)

```
SELECT ST_AsText(CG_AlphaShape('MULTIPOINT((63 84),(76 88),(68 73),(53 18),(91 50),(81 70),
(88 29),(24 82),(32 51),(37 23),(27 54),(84 19),(75 87),(44 42),(77 67),(90 30) ←
,(36 61),(32 65),
(81 47),(88 58),(68 73),(49 95),(81 60),(87 50),
(78 16),(79 21),(30 22),(78 43),(26 85),(48 34),(35 35),(36 40),(31 79),(83 29) ←
,(27 84),(52 98),(72 95),(85 71),
(75 84),(75 77),(81 29),(77 73),(41 42),(83 72),(23 36),(89 53),(27 57),(57 97) ←
,(27 77),(39 88),(60 81),
(80 72),(54 32),(55 26),(62 22),(70 20),(76 27),(84 35),(87 42),(82 54),(83 64) ←
,(69 86),(60 90),(50 86),(43 80),(36 73),
(36 68),(40 75),(24 67),(23 60),(26 44),(28 33),(40 32),(43 19),(65 16),(73 16) ←
,(38 46),(31 59),(34 86),(45 90),(64 97)')::geometry,80.2));
```

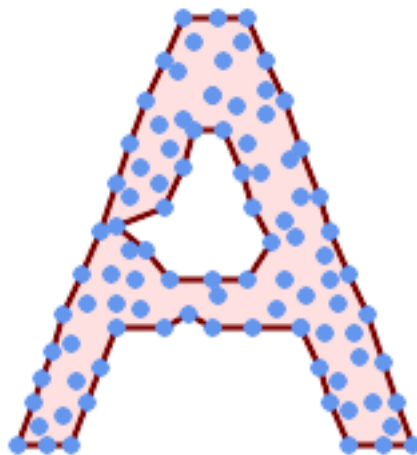
```
POLYGON((89 53,91 50,87 42,90 30,88 29,84 19,78 16,73 16,65 16,53 18,43 19,
37 23,30 22,28 33,23 36,26 44,27 54,23 60,24 67,27 77,
24 82,26 85,34 86,39 88,45 90,49 95,52 98,57 97,
64 97,72 95,76 88,75 84,83 72,85 71,88 58,89 53))
```



Alpha-shape of a MultiPoint, allowing holes (same example as [CG_OptimalAlphaShape](#))

```
SELECT ST_AsText(CG_AlphaShape('MULTIPOINT((63 84),(76 88),(68 73),(53 18),(91 50),(81 70) ←
, (88 29),(24 82),(32 51),(37 23),(27 54),(84 19),(75 87),(44 42),(77 67),(90 30),(36 61) ←
, (32 65),(81 47),(88 58),(68 73),(49 95),(81 60),(87 50),
(78 16),(79 21),(30 22),(78 43),(26 85),(48 34),(35 35),(36 40),(31 79),(83 29),(27 84) ←
, (52 98),(72 95),(85 71),
(75 84),(75 77),(81 29),(77 73),(41 42),(83 72),(23 36),(89 53),(27 57),(57 97),(27 77) ←
, (39 88),(60 81),
(80 72),(54 32),(55 26),(62 22),(70 20),(76 27),(84 35),(87 42),(82 54),(83 64),(69 86) ←
, (60 90),(50 86),(43 80),(36 73),
(36 68),(40 75),(24 67),(23 60),(26 44),(28 33),(40 32),(43 19),(65 16),(73 16),(38 46) ←
, (31 59),(34 86),(45 90),(64 97))'::geometry, 100.1,true))
```

```
POLYGON((89 53,91 50,87 42,90 30,84 19,78 16,73 16,65 16,53 18,43 19,30 22,28 33,23 36,
26 44,27 54,23 60,24 67,27 77,24 82,26 85,34 86,39 88,45 90,49 95,52 98,57 97,64 97,72 95,
76 88,75 84,83 72,85 71,88 58,89 53),(36 61,36 68,40 75,43 80,60 81,68 73,77 67,
81 60,82 54,81 47,78 43,76 27,62 22,54 32,44 42,38 46,36 61))
```



Alpha-shape of a MultiPoint, allowing holes (same example as [ST_ConcaveHull](#))

```
SELECT ST_AsText(CG_AlphaShape(
    'MULTIPOINT ((132 64), (114 64), (99 64), (81 64), (63 64), (57 49), (52 ←
    36), (46 20), (37 20), (26 20), (32 36), (39 55), (43 69), (50 84), (57 ←
    100), (63 118), (68 133), (74 149), (81 164), (88 180), (101 180), (112 ←
    180), (119 164), (126 149), (132 131), (139 113), (143 100), (150 84), ←
    (157 69), (163 51), (168 36), (174 20), (163 20), (150 20), (143 36), ←
    (139 49), (132 64), (99 151), (92 138), (88 124), (81 109), (74 93), (70 ←
    82), (83 82), (99 82), (112 82), (126 82), (121 96), (114 109), (110 ←
    122), (103 138), (99 151), (34 27), (43 31), (48 44), (46 58), (52 73), ←
    (63 73), (61 84), (72 71), (90 69), (101 76), (123 71), (141 62), (166 ←
    27), (150 33), (159 36), (146 44), (154 53), (152 62), (146 73), (134 ←
    76), (143 82), (141 91), (130 98), (126 104), (132 113), (128 127), (117 ←
    122), (112 133), (119 144), (108 147), (119 153), (110 171), (103 164), ←
    (92 171), (86 160), (88 142), (79 140), (72 124), (83 131), (79 118), ←
    (68 113), (63 102), (68 93), (35 45))'::geometry,102.2, true));
```

```
POLYGON((26 20,32 36,35 45,39 55,43 69,50 84,57 100,63 118,68 133,74 149,81 164,88 180,
    101 180,112 180,119 164,126 149,132 131,139 113,143 100,150 84,157 69,163 ←
    51,168 36,
    174 20,163 20,150 20,143 36,139 49,132 64,114 64,99 64,90 69,81 64,63 64,57 ←
    49,52 36,46 20,37 20,26 20),
    (74 93,81 109,88 124,92 138,103 138,110 122,114 109,121 96,112 82,99 82,83 ←
    82,74 93))
```

☒☒

[ST_ConcaveHull, CG_OptimalAlphaShape](#)

8.3.18 CG_ApproxConvexPartition

CG_ApproxConvexPartition — Computes approximal convex partition of the polygon geometry

Synopsis

```
geometry CG_ApproxConvexPartition(geometry geom);
```

☒☒

Computes approximal convex partition of the polygon geometry (using a triangulation).

Note

A partition of a polygon P is a set of polygons such that the interiors of the polygons do not intersect and the union of the polygons is equal to the interior of the original polygon P. CG_ApproxConvexPartition and CG_GreeneApproxConvexPartition functions produce approximately optimal convex partitions. Both these functions produce convex decompositions by first decomposing the polygon into simpler polygons; CG_ApproxConvexPartition uses a triangulation and CG_GreeneApproxConvexPartition a monotone partition. These two functions both guarantee that they will produce no more than four times the optimal number of convex pieces but they differ in their runtime complexities. Though the triangulation-based approximation algorithm often results in fewer convex pieces, this is not always the case.

 Note!

 ☒☒
**Warning**

`ST_ApproximateMedialAxis` is deprecated as of 3.5.0. Use `CG_ApproximateMedialAxis` instead.

Return an approximate medial axis for the areal input based on its straight skeleton. Uses an SFCGAL specific API when built against a capable version (1.2.0+). Otherwise the function is just a wrapper around `CG_StraightSkeleton` (slower case).

2.2.0 ☒☒☒☒☒☒☒☒☒☒☒.



This method needs SFCGAL backend.



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



This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.20 `CG_ApproximateMedialAxis`

`CG_ApproximateMedialAxis` — ☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **`CG_ApproximateMedialAxis`**(geometry geom);

☒☒

Return an approximate medial axis for the areal input based on its straight skeleton. Uses an SFCGAL specific API when built against a capable version (1.2.0+). Otherwise the function is just a wrapper around `CG_StraightSkeleton` (slower case).

Availability: 3.5.0



This method needs SFCGAL backend.



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



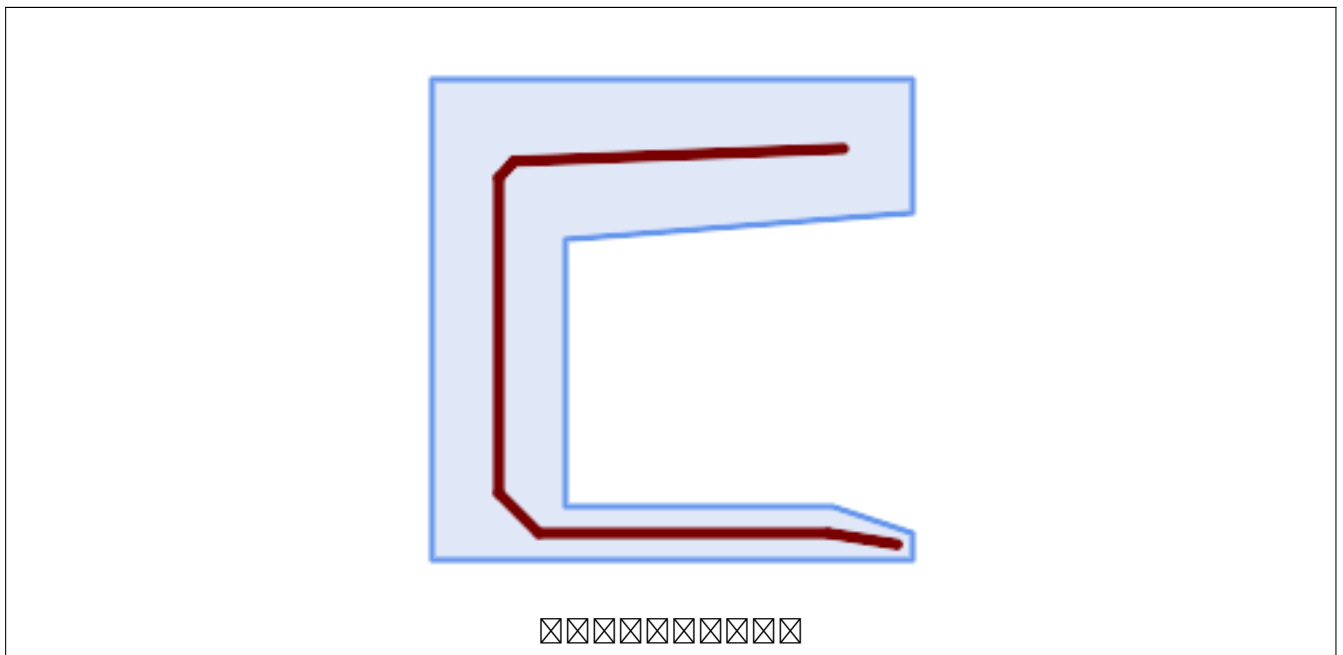
This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
SELECT CG_ApproximateMedialAxis(ST_GeomFromText('POLYGON (( 190 190, 10 190, 10 10, 190 10, ↵
  190 20, 160 30, 60 30, 60 130, 190 140, 190 190 ))'));
```



☒☒

[CG_StraightSkeleton](#)

8.3.21 ST_ConstrainedDelaunayTriangles

ST_ConstrainedDelaunayTriangles — Return a constrained Delaunay triangulation around the given input geometry.

Synopsis

```
geometry ST_ConstrainedDelaunayTriangles(geometry g1);
```

☒☒



Warning

[ST_ConstrainedDelaunayTriangles](#) is deprecated as of 3.5.0. Use [CG_ConstrainedDelaunayTriangles](#) instead.

Return a **Constrained Delaunay triangulation** around the vertices of the input geometry. Output is a TIN.

✔ This method needs SFCGAL backend.

2.1.0 ☒☒☒☒☒☒☒☒☒☒.

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

8.3.22 CG_ConstrainedDelaunayTriangles

CG_ConstrainedDelaunayTriangles — Return a constrained Delaunay triangulation around the given input geometry.

Synopsis

```
geometry CG_ConstrainedDelaunayTriangles(geometry g1);
```





Warning

`CG_ConstrainedDelaunayTriangles` is deprecated as of 3.5.0. Use `CG_ConstrainedDelaunayTriangles` instead.

Return a **Constrained Delaunay triangulation** around the vertices of the input geometry. Output is a TIN.



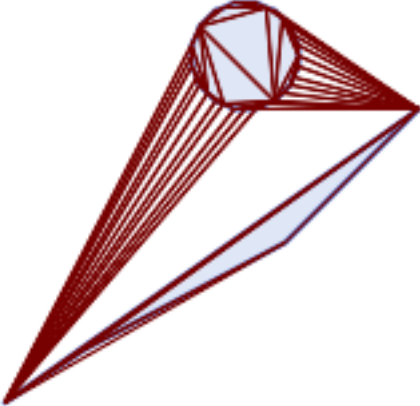
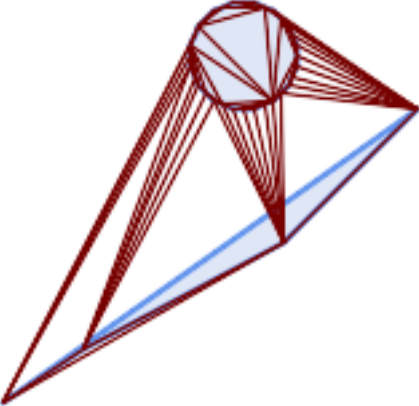
This method needs SFCGAL backend.

2.1.0     .



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



	
<p><i>CG_ConstrainedDelaunayTriangles of 2 polygons</i></p>	<p><i>ST_DelaunayTriangles of 2 polygons. Triangle edges cross polygon boundaries.</i></p>
<pre>select CG_ConstrainedDelaunayTriangles(ST_Union(POLYGON((175 150, 20 40, 50 60, 125 100, 175 150)), ST_Buffer('POINT(110 170)::geometry, 20)));</pre>	<pre>select ST_DelaunayTriangles(ST_Union(POLYGON((175 150, 20 40, 50 60, 125 100, 175 150)), ST_Buffer('POINT(110 170)::geometry, 20)));</pre>

☒☒

[ST_DelaunayTriangles](#), [ST_TriangulatePolygon](#), [CG_Tessellate](#), [ST_ConcaveHull](#), [ST_Dump](#)

8.3.23 ST_Extrude

ST_Extrude — ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

geometry **ST_Extrude**(geometry geom, float x, float y, float z);





☒☒



Warning

ST_Extrude is deprecated as of 3.5.0. Use **CG_Extrude** instead.

2.1.0 

-  This method needs SFCGAL backend.
-  This function supports 3d and will not drop the z-index.
-  This function supports Polyhedral surfaces.
-  This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.24 CG_Extrude





CG_Extrude — 

Synopsis

geometry **CG_Extrude**(geometry geom, float x, float y, float z);



Availability: 3.5.0

-  This method needs SFCGAL backend.
-  This function supports 3d and will not drop the z-index.
-  This function supports Polyhedral surfaces.
-  This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).



PostGIS [ST_AsX3D](#)  3  [X3Dom HTML](#)     
[HTML](#)  .

8.3.25 CG_ExtrudeStraightSkeleton

CG_ExtrudeStraightSkeleton — Straight Skeleton Extrusion

Synopsis

geometry **CG_ExtrudeStraightSkeleton**(geometry geom, float roof_height, float body_height = 0);

☒☒

Computes an extrusion with a maximal height of the polygon geometry.

Note



Perhaps the first (historically) use-case of straight skeletons: given a polygonal roof, the straight skeleton directly gives the layout of each tent. If each skeleton edge is lifted from the plane a height equal to its offset distance, the resulting roof is "correct" in that water will always fall down to the contour edges (the roof's border), regardless of where it falls on the roof. The function computes this extrusion aka "roof" on a polygon. If the argument `body_height > 0`, so the polygon is extruded like with `CG_Extrude(polygon, 0, 0, body_height)`. The result is an union of these polyhedralsurfaces.

Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0



This method needs SFCGAL backend.

☒☒

```
SELECT ST_AsText(CG_ExtrudeStraightSkeleton('POLYGON (( 0 0, 5 0, 5 5, 4 5, 4 4, 0 4, 0 0 ) ←
, (1 1, 1 2, 2 2, 2 1, 1 1))', 3.0, 2.0));
```

```
POLYHEDRALSURFACE Z (((0 0 0,0 4 0,4 4 0,4 5 0,5 5 0,5 0 0,0 0 0),(1 1 0,2 1 0,2 2 0,1 2 ←
0,1 1 0)),((0 0 0,0 0 2,0 4 2,0 4 0,0 0 0)),((0 4 0,0 4 2,4 4 2,4 4 0,0 4 0)),((4 4 0,4 ←
4 2,4 5 2,4 5 0,4 4 0)),((4 5 0,4 5 2,5 5 2,5 5 0,4 5 0)),((5 5 0,5 5 2,5 0 2,5 0 0,5 5 ←
0)),((5 0 0,5 0 2,0 0 2,0 0 0,5 0 0)),((1 1 0,1 1 2,2 1 2,2 1 0,1 1 0)),((2 1 0,2 1 2,2 ←
2 2,2 2 0,2 1 0)),((2 2 0,2 2 2,1 2 2,1 2 0,2 2 0)),((1 2 0,1 2 2,1 1 2,1 1 0,1 2 0) ←
,((4 5 2,5 5 2,4 4 2,4 5 2)),((2 1 2,5 0 2,0 0 2,2 1 2)),((5 5 2,5 0 2,4 4 2,5 5 2)),((2 ←
1 2,0 0 2,1 1 2,2 1 2)),((1 2 2,1 1 2,0 0 2,1 2 2)),((0 4 2,2 2 2,1 2 2,0 4 2)),((0 4 ←
2,1 2 2,0 0 2,0 4 2)),((4 4 2,5 0 2,2 2 2,4 4 2)),((4 4 2,2 2 2,0 4 2,4 4 2)),((2 2 2,5 ←
0 2,2 1 2,2 2 2)),((0.5 2.5 2.5,0 0 2,0.5 0.5 2.5,0.5 2.5 2.5)),((1 3 3,0 4 2,0.5 2.5 ←
2.5,1 3 3)),((0.5 2.5 2.5,0 4 2,0 0 2,0.5 2.5 2.5)),((2.5 0.5 2.5,5 0 2,3.5 1.5 3.5,2.5 ←
0.5 2.5)),((0 0 2,5 0 2,2.5 0.5 2.5,0 0 2)),((0.5 0.5 2.5,0 0 2,2.5 0.5 2.5,0.5 0.5 2.5) ←
),((4.5 3.5 2.5,5 2,4.5 4.5 2.5,4.5 3.5 2.5)),((3.5 2.5 3.5,3.5 1.5 3.5,4.5 3.5 ←
2.5,3.5 2.5 3.5)),((4.5 3.5 2.5,5 0 2,5 2,4.5 3.5 2.5)),((3.5 1.5 3.5,5 0 2,4.5 3.5 ←
2.5,3.5 1.5 3.5)),((5 5 2,4 5 2,4.5 4.5 2.5,5 5 2)),((4.5 4.5 2.5,4 4 2,4.5 3.5 2.5,4.5 ←
4.5 2.5)),((4.5 4.5 2.5,4 5 2,4 4 2,4.5 4.5 2.5)),((3 3 3,0 4 2,1 3 3,3 3 3)),((3.5 2.5 ←
3.5,4.5 3.5 2.5,3 3 3,3.5 2.5 3.5)),((3 3 3,4 4 2,0 4 2,3 3 3)),((4.5 3.5 2.5,4 4 2,3 3 ←
3,4.5 3.5 2.5)),((2 1 2,1 1 2,0.5 0.5 2.5,2 1 2)),((2.5 0.5 2.5,2 1 2,0.5 0.5 2.5,2.5 ←
0.5 2.5)),((1 1 2,1 2 2,0.5 2.5 2.5,1 1 2)),((0.5 0.5 2.5,1 1 2,0.5 2.5 2.5,0.5 0.5 2.5) ←
),((1 3 3,2 2 2,3 3 3,1 3 3)),((0.5 2.5 2.5,1 2 2,1 3 3,0.5 2.5 2.5)),((1 3 3,1 2 2,2 2 ←
2,1 3 3)),((2 2 2,2 1 2,2.5 0.5 2.5,2 2 2)),((3.5 2.5 3.5,3 3 3,3.5 1.5 3.5,3.5 2.5 3.5) ←
),((3.5 1.5 3.5,2 2 2,2.5 0.5 2.5,3.5 1.5 3.5)),((3 3 3,2 2 2,3.5 1.5 3.5,3 3 3)))
```

☒☒

[ST_Extrude](#), [CG_StraightSkeleton](#)

8.3.26 CG_GreeneApproxConvexPartition

CG_GreeneApproxConvexPartition — Computes approximal convex partition of the polygon geometry

Synopsis

geometry **CG_GreeneApproxConvexPartition**(geometry geom);

☒☒

Computes approximal monotone convex partition of the polygon geometry.

Note

A partition of a polygon P is a set of polygons such that the interiors of the polygons do not intersect and the union of the polygons is equal to the interior of the original polygon P. CG_ApproxConvexPartition and CG_GreeneApproxConvexPartition functions produce approximately optimal convex partitions. Both these functions produce convex decompositions by first decomposing the polygon into simpler polygons; CG_ApproxConvexPartition uses a triangulation and CG_GreeneApproxConvexPartition a monotone partition. These two functions both guarantee that they will produce no more than four times the optimal number of convex pieces but they differ in their runtime complexities. Though the triangulation-based approximation algorithm often results in fewer convex pieces, this is not always the case.

Note!

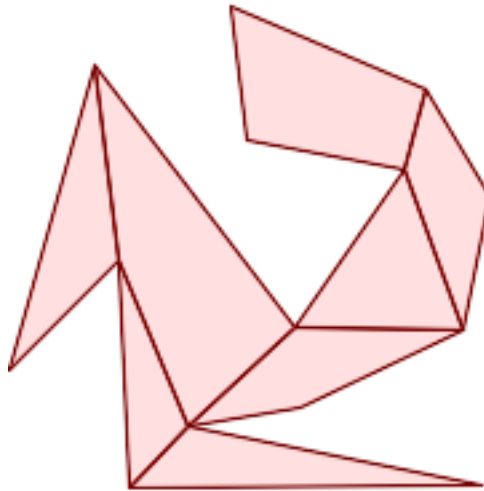
Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0



This method needs SFCGAL backend.

☒☒



Greene Approximal Convex Partition (same example As [CG_YMonotonePartition](#), [CG_ApproxConvexPartition](#) and [CG_OptimalConvexPartition](#))

```
SELECT ST_AsText(CG_GreeneApproxConvexPartition('POLYGON((156 150,83 181,89 131,148 120,107 61,32 159,0 45,41 86,45 1,177 2,67 24,109 31,170 60,180 110,156 150))'::geometry));

GEOMETRYCOLLECTION(POLYGON((32 159,0 45,41 86,32 159)),POLYGON((45 1,177 2,67 24,45 1)),
POLYGON((67 24,109 31,170 60,107 61,67 24)),POLYGON((41 86,45 1,67 24,41 86)),POLYGON
((107 61,32 159,41 86,67 24,107 61)),POLYGON((148 120,107 61,170 60,148 120)),POLYGON
((148 120,170 60,180 110,156 150,148 120)),POLYGON((156 150,83 181,89 131,148 120,156 150)))
```

☒☒

[CG_YMonotonePartition](#), [CG_ApproxConvexPartition](#), [CG_OptimalConvexPartition](#)

8.3.27 ST_MinkowskiSum

ST_MinkowskiSum — ☒☒☒☒☒☒☒☒☒☒☒☒.

Synopsis

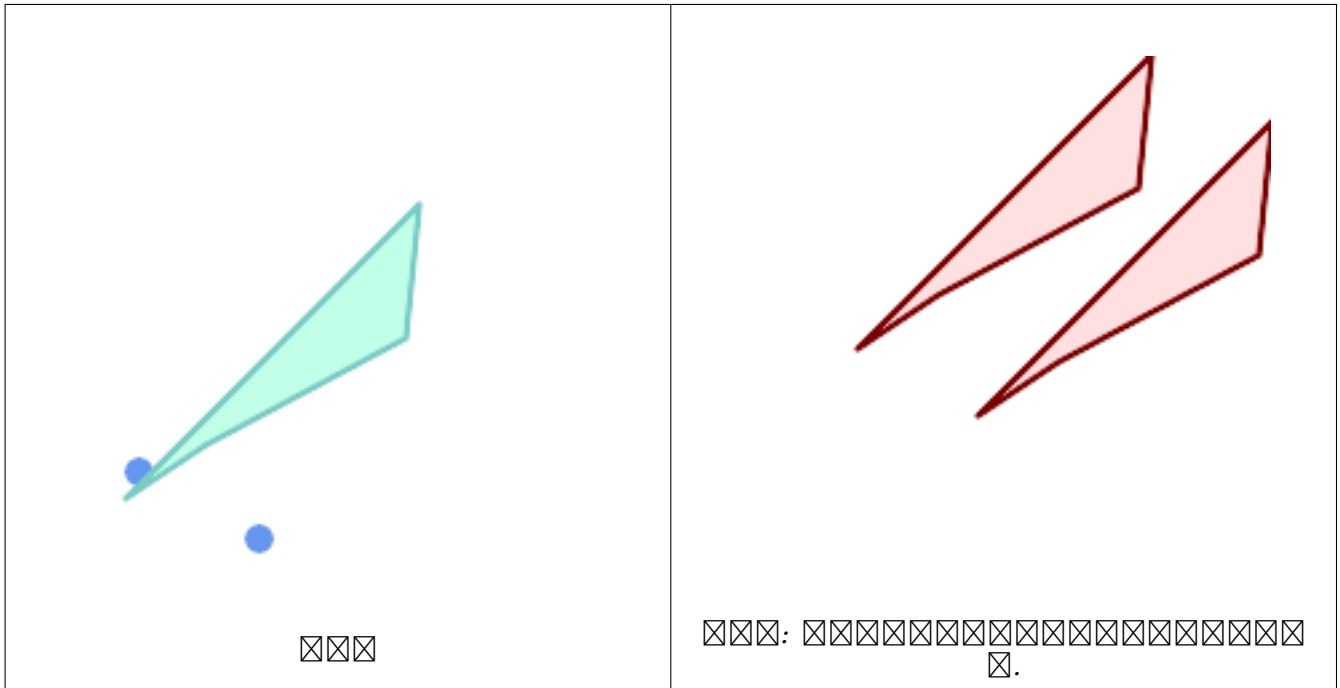
geometry **ST_MinkowskiSum**(geometry geom1, geometry geom2);

☒☒



Warning

ST_MinkowskiSum is deprecated as of 3.5.0. Use [CG_MinkowskiSum](#) instead.



```
SELECT CG_MinkowskiSum(mp, poly)
  FROM (SELECT 'MULTIPOINT(25 50,70 25)::geometry As mp,
  'POLYGON((130 150, 20 40, 50 60, 125 100, 130 150))::geometry As poly
  ) As foo

-- wkt --
MULTIPOLYGON(
  ((70 115,100 135,175 175,225 225,70 115)),
  ((120 65,150 85,225 125,275 175,120 65))
)
```

8.3.29 ST_OptimalAlphaShape

ST_OptimalAlphaShape — Computes an Alpha-shape enclosing a geometry using an "optimal" alpha value.

Synopsis

geometry **ST_OptimalAlphaShape**(geometry geom, boolean allow_holes = false, integer nb_components = 1);

☒☒



Warning

ST_OptimalAlphaShape is deprecated as of 3.5.0. Use CG_OptimalAlphaShape instead.

Computes the "optimal" alpha-shape of the points in a geometry. The alpha-shape is computed using a value of α chosen so that:

1. the number of polygon elements is equal to or smaller than `nb_components` (which defaults to 1)
2. all input points are contained in the shape

The result will not contain holes unless the optional `allow_holes` argument is specified as true.

Availability: 3.3.0 - requires SFCGAL \geq 1.4.1.



This method needs SFCGAL backend.

8.3.30 CG_OptimalAlphaShape

`CG_OptimalAlphaShape` — Computes an Alpha-shape enclosing a geometry using an "optimal" alpha value.

Synopsis

```
geometry CG_OptimalAlphaShape(geometry geom, boolean allow_holes = false, integer nb_components = 1);
```



Computes the "optimal" alpha-shape of the points in a geometry. The alpha-shape is computed using a value of α chosen so that:

1. the number of polygon elements is equal to or smaller than `nb_components` (which defaults to 1)
2. all input points are contained in the shape

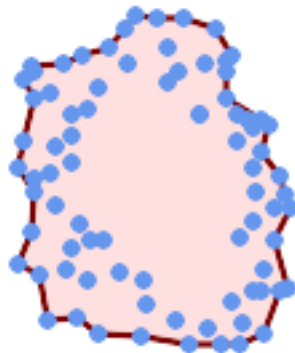
The result will not contain holes unless the optional `allow_holes` argument is specified as true.

Availability: 3.5.0 - requires SFCGAL \geq 1.4.1.



This method needs SFCGAL backend.

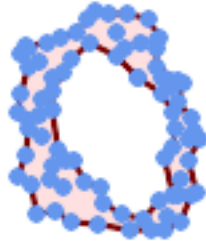
☒☒



Optimal alpha-shape of a MultiPoint (same example as [CG_AlphaShape](#))

```
SELECT ST_AsText(CG_OptimalAlphaShape('MULTIPOINT((63 84),(76 88),(68 73),(53 18),(91 50) ←
    ,(81 70),
    (88 29),(24 82),(32 51),(37 23),(27 54),(84 19),(75 87),(44 42),(77 67),(90 ←
    30),(36 61),(32 65),
    (81 47),(88 58),(68 73),(49 95),(81 60),(87 50),
    (78 16),(79 21),(30 22),(78 43),(26 85),(48 34),(35 35),(36 40),(31 79),(83 ←
    29),(27 84),(52 98),(72 95),(85 71),
    (75 84),(75 77),(81 29),(77 73),(41 42),(83 72),(23 36),(89 53),(27 57),(57 ←
    97),(27 77),(39 88),(60 81),
    (80 72),(54 32),(55 26),(62 22),(70 20),(76 27),(84 35),(87 42),(82 54),(83 ←
    64),(69 86),(60 90),(50 86),(43 80),(36 73),
    (36 68),(40 75),(24 67),(23 60),(26 44),(28 33),(40 32),(43 19),(65 16),(73 ←
    16),(38 46),(31 59),(34 86),(45 90),(64 97))'::geometry));

POLYGON((89 53,91 50,87 42,90 30,88 29,84 19,78 16,73 16,65 16,53 18,43 19,37 23,30 22,28 ←
    33,23 36,
    26 44,27 54,23 60,24 67,27 77,24 82,26 85,34 86,39 88,45 90,49 95,52 98,57 ←
    97,64 97,72 95,76 88,75 84,75 77,83 72,85 71,83 64,88 58,89 53))
```



Optimal alpha-shape of a MultiPoint, allowing holes (same example as [CG_AlphaShape](#))

```
SELECT ST_AsText(CG_OptimalAlphaShape('MULTIPOINT((63 84),(76 88),(68 73),(53 18),(91 50) ←
, (81 70),(88 29),(24 82),(32 51),(37 23),(27 54),(84 19),(75 87),(44 42),(77 67),(90 30) ←
, (36 61),(32 65),(81 47),(88 58),(68 73),(49 95),(81 60),(87 50),
(78 16),(79 21),(30 22),(78 43),(26 85),(48 34),(35 35),(36 40),(31 79),(83 29),(27 ←
84),(52 98),(72 95),(85 71),
(75 84),(75 77),(81 29),(77 73),(41 42),(83 72),(23 36),(89 53),(27 57),(57 97),(27 ←
77),(39 88),(60 81),
(80 72),(54 32),(55 26),(62 22),(70 20),(76 27),(84 35),(87 42),(82 54),(83 64),(69 ←
86),(60 90),(50 86),(43 80),(36 73),
(36 68),(40 75),(24 67),(23 60),(26 44),(28 33),(40 32),(43 19),(65 16),(73 16),(38 ←
46),(31 59),(34 86),(45 90),(64 97))'::geometry, allow_holes => true));
```

```
POLYGON((89 53,91 50,87 42,90 30,88 29,84 19,78 16,73 16,65 16,53 18,43 19,37 23,30 22,28 ←
33,23 36,26 44,27 54,23 60,24 67,27 77,24 82,26 85,34 86,39 88,45 90,49 95,52 98,57 ←
97,64 97,72 95,76 88,75 84,75 77,83 72,85 71,83 64,88 58,89 53),(36 61,36 68,40 75,43 ←
80,50 86,60 81,68 73,77 67,81 60,82 54,81 47,78 43,81 29,76 27,70 20,62 22,55 26,54 ←
32,48 34,44 42,38 46,36 61))
```

☒☒

[ST_ConcaveHull](#), [CG_AlphaShape](#)

8.3.31 CG_OptimalConvexPartition

`CG_OptimalConvexPartition` — Computes an optimal convex partition of the polygon geometry

Synopsis

geometry **CG_OptimalConvexPartition**(geometry geom);

☒☒

Computes an optimal convex partition of the polygon geometry.



Note

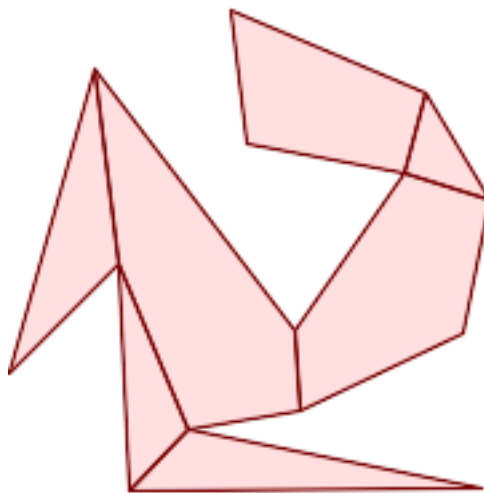
A partition of a polygon P is a set of polygons such that the interiors of the polygons do not intersect and the union of the polygons is equal to the interior of the original polygon P. `CG_OptimalConvexPartition` produces a partition that is optimal in the number of pieces.

Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0



This method needs SFCGAL backend.



Optimal Convex Partition (same example As [CG_YMonotonePartition](#), [CG_ApproxConvexPartition](#) and [CG_GreeneApproxConvexPartition](#))

```
SELECT ST_AsText(CG_OptimalConvexPartition('POLYGON((156 150,83 181,89 131,148 120,107 ↵
61,32 159,0 45,41 86,45 1,177 2,67 24,109 31,170 60,180 110,156 150))'::geometry));
```

```
GEOMETRYCOLLECTION(POLYGON((156 150,83 181,89 131,148 120,156 150)),POLYGON((32 159,0 45,41 ↵
86,32 159)),POLYGON((45 1,177 2,67 24,45 1)),POLYGON((41 86,45 1,67 24,41 86)),POLYGON ↵
((107 61,32 159,41 86,67 24,109 31,107 61)),POLYGON((148 120,107 61,109 31,170 60,180 ↵
110,148 120)),POLYGON((156 150,148 120,180 110,156 150)))
```



[CG_YMonotonePartition](#), [CG_ApproxConvexPartition](#), [CG_GreeneApproxConvexPartition](#)

8.3.32 CG_StraightSkeleton

`CG_StraightSkeleton` — ☒☒☒☒☒☒☒☒☒ (straight skeleton) ☒☒☒☒☒☒.

Synopsis

geometry **CG_StraightSkeleton**(geometry geom, boolean use_distance_as_m = false);

☒☒

Availability: 3.5.0

Requires SFCGAL >= 1.3.8 for option use_distance_as_m

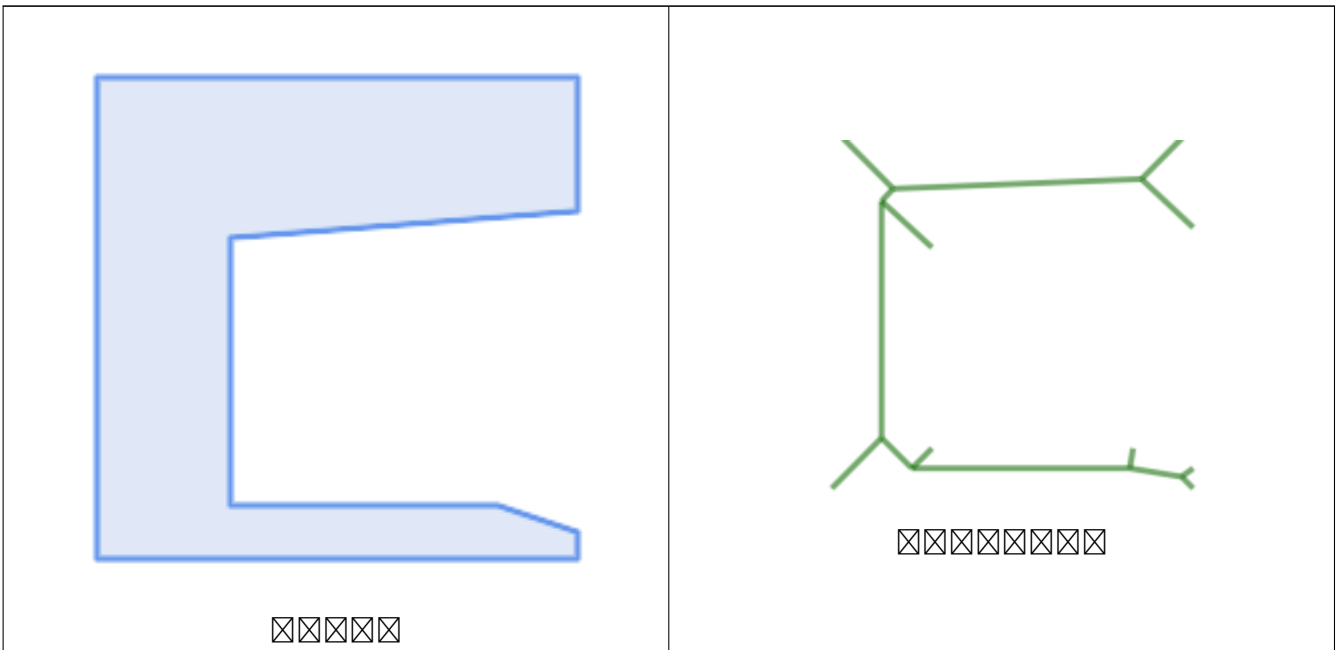
- ✔ This method needs SFCGAL backend.
- ✔ This function supports 3d and will not drop the z-index.
- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
SELECT CG_StraightSkeleton(ST_GeomFromText('POLYGON (( 190 190, 10 190, 10 10, 190 10, 190 ←
20, 160 30, 60 30, 60 130, 190 140, 190 190 ))'));

ST_AsText(CG_StraightSkeleton('POLYGON((0 0,1 0,1 1,0 1,0 0))', true);

MULTILINESTRING M ((0 0 0,0.5 0.5 0.5),(1 0 0,0.5 0.5 0.5),(1 1 0,0.5 0.5 0.5),(0 1 0,0.5 ←
0.5 0.5))
```



☒☒

CG_ExtrudeStraightSkeleton

8.3.33 ST_StraightSkeleton

ST_StraightSkeleton — ☒☒☒☒☒☒☒☒☒ (straight skeleton) ☒☒☒☒☒☒.

Synopsis

geometry **ST_StraightSkeleton**(geometry geom);



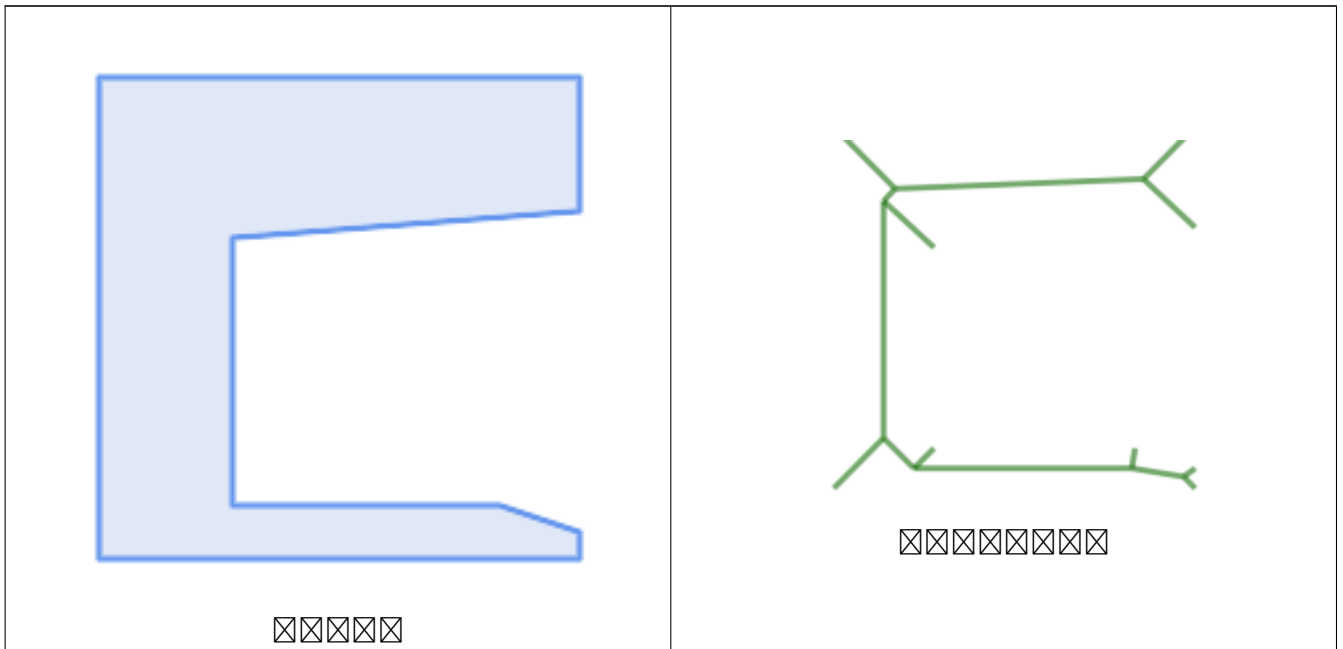
Warning

ST_StraightSkeleton is deprecated as of 3.5.0. Use **CG_StraightSkeleton** instead.

2.1.0

- ✔ This method needs SFCGAL backend.
- ✔ This function supports 3d and will not drop the z-index.
- ✔ This function supports Polyhedral surfaces.
- ✔ This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

```
SELECT ST_StraightSkeleton(ST_GeomFromText('POLYGON (( 190 190, 10 190, 10 10, 190 10, 190 20, 160 30, 60 30, 60 130, 190 140, 190 190 ))'));
```



CG_ExtrudeStraightSkeleton

8.3.34 ST_Tessellate

ST_Tessellate — 將多邊形 (tessellation) 轉換為 TIN 格式。返回 TIN 格式的多邊形。

Synopsis

geometry ST_Tessellate(geometry geom);

返回



Warning

ST_Tessellate is deprecated as of 3.5.0. Use CG_Tessellate instead.





[返回] 將多邊形 (tessellation) 轉換為 TIN 格式。返回 TIN 格式的多邊形。



Note

ST_TriangulatePolygon does similar to this function except that it returns a geometry collection of polygons instead of a TIN and also only works with 2D geometries.

2.1.0 將多邊形轉換為 TIN。

-  This method needs SFCGAL backend.
-  This function supports 3d and will not drop the z-index.
-  This function supports Polyhedral surfaces.
-  This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

8.3.35 CG_Tessellate

CG_Tessellate — 將多邊形 (tessellation) 轉換為 TIN 格式。返回 TIN 格式的多邊形。

Synopsis

geometry CG_Tessellate(geometry geom);

返回

[返回] 將多邊形 (tessellation) 轉換為 TIN 格式。返回 TIN 格式的多邊形。

**Note**

ST_TriangulatePolygon does similar to this function except that it returns a geometry collection of polygons instead of a TIN and also only works with 2D geometries.

Availability: 3.5.0



This method needs SFCGAL backend.



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


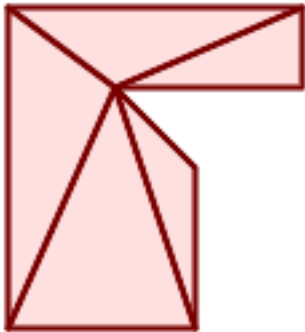


This function supports Polyhedral surfaces.



This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).



<pre>SELECT 'POLYGON ((10 190, 10 70, 80 70, ← 80 130, 50 160, 120 160, 120 190, 10 190)</pre>  <p>☒☒☒☒☒</p>	<pre>SELECT CG_Tesselate(' ← POLYGON ((10 190, 10 70, 80 70, 80 130, 50 160, ; ST_AsText ☒☒☒: ::geometry; TIN(((80 130, 50 160, 80 70, 80 130)), ((50 ← 160, 10 190, 10 70, 50 160)), ((80 70, 50 160, 10 70, 80 ← 70)), ((120 160, 120 190, 50 160, 120 160)), ((120 190, 10 190, 50 ← 160, 120 190)))</pre>  <p>☒☒☒☒☒☒☒☒</p>
---	---

☒☒

[CG_ConstrainedDelaunayTriangles](#), [ST_DelaunayTriangles](#), [ST_TriangulatePolygon](#)

8.3.36 CG_Triangulate

CG_Triangulate — Triangulates a polygonal geometry

Synopsis

```
geometry CG_Triangulate( geometry geom );
```

☒☒

Triangulates a polygonal geometry.

Performed by the SFCGAL module

**Note**

NOTE: this function returns a geometry representing the triangulated result.

Availability: 3.5.0



This method needs SFCGAL backend.

☒☒☒☒

```
SELECT CG_Triangulate('POLYGON((0.0 0.0,1.0 0.0,1.0 1.0,0.0 1.0,0.0 0.0),(0.2 0.2,0.2 0.8,0.8 0.8,0.8 0.2,0.2 0.2))');
      cg_triangulate
      -----
      TIN(((0.8 0.2,0.2 0.2,1 0,0.8 0.2)),((0.2 0.2,0 0,1 0,0.2 0.2)),((1 1,0.8 0.8,0.8 0.2,1 1)),((0 1,0 0,0.2 0.2,0 1)),((0 1,0.2 0.8,1 1,0 1)),((0 1,0.2 0.2,0.2 0.8,0 1)),((0.2 0.8,0.8 0.8,1 1,0.2 0.8)),((0.2 0.8,0.2 0.2,0.8 0.8)),((1 1,0.8 0.2,1 0,1 1)),((0.8 0.8,0.2 0.8,0.8 0.2,0.8 0.8)))
      (1 row)
```

☒☒

[CG_ConstrainedDelaunayTriangles](#), [ST_DelaunayTriangles](#), [ST_TriangulatePolygon](#)

8.3.37 CG_Visibility

CG_Visibility — Compute a visibility polygon from a point or a segment in a polygon geometry

Synopsis

```
geometry CG_Visibility(geometry polygon, geometry point);
geometry CG_Visibility(geometry polygon, geometry pointA, geometry pointB);
```

☒☒

Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0



This method needs SFCGAL backend.



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



This function supports Polyhedral surfaces.

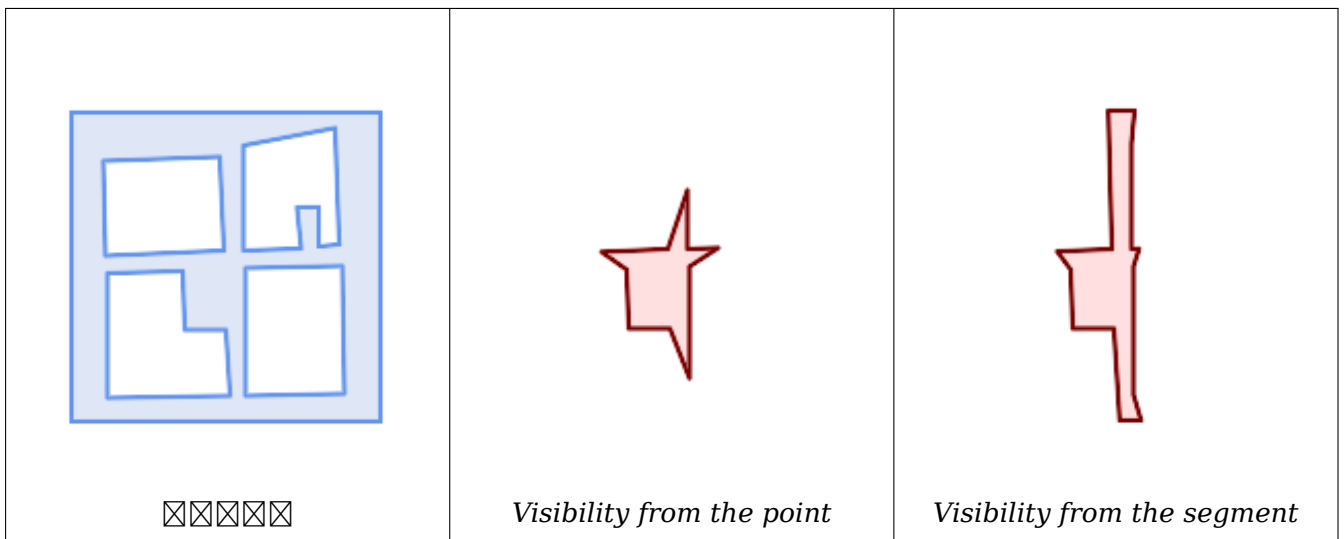


This function supports Triangles and Triangulated Irregular Network Surfaces (TIN).

☒☒

```
SELECT CG_Visibility('POLYGON((23.5 23.5,23.5 173.5,173.5 173.5,173.5 23.5,23.5 23.5),(108 98,108 36,156 37,155 99,108 98),(107 157.5,107 106.5,135 107.5,133 127.5,143.5 127.5,143.5 108.5,153.5 109.5,151.5 166,107 157.5),(41 95.5,41 35,100.5 36,98.5 68,78.5 68,77.5 96.5,41 95.5),(39 150,40 104,97.5 106.5,95.5 152,39 150))'::geometry, 'POINT(91 87)'::geometry);
```

```
SELECT CG_Visibility('POLYGON((23.5 23.5,23.5 173.5,173.5 173.5,173.5 23.5,23.5 23.5),(108 98,108 36,156 37,155 99,108 98),(107 157.5,107 106.5,135 107.5,133 127.5,143.5 127.5,143.5 108.5,153.5 109.5,151.5 166,107 157.5),(41 95.5,41 35,100.5 36,98.5 68,78.5 68,77.5 96.5,41 95.5),(39 150,40 104,97.5 106.5,95.5 152,39 150))'::geometry, 'POINT(78.5 68)'::geometry, 'POINT(98.5 68)'::geometry);
```



8.3.38 CG_YMonotonePartition

CG_YMonotonePartition — Computes y-monotone partition of the polygon geometry

Synopsis

```
geometry CG_YMonotonePartition(geometry geom);
```

☒☒

Computes y-monotone partition of the polygon geometry.

Note



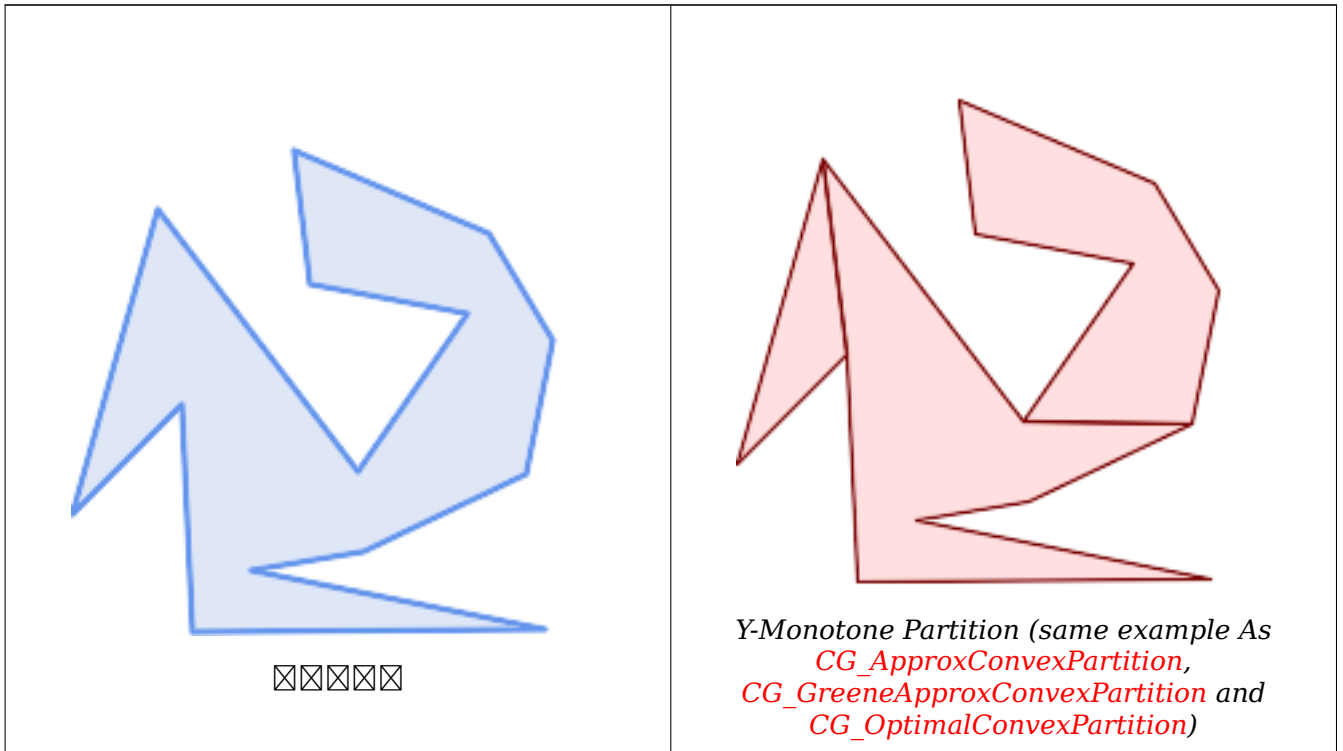
A partition of a polygon P is a set of polygons such that the interiors of the polygons do not intersect and the union of the polygons is equal to the interior of the original polygon P. A y-monotone polygon is a polygon whose vertices v_1, \dots, v_n can be divided into two chains v_1, \dots, v_k and v_k, \dots, v_n, v_1 , such that any horizontal line intersects either chain at most once. This algorithm does not guarantee a bound on the number of polygons produced with respect to the optimal number.

Availability: 3.5.0 - requires SFCGAL >= 1.5.0.

Requires SFCGAL >= 1.5.0

✔ This method needs SFCGAL backend.

☒☒



```
SELECT ST_AsText(CG_YMonotonePartition('POLYGON((156 150,83 181,89 131,148 120,107 61,32 ↵
159,0 45,41 86,45 1,177 2,67 24,109 31,170 60,180 110,156 150))'::geometry));
```

```
GEOMETRYCOLLECTION(POLYGON((32 159,0 45,41 86,32 159)),POLYGON((107 61,32 159,41 86,45 ↵
1,177 2,67 24,109 31,170 60,107 61)),POLYGON((156 150,83 181,89 131,148 120,107 61,170 ↵
60,180 110,156 150)))
```

☒☒

CG_ApproxConvexPartition, CG_GreeneApproxConvexPartition, CG_OptimalConvexPartition

Chapter 9

Topology

PostGIS (face), (edge), (node) .
 Sandro Santilli’s presentation at PostGIS Day Paris 2011 conference gives a good synopsis of PostGIS Topology and where it is headed [Topology with PostGIS 2.0 slide deck](#).
 Vincent Picavet provides a good synopsis and overview of what is Topology, how is it used, and various FOSS4G tools that support it in [PostGIS Topology PGConf EU 2012](#).
 GIS [US Census Topologically Integrated Geographic Encoding and Referencing System \(TIGER\)](#) . PostGIS [Topology_Load_Tiger](#) .
 PostGIS PostGIS , PostGIS . PostGIS 2.0.0 , , , SQL-MM .
[PostGIS Topology Wiki](#) .
 topology .
 SQL/MM ST_ , PostGIS .
 Topology support is build by default starting with PostGIS 2.0, and can be disabled specifying --without-topology configure option at build time as described in [Chapter 2](#)

9.1

9.1.1 getfaceedges_returntype

getfaceedges_returntype — A composite type that consists of a sequence number and an edge number.

A composite type that consists of a sequence number and an edge number. This is the return type for ST_GetFaceEdges and GetNodeEdges functions.

1. sequence : SRID topology.topology .
2. edge : .

9.1.2 TopoGeometry

TopoGeometry — A composite type representing a topologically defined geometry.

TopoGeometry, ID TopoGeometry topology_id, layer_id, id, type

1. topology_id: SRID topology.topology
2. layer_id: TopoGeometry layer_id topology_id layer_id topology.layers (unique reference)
3. id: ,
4. 1 4 type. 1: [] , 2: [] , 3: [] , 4: [] .

CreateTopoGeom

9.1.3 validatetopology_returntype

validatetopology_returntype — A composite type that consists of an error message and id1 and id2 to denote location of error. This is the return type for ValidateTopology.

2 ValidateTopology ID id1 id2

1. error (varchar): coincident nodes(), edge crosses node(), edge not simple(), edge end node geometry mismatch(), edge start node geometry mismatch(), face overlaps face(), face within face()
2. id1: (edge)/(face)/(node)
3. id2: 2 ,

`topology.layer`

[child_layer] (NULL) , () TopoGeometry . (child_layer TopoGeometry) TopoGeometry .

(AddTopoGeometryColumn ID) TopoGeometry .

Valid feature_types are: POINT, MULTIPOINT, LINE, MULTILINE, POLYGON, MULTIPOLYGON, COLLECTION

Availability: 1.1

```
-- Note for this example we created our new table in the ma_topo schema
-- though we could have created it in a different schema -- in which case topology_name and ←
-- schema_name would be different
CREATE SCHEMA ma;
CREATE TABLE ma.parcels(gid serial, parcel_id varchar(20) PRIMARY KEY, address text);
SELECT topology.AddTopoGeometryColumn('ma_topo', 'ma', 'parcels', 'topo', 'POLYGON');
```

```
CREATE SCHEMA ri;
CREATE TABLE ri.roads(gid serial PRIMARY KEY, road_name text);
SELECT topology.AddTopoGeometryColumn('ri_topo', 'ri', 'roads', 'topo', 'LINE');
```

[DropTopoGeometryColumn](#), [toTopoGeom](#), [CreateTopology](#), [CreateTopoGeom](#)

9.3.2 RenameTopoGeometryColumn

RenameTopoGeometryColumn — Renames a topogeometry column

Synopsis

`topology.layer` **RenameTopoGeometryColumn**(regclass layer_table, name feature_column, name new_name)

This function changes the name of an existing TopoGeometry column ensuring metadata information about it is updated accordingly.

Availability: 3.4.0

```
SELECT topology.RenameTopoGeometryColumn('public.parcels', 'topogeom', 'tgeom');
```

☒☒

[AddTopoGeometryColumn, RenameTopology](#)

9.3.3 DropTopology

DropTopology — `DropTopology`: Removes a topology from the `topology.topology` table, and removes its associated `geometry_columns` table.

Synopsis

```
integer DropTopology(varchar topology_schema_name);
```

☒☒

`DropTopology` removes a topology from the `topology.topology` table, and removes its associated `geometry_columns` table. The topology schema name is required. The topology schema name is required. The topology schema name is required.

Availability: 1.1

☒☒

`ma_topo` is a topology schema. The `DropTopology` function is used to remove a topology from the `topology.topology` table.

```
SELECT topology.DropTopology('ma_topo');
```

☒☒

[DropTopoGeometryColumn](#)

9.3.4 RenameTopology

RenameTopology — Renames a topology

Synopsis

```
varchar RenameTopology(varchar old_name, varchar new_name);
```

☒☒

Renames a topology schema, updating its metadata record in the `topology.topology` table.

Availability: 3.4.0

☒☒

Adds missing entries to the `topology.layer` table by inspecting topology constraints on tables. This function is useful for fixing up entries in topology catalog after restores of schemas with topo data.

It returns the list of entries created. Returned columns are `schema_name`, `table_name`, `feature_column`.

2.3.0 ☒☒☒☒☒☒☒☒☒☒.

☒☒

```
SELECT CreateTopology('strk_topo');
CREATE SCHEMA strk;
CREATE TABLE strk.parcels(gid serial, parcel_id varchar(20) PRIMARY KEY, address text);
SELECT topology.AddTopoGeometryColumn('strk_topo', 'strk', 'parcels', 'topo', 'POLYGON');
-- this will return no records because this feature is already registered
SELECT *
  FROM topology.Populate_Topology_Layer();

-- let's rebuild
TRUNCATE TABLE topology.layer;

SELECT *
  FROM topology.Populate_Topology_Layer();

SELECT topology_id,layer_id, schema_name As sn, table_name As tn, feature_column As fc
FROM topology.layer;
```

```
schema_name | table_name | feature_column
-----+-----+-----
strk        | parcels    | topo
(1 row)

topology_id | layer_id | sn | tn | fc
-----+-----+-----+-----+-----
          2 |         2 | strk | parcels | topo
(1 row)
```

☒☒

AddTopoGeometryColumn

9.3.7 TopologySummary

TopologySummary — Takes a topology name and provides summary totals of types of objects in topology.

Synopsis

text **TopologySummary**(varchar topology_schema_name);

☒☒

Takes a topology name and provides summary totals of types of objects in topology.

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
SELECT topology.topologysummary('city_data');
           topologysummary
-----
Topology city_data (329), SRID 4326, precision: 0
22 nodes, 24 edges, 10 faces, 29 topogeoms in 5 layers
Layer 1, type Polygonal (3), 9 topogeoms
  Deploy: features.land_parcels.feature
Layer 2, type Puntal (1), 8 topogeoms
  Deploy: features.traffic_signs.feature
Layer 3, type Lineal (2), 8 topogeoms
  Deploy: features.city_streets.feature
Layer 4, type Polygonal (3), 3 topogeoms
  Hierarchy level 1, child layer 1
  Deploy: features.big_parcels.feature
Layer 5, type Puntal (1), 1 topogeoms
  Hierarchy level 1, child layer 2
  Deploy: features.big_signs.feature
```

☒☒

Topology_Load_Tiger

9.3.8 ValidateTopology

ValidateTopology — Returns a set of validate_topology_returntype objects detailing issues with topology.

Synopsis

setof validate_topology_returntype **ValidateTopology**(varchar toponame, geometry bbox);

☒☒

Returns a set of **validate_topology_returntype** objects detailing issues with topology, optionally limiting the check to the area specified by the **bbox** parameter.

List of possible errors, what they mean and what the returned ids represent are displayed below:

☒☒	id1	id2	Meaning
coincident nodes	Identifier of first node.	Identifier of second node.	Two nodes have the same geometry.
edge crosses node(☒☒☒☒☒☒☒☒☒☒)	Identifier of the edge.	Identifier of the node.	An edge has a node in its interior. See ST_Relate .

	id1	id2	Meaning
invalid edge(<code>edge_id</code>)	Identifier of the edge.		An edge geometry is invalid. See ST_IsValid .
edge not simple(<code>edge_id</code>)	Identifier of the edge.		An edge geometry has self-intersections. See ST_IsSimple .
edge crosses edge(<code>edge_id1</code> , <code>edge_id2</code>)	Identifier of first edge.	Identifier of second edge.	Two edges have an interior intersection. See ST_Relate .
edge start node geometry mismatch(<code>edge_id</code> , <code>start_node_id</code>)	Identifier of the edge.	Identifier of the indicated start node.	The geometry of the node indicated as the starting node for an edge does not match the first point of the edge geometry. See ST_StartPoint .
edge end node geometry mis-match(<code>edge_id</code> , <code>end_node_id</code>)	Identifier of the edge.	Identifier of the indicated end node.	The geometry of the node indicated as the ending node for an edge does not match the last point of the edge geometry. See ST_EndPoint .
face without edges(<code>face_id</code>)	Identifier of the orphaned face.		No edge reports an existing face on either of its sides (left_face, right_face).
face has no rings(<code>face_id</code>)	Identifier of the partially-defined face.		Edges reporting a face on their sides do not form a ring.
face has wrong mbr	Identifier of the face with wrong mbr cache.		Minimum bounding rectangle of a face does not match minimum bounding box of the collection of edges reporting the face on their sides.
hole not in advertised face	Signed identifier of an edge, identifying the ring. See GetRingEdges .		A ring of edges reporting a face on its exterior is contained in different face.
not-isolated node has not- containing_face	Identifier of the ill-defined node.		A node which is reported as being on the boundary of one or more edges is indicating a containing face.
isolated node has containing_face	Identifier of the ill-defined node.		A node which is not reported as being on the boundary of any edges is lacking the indication of a containing face.

	id1	id2	Meaning
isolated node has wrong containing_face	Identifier of the misrepresented node.		A node which is not reported as being on the boundary of any edges indicates a containing face which is not the actual face containing it. See GetFaceContainingPoint .
invalid next_right_edge	Identifier of the misrepresented edge.	Signed id of the edge which should be indicated as the next right edge.	The edge indicated as the next edge encountered walking on the right side of an edge is wrong.
invalid next_left_edge	Identifier of the misrepresented edge.	Signed id of the edge which should be indicated as the next left edge.	The edge indicated as the next edge encountered walking on the left side of an edge is wrong.
mixed face labeling in ring	Signed identifier of an edge, identifying the ring. See GetRingEdges .		Edges in a ring indicate conflicting faces on the walking side. This is also known as a "Side Location Conflict".
non-closed ring	Signed identifier of an edge, identifying the ring. See GetRingEdges .		A ring of edges formed by following next_left_edge/next_right_edge attributes starts and ends on different nodes.
face has multiple shells	Identifier of the contended face.	Signed identifier of an edge, identifying the ring. See GetRingEdges .	More than a one ring of edges indicate the same face on its interior.

1.0.0

2.0.0, (false positive)

2.2.0 'edge crosses node' id1 id2

Changed: 3.2.0 added optional bbox parameter, perform face labeling and edge linking checks.

```
SELECT * FROM topology.ValidateTopology('ma_topo');
      error      | id1 | id2
-----+-----+-----
face without edges | 1 |
```

[validatetopology_returntype](#), [Topology_Load_Tiger](#)

9.3.9 ValidateTopologyRelation

ValidateTopologyRelation — Returns info about invalid topology relation records

Synopsis

```
setof record ValidateTopologyRelation(varchar toponame);
```

☒☒

Returns a set records giving information about invalidities in the relation table of the topology.

Availability: 3.2.0

☒☒

[ValidateTopology](#)

9.3.10 FindTopology

FindTopology — Returns a topology record by different means.

Synopsis

```
topology FindTopology(TopoGeometry topogeom);
topology FindTopology(regclass layerTable, name layerColumn);
topology FindTopology(name layerSchema, name layerTable, name layerColumn);
topology FindTopology(text topoName);
topology FindTopology(int id);
```

☒☒

Takes a topology identifier or the identifier of a topology-related object and returns a topology.topology record.

Availability: 3.2.0

☒☒

```
SELECT name(findTopology('features.land_parcel', 'feature'));
   name
-----
city_data
(1 row)
```

☒☒

[FindLayer](#)

9.3.11 FindLayer

FindLayer — Returns a topology.layer record by different means.

Synopsis

```
topology.layer FindLayer(TopoGeometry tg);
topology.layer FindLayer(regclass layer_table, name feature_column);
topology.layer FindLayer(name schema_name, name table_name, name feature_column);
topology.layer FindLayer(integer topology_id, integer layer_id);
```

☒☒

Takes a layer identifier or the identifier of a topology-related object and returns a topology.layer record.

Availability: 3.2.0

☒☒

```
SELECT layer_id(findLayer('features.land_parcels', 'feature'));
 layer_id
-----
         1
(1 row)
```

☒☒

FindTopology

9.4 Topology Statistics Management

Adding elements to a topology triggers many database queries for finding existing edges that will be split, adding nodes and updating edges that will node with the new linework. For this reason it is useful that statistics about the data in the topology tables are up-to-date.

PostGIS Topology population and editing functions do not automatically update the statistics because a updating stats after each and every change in a topology would be overkill, so it is the caller's duty to take care of that.



Note

That the statistics updated by autovacuum will NOT be visible to transactions which started before autovacuum process completed, so long-running transactions will need to run ANALYZE themselves, to use updated statistics.

9.5 ☒☒☒☒☒

9.5.1 CreateTopology

CreateTopology — Creates a new topology schema and registers it in the topology.topology table.

Synopsis

```
integer CreateTopology(varchar topology_schema_name);
integer CreateTopology(varchar topology_schema_name, integer srid);
integer CreateTopology(varchar topology_schema_name, integer srid, double precision prec);
integer CreateTopology(varchar topology_schema_name, integer srid, double precision prec, boolean hasz);
```

☒☒

Creates a new topology schema with name `topology_name` and registers it in the `topology.topology` table. Topologies must be uniquely named. The topology tables (`edge_data`, `face`, `node`, and `relation`) are created in the schema. It returns the id of the topology.

The `srid` is the **spatial reference system** SRID for the topology.

The tolerance `prec` is measured in the units of the spatial reference system. The tolerance defaults to 0.

`hasz` defaults to false if not specified.

This is similar to the SQL/MM **ST_InitTopoGeo** but has more functionality.

Availability: 1.1

Enhanced: 2.0 added the signature accepting `hasZ`

☒☒

Create a topology schema called `ma_topo` that stores edges and nodes in Massachusetts State Plane-meters (SRID = 26986). The tolerance represents 0.5 meters since the spatial reference system is meter-based.

```
SELECT topology.CreateTopology('ma_topo', 26986, 0.5);
```

Create a topology for Rhode Island called `ri_topo` in spatial reference system State Plane-feet (SRID = 3438)

```
SELECT topology.CreateTopology('ri_topo', 3438) AS topoid;
topoid
-----
2
```

☒☒

Section [4.5](#), **ST_InitTopoGeo**, **Topology_Load_Tiger**

9.5.2 CopyTopology

CopyTopology — Makes a copy of a topology (nodes, edges, faces, layers and TopoGeometries) into a new schema

Synopsis

```
integer CopyTopology(varchar existing_topology_name, varchar new_name);
```

☒☒

Creates a new topology with name `new_name`, with SRID and precision copied from `existing_topology_name`. The nodes, edges and faces in `existing_topology_name` are copied into the new topology, as well as Layers and their associated TopoGeometries.



Note

The new rows in the `topology.layer` table contain synthetic values for `schema_name`, `table_name` and `feature_column`. This is because the TopoGeometry objects exist only as a definition and are not yet available in a user-defined table.

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

Make a backup of a topology called `ma_topo`.

```
SELECT topology.CopyTopology('ma_topo', 'ma_topo_backup');
```

☒☒

Section [4.5, CreateTopology, RenameTopology](#)

9.5.3 ST_InitTopoGeo

`ST_InitTopoGeo` — Creates a new topology schema and registers it in the `topology.topology` table.

Synopsis

```
text ST_InitTopoGeo(varchar topology_schema_name);
```

☒☒

This is the SQL-MM equivalent of [CreateTopology](#). It lacks options for spatial reference system and tolerance. It returns a text description of the topology creation, instead of the topology id.

Availability: 1.1



This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.17

☒☒

```
SELECT topology.ST_InitTopoGeo('topo_schema_to_create') AS topocreation;
           astopocreation
```

```
-----
Topology-Geometry 'topo_schema_to_create' (id:7) created.
```


9.5.5 TopoGeo_AddPoint

`TopoGeo_AddPoint` — (split)

Synopsis

```
integer TopoGeo_AddPoint(varchar atopolgy, geometry apoint, float8 tolerance);
```

Adds a point to an existing topology and returns its identifier. The given point will snap to existing nodes or edges within given tolerance. An existing edge may be split by the snapped point.

2.0.0

[TopoGeo_AddLineString](#), [TopoGeo_AddPolygon](#), [TopoGeo_LoadGeometry](#), [AddNode](#), [CreateTopology](#)

9.5.6 TopoGeo_AddLineString

`TopoGeo_AddLineString` — Adds a linestring to an existing topology using a tolerance and possibly splitting existing edges/faces. Returns edge identifiers.

Synopsis

```
SETOF integer TopoGeo_AddLineString(varchar atopolgy, geometry aline, float8 tolerance);
```

Adds a linestring to an existing topology and returns 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. New nodes and faces may be added.



Note

Updating statistics about topologies being loaded via this function is up to caller, see [maintaining statistics during topology editing and population](#).

2.0.0

[TopoGeo_AddPoint](#), [TopoGeo_AddPolygon](#), [TopoGeo_LoadGeometry](#), [AddEdge](#), [CreateTopology](#)

9.5.7 TopoGeo_AddPolygon

`TopoGeo_AddPolygon` — Adds a polygon to an existing topology using a tolerance and possibly splitting existing edges/faces. Returns face identifiers.

Synopsis

SETOF integer **TopoGeo_AddPolygon**(varchar atopolgy, geometry apoly, float8 tolerance);



Adds a polygon to an existing topology and returns a set of face identifiers forming it up. The boundary of the given polygon will snap to existing nodes or edges within given tolerance. Existing edges and faces may be split by the boundary of the new polygon.



Note

Updating statistics about topologies being loaded via this function is up to caller, see [maintaining statistics during topology editing and population](#).

2.0.0     .



[TopoGeo_AddPoint](#), [TopoGeo_AddLineString](#), [TopoGeo_LoadGeometry](#), [AddFace](#), [CreateTopology](#)

9.5.8 TopoGeo_LoadGeometry

`TopoGeo_LoadGeometry` — Load a geometry into an existing topology, snapping and splitting as needed.

Synopsis

void **TopoGeo_LoadGeometry**(varchar atopolgy, geometry ageom, float8 tolerance);



Loads a geometry into an existing topology. The given geometry will snap to existing nodes or edges within given tolerance. Existing edges and faces may be split as a consequence of the load.



Note

Updating statistics about topologies being loaded via this function is up to caller, see [maintaining statistics during topology editing and population](#).

Availability: 3.5.0

[TopoGeo_AddPoint](#), [TopoGeo_AddLineString](#), [TopoGeo_AddPolygon](#), [CreateTopology](#)

9.6

9.6.1 ST_AddIsoNode

`ST_AddIsoNode` — Add an isolated node to a topology. `faceid` is the ID of the face. `nodeid` is the ID of the node. `geom` is the geometry of the node. `geom` can be NULL.

Synopsis

```
integer ST_AddIsoNode(varchar atopology, integer aface, geometry apoint);
```

`atopology` is the topology name. `aface` is the ID of the face. `apoint` is the geometry of the node. `nodeid` is the ID of the node.

`geom` is the geometry of the node. `geom` can be NULL. `geom` is a geometry object. `geom` is a geometry object. `geom` is a geometry object.

`aface` is the ID of the face. `apoint` is the geometry of the node.

Availability: 1.1

 This method implements the SQL/MM specification. SQL-MM: Topo-Net Routines: X+1.3.1

[AddNode](#), [CreateTopology](#), [DropTopology](#), [ST_Intersects](#)

9.6.2 ST_AddIsoEdge

`ST_AddIsoEdge` — Add an isolated edge to a topology. `anode` and `anothernode` are the IDs of the nodes. `alinesring` is the geometry of the edge. `edgeid` is the ID of the edge.

Synopsis

```
integer ST_AddIsoEdge(varchar atopology, integer anode, integer anothernode, geometry alinesring);
```


9.6.4 ST_AddEdgeModFace

ST_AddEdgeModFace — `integer, geometry, integer, integer, geometry`

Synopsis

`integer ST_AddEdgeModFace(varchar atopolology, integer anode, integer anothernode, geometry acurve);`

`integer`

`geometry, integer, integer, geometry`



Note

... (SRID) ... (universe face) ...

... ID ...

...

... NULL ... node ... acurve ... anothernode ...

acurve ... (SRID) ...

2.0 ...



This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.13

`integer`

`integer`

[ST_RemEdgeModFace](#)

[ST_AddEdgeNewFaces](#)

9.6.5 ST_RemEdgeNewFace

ST_RemEdgeNewFace — `integer, integer`

Synopsis

`integer ST_RemEdgeNewFace(varchar atopolology, integer anedge);`

ST

Refuses to remove an edge participating in the definition of an existing TopoGeometry. Refuses to heal two faces if any TopoGeometry is defined by only one of them (and not the other).

Refuses to remove an edge participating in the definition of an existing TopoGeometry. Refuses to heal two faces if any TopoGeometry is defined by only one of them (and not the other).

Refuses to remove an edge participating in the definition of an existing TopoGeometry. Refuses to heal two faces if any TopoGeometry is defined by only one of them (and not the other).

2.0

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.14

ST

ST

ST_RemEdgeModFace

ST_AddEdgeNewFaces

9.6.6 ST_RemEdgeModFace

ST_RemEdgeModFace — Removes an edge, and if the edge separates two faces deletes one face and modifies the other face to cover the space of both.

Synopsis

integer ST_RemEdgeModFace(varchar atopology, integer anedge);

ST

Removes an edge, and if the removed edge separates two faces deletes one face and modifies the other face to cover the space of both. Preferentially keeps the face on the right, to be consistent with ST_AddEdgeModFace. Returns the id of the face which is preserved.

Refuses to remove an edge participating in the definition of an existing TopoGeometry. Refuses to heal two faces if any TopoGeometry is defined by only one of them (and not the other).

Refuses to remove an edge participating in the definition of an existing TopoGeometry. Refuses to heal two faces if any TopoGeometry is defined by only one of them (and not the other).

Refuses to remove an edge participating in the definition of an existing TopoGeometry. Refuses to heal two faces if any TopoGeometry is defined by only one of them (and not the other).

2.0

This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.15

9.6.8 ST_ModEdgeSplit

ST_ModEdgeSplit — Splits an edge in a topology at a point. Returns the id of the deleted node.

Synopsis

integer **ST_ModEdgeSplit**(varchar atopology, integer anedge, geometry apoint);

⊠

⊠, ⊠, ⊠. ⊠. ⊠.

Availability: 1.1

⊠: 2.0 ⊠, ⊠ ST_ModEdgesSplit ⊠.

✔ This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9

⊠

```

-- Add an edge --
SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227592 893910, 227600 893910)', 26986) ) As edgeid;

-- edgeid-
3

-- Split the edge --
SELECT topology.ST_ModEdgeSplit('ma_topo', 3, ST_SetSRID(ST_Point(227594,893910),26986) ) As node_id;
      node_id
-----
7

```

⊠

[ST_NewEdgesSplit](#), [ST_ModEdgeHeal](#), [ST_NewEdgeHeal](#), [AddEdge](#)

9.6.9 ST_ModEdgeHeal

ST_ModEdgeHeal — Heals two edges by deleting the node connecting them, modifying the first edge and deleting the second edge. Returns the id of the deleted node.

Synopsis

int **ST_ModEdgeHeal**(varchar atopology, integer anedge, integer anotheredge);



Heals two edges by deleting the node connecting them, modifying the first edge and deleting the second edge. Returns the id of the deleted node. Updates all existing joined edges and relationships accordingly.

2.0 

 This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9



[ST_ModEdgeSplit](#) [ST_NewEdgesSplit](#)

9.6.10 ST_NewEdgeHeal

`ST_NewEdgeHeal` — Heals two edges by deleting the node connecting them, deleting both edges, and replacing them with an edge whose direction is the same as the first edge provided.


Synopsis

```
int ST_NewEdgeHeal(varchar atopology, integer anedge, integer anotheredge);
```



Heals two edges by deleting the node connecting them, deleting both edges, and replacing them with an edge whose direction is the same as the first edge provided. Returns the id of the new edge replacing the healed ones. Updates all existing joined edges and relationships accordingly.

2.0 

 This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X.3.9



[ST_ModEdgeHeal](#) [ST_ModEdgeSplit](#) [ST_NewEdgesSplit](#)

9.6.11 ST_MoveIsoNode

`ST_MoveIsoNode` — Moves an isolated node in a topology from one point to another. If new `apoint` geometry exists as a node an error is thrown. Returns description of move.

Synopsis

```
text ST_MoveIsoNode(varchar atopology, integer anode, geometry apoint);
```


☒☒

```
-- Add an edge --
SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227575 893917,227592 893900) ←
', 26986) ) As edgeid;
-- result-
edgeid
-----
      2
-- Split the new edge --
SELECT topology.ST_NewEdgesSplit('ma_topo', 2, ST_GeomFromText('POINT(227578.5 893913.5)', ←
26986) ) As newnodeid;
newnodeid
-----
      6
```

☒☒

[ST_ModEdgeSplit](#) [ST_ModEdgeHeal](#) [ST_NewEdgeHeal](#) [AddEdge](#)

9.6.13 ST_RemoveIsoNode

ST_RemoveIsoNode — Removes an isolated node from a topology. **ST_RemoveIsoNode** (text topology, integer anode) returns text, geometry.

Synopsis

text **ST_RemoveIsoNode**(varchar atopolgy, integer anode);

☒☒

Removes an isolated node from a topology. **ST_RemoveIsoNode** (text topology, integer anode) returns text, geometry.

Availability: 1.1



This method implements the SQL/MM specification. SQL-MM: Topo-Geo and Topo-Net 3: Routine Details: X+1.3.3

☒☒

```
-- Remove an isolated node with no face --
SELECT topology.ST_RemoveIsoNode('ma_topo', 7 ) As result;
result
-----
Isolated node 7 removed
```

☒☒

[ST_AddIsoNode](#)

**Note**

tolerance = 0 ST_Intersects, ST_DWithin.

GEOS

2.0.0.

AddEdge

```
SELECT topology.GetEdgeByPoint('ma_topo',geom, 1) As with1mtol, topology.GetEdgeByPoint(' ←
      ma_topo',geom,0) As withnotol
FROM ST_GeomFromEWKT('SRID=26986;POINT(227622.6 893843)') As geom;
with1mtol | withnotol
-----+-----
          2 |          0
```

```
SELECT topology.GetEdgeByPoint('ma_topo',geom, 1) As nearnode
FROM ST_GeomFromEWKT('SRID=26986;POINT(227591.9 893900.4)') As geom;
-- get error --
ERROR:  Two or more edges found
```

AddEdge, GetNodeByPoint, GetFaceByPoint

9.7.2 GetFaceByPoint

GetFaceByPoint — Finds face intersecting a given point.

Synopsis

integer **GetFaceByPoint**(varchar atopology, geometry apoint, float8 tol1);

Finds a face referenced by a Point, with given tolerance.

The function will effectively look for a face intersecting a circle having the point as center and the tolerance as radius.

If no face intersects the given query location, 0 is returned (universal face).

If more than one face intersect the query location an exception is thrown.

2.0.0.

Enhanced: 3.2.0 more efficient implementation and clearer contract, stops working with invalid topologies.

☒☒

```
SELECT topology.GetFaceByPoint('ma_topo',geom, 10) As with1mtol, topology.GetFaceByPoint(' ←
ma_topo',geom,0) As withnotol
FROM ST_GeomFromEWKT('POINT(234604.6 899382.0)') As geom;

with1mtol | withnotol
-----+-----
1 | 0
```

```
SELECT topology.GetFaceByPoint('ma_topo',geom, 1) As nearnode
FROM ST_GeomFromEWKT('POINT(227591.9 893900.4)') As geom;

-- get error --
ERROR: Two or more faces found
```

☒☒

[GetFaceContainingPoint](#), [AddFace](#), [GetNodeByPoint](#), [GetEdgeByPoint](#)

9.7.3 GetFaceContainingPoint

`GetFaceContainingPoint` — Finds the face containing a point.

Synopsis

integer **GetFaceContainingPoint**(text atopology, geometry apoint);

☒☒

Returns the id of the face containing a point.

An exception is thrown if the point falls on a face boundary.



Note

The function relies on a valid topology, using edge linking and face labeling.

Availability: 3.2.0

☒☒

[ST_GetFaceGeometry](#)

9.7.4 GetNodeByPoint

`GetNodeByPoint` — Finds the node-id of a node at a point location.

Synopsis

integer **GetNodeByPoint**(varchar atopology, geometry apoint, float8 toll1);

☒☒

Retrieves the id of a node at a point location.

The function returns an integer (id-node) given a topology, a POINT and a tolerance. If tolerance = 0 means exact intersection, otherwise retrieves the node from an interval.

If apoint doesn't intersect a node, returns 0 (zero).

If use tolerance > 0 and there is more than one node near the point then an exception is thrown.



Note

☒☒☒☒ tolerance = 0 ☒☒☒ ST_Intersects ☒, ☒☒☒☒☒☒ ST_DWithin ☒☒☒☒☒☒.

GEOS ☒☒☒☒☒

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

☒☒☒☒☒☒ **AddEdge** ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

```
SELECT topology.GetNodeByPoint('ma_topo',geom, 1) As nearnode
FROM ST_GeomFromEWKT('SRID=26986;POINT(227591.9 893900.4)') As geom;
nearnode
```

```
-----
      2
```

```
SELECT topology.GetNodeByPoint('ma_topo',geom, 1000) As too_much_tolerance
FROM ST_GeomFromEWKT('SRID=26986;POINT(227591.9 893900.4)') As geom;
```

```
----get error--
ERROR:  Two or more nodes found
```

☒☒

AddEdge, GetEdgeByPoint, GetFaceByPoint

9.7.5 GetTopologyID

GetTopologyID — ☒☒☒☒☒☒☒☒☒ topology.topology ☒☒☒☒☒☒☒☒☒ ID ☒☒☒☒☒☒☒.

Synopsis

integer **GetTopologyID**(varchar toponame);

Synopsis

varchar **GetTopologyName**(integer topology_id);

ID topology.topology (sequence) ID(edgeid)

Availability: 1.1

```
SELECT topology.GetTopologyName(1) As topo_name;
topo_name
-----
ma_topo
```

[CreateTopology](#), [DropTopology](#), [GetTopologyID](#), [GetTopologySRID](#)

9.7.8 ST_GetFaceEdges

ST_GetFaceEdges — aface


Synopsis

getfaceedges_returntype **ST_GetFaceEdges**(varchar atopology, integer aface);

aface (sequence) ID(edgeid)

(sequence) ID(edgeid)

2.0

 This method implements the SQL/MM specification. SQL-MM 3 Topo-Geo and Topo-Net 3: Routine Details: X.3.5

```
-- Returns the edges bounding face 1
SELECT (topology.ST_GetFaceEdges('tt', 1)).*;
-- result --
sequence | edge
-----+-----
1 | -4
2 | 5
```


9.7.10 GetRingEdges

GetRingEdges — 返回指定拓扑中指定环的边。

Synopsis

getfaceedges_returntype **GetRingEdges**(varchar atopolgy, integer aring, integer max_edges=null);

返回

返回指定拓扑中指定环的边。返回类型 (sequence) 为 `getfaceedges_returntype` ID(edgeid) 为整数。返回 1 个结果。

返回指定拓扑中指定环的边。返回类型 (sequence) 为 `getfaceedges_returntype` ID 为整数, 返回指定拓扑中指定环的边。返回 1 个结果。

max_edges 为 NULL 返回指定拓扑中指定环的边。返回指定拓扑中指定环的边。



Note

返回指定拓扑中指定环的边。

2.0.0 返回指定拓扑中指定环的边。

返回

[ST_GetFaceEdges](#), [GetNodeEdges](#)

9.7.11 GetNodeEdges

GetNodeEdges — 返回指定拓扑中指定节点的边。

Synopsis

getfaceedges_returntype **GetNodeEdges**(varchar atopolgy, integer anode);

返回

返回指定拓扑中指定节点的边。返回类型 (sequence) 为 `getfaceedges_returntype` ID 为整数。返回 1 个结果。返回指定拓扑中指定节点的边。返回指定拓扑中指定节点的边。返回指定拓扑中指定节点的边。



Note

返回指定拓扑中指定节点的边。

2.0 返回指定拓扑中指定节点的边。

**Note**

`aline` srid srid srid. .

GEOS

**Warning**

`AddEdge` is deprecated as of 3.5.0. Use `TopoGeo_AddLineString` instead.

2.0.0

```
SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227575.8 893917.2,227591.9
      893900.4)', 26986) ) As edgeid;
-- result-
edgeid
-----
1

SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227591.9 893900.4,227622.6
      893844.2,227641.6 893816.5,
      227704.5 893778.5)', 26986) ) As edgeid;
-- result --
edgeid
-----
2

SELECT topology.AddEdge('ma_topo', ST_GeomFromText('LINESTRING(227591.2 893900, 227591.9
      893900.4,
      227704.5 893778.5)', 26986) ) As edgeid;
-- gives error --
ERROR:  Edge intersects (not on endpoints) with existing edge 1
```

[TopoGeo_AddLineString](#), [CreateTopology](#), Section 4.5

9.8.4 AddFace

`AddFace` — (face primitive)

Synopsis

integer **AddFace**(varchar toponame, geometry apolygon, boolean force_new=false);

面

面 (face primitive) 是面元。

面元包含 left_face 和 right_face 两个面。面元包含 containing_face 面元。



Note

面元包含 next_left_edge 和 next_right_edge 两个边元。

面元 (面元) 是面元。面元包含 next_left_edge 和 next_right_edge 两个边元。

apolygon 面元, force_new 是 (面元) 面元 ID 面元, force_new 面元 ID 面元。



Note

面元 (force_new = true) 面元, 面元, 面元 MBR 面元。



Note

apolygon 面元 srid 面元 srid 面元。面元。

2.0.0 面元。

面

```
-- 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
```



```
--use to verify what has happened --
SELECT * FROM
  topology.TopologySummary('topo_boston_test');

-- summary--
Topology topo_boston_test (5), SRID 2249, precision 0
61 nodes, 87 edges, 35 faces, 15 topogeoms in 1 layers
Layer 1, type Polygonal (3), 15 topogeoms
Deploy: public.nei_topo.topo

-- Shrink all TopoGeometry polygons by 10 meters
UPDATE nei_topo SET topo = ST_Buffer(clearTopoGeom(topo), -10);

-- Get the no-one-lands left by the above operation
-- I think GRASS calls this "polygon0 layer"
SELECT ST_GetFaceGeometry('topo_boston_test', f.face_id)
  FROM topo_boston_test.face f
  WHERE f.face_id
 > 0 -- don't consider the universe face
  AND NOT EXISTS ( -- check that no TopoGeometry references the face
    SELECT * FROM topo_boston_test.relation
    WHERE layer_id = 1 AND element_id = f.face_id
  );
```

☒☒

[CreateTopology](#), [AddTopoGeometryColumn](#), [CreateTopoGeom](#), [TopologySummary](#), [clearTopoGeom](#)

9.9.3 TopoElementArray_Agg

TopoElementArray_Agg — Returns a `topoelementarray` for a set of `element_id`, type arrays (`topoelements`).

Synopsis

`topoelementarray` **TopoElementArray_Agg**(`topoelement set tefield`);

☒☒

TopoElement ☒☒☒☒☒☒ **TopoElementArray** ☒☒☒☒☒☒☒☒☒☒.

2.0.0 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
SELECT topology.TopoElementArray_Agg(ARRAY[e,t]) As tea
  FROM generate_series(1,3) As e CROSS JOIN generate_series(1,4) As t;
  tea
-----
{{1,1},{1,2},{1,3},{1,4},{2,1},{2,2},{2,3},{2,4},{3,1},{3,2},{3,3},{3,4}}
```


☒☒

TopoGeometry ☒☒☒☒☒☒ **TopoElement** ☒☒☒☒☒☒.

2.3 ☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```
-- Remove face 43 from TopoGeometry tg
UPDATE mylayer SET tg = TopoGeom_remElement(tg, '{43,3}');
```

☒☒

TopoGeom_addElement, CreateTopoGeom

9.10.4 TopoGeom_addTopoGeom

TopoGeom_addTopoGeom — Adds element of a TopoGeometry to the definition of another TopoGeometry.

Synopsis

topogeometry **TopoGeom_addTopoGeom**(topogeometry tgt, topogeometry src);

☒☒

Adds the elements of a **TopoGeometry** to the definition of another TopoGeometry, possibly changing its cached type (type attribute) to a collection, if needed to hold all elements in the source object.

The two TopoGeometry objects need be defined against the *same* topology and, if hierarchically defined, need be composed by elements of the same child layer.

Availability: 3.2

☒☒

```
-- Set an "overall" TopoGeometry value to be composed by all
-- elements of specific TopoGeometry values
UPDATE mylayer SET tg_overall = TopoGeom_addTopogeom(
    TopoGeom_addTopoGeom(
        clearTopoGeom(tg_overall),
        tg_specific1
    ),
    tg_specific2
);
```

☒☒

TopoGeom_addElement, clearTopoGeom, CreateTopoGeom

9.10.5 toTopoGeom

toTopoGeom — Adds a geometry shape to an existing topo geometry.

Refer to [toTopoGeom](#).

9.11 TopoGeometry

9.11.1 GetTopoGeomElementArray

GetTopoGeomElementArray — Returns a topoelementarray (an array of topoelements) containing the topological elements and type of the given TopoGeometry (primitive elements).

Synopsis

topoelementarray **GetTopoGeomElementArray**(varchar toponame, integer layer_id, integer tg_id);
 topoelementarray **GetTopoGeomElementArray**(topogeometry tg);

`GetTopoGeomElementArray` (TopoGeometry) returns TopoElementArray. `GetTopoGeomElements` (TopoGeometry) returns TopoElementArray.

tg_id topology.layer_id layer_id TopoGeometry ID.

Availability: 1.1

[GetTopoGeomElements](#), [TopoElementArray](#)

9.11.2 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);

9.12 TopoGeometry

9.12.1 AsGML

AsGML — TopoGeometry GML

Synopsis

```
text AsGML(topogeometry tg);
text AsGML(topogeometry tg, text nsprefix_in);
text AsGML(topogeometry tg, regclass visitedTable);
text AsGML(topogeometry tg, regclass visitedTable, text nsprefix);
text AsGML(topogeometry tg, text nsprefix_in, integer precision, integer options);
text AsGML(topogeometry tg, text nsprefix_in, integer precision, integer options, regclass visitedTable);
text AsGML(topogeometry tg, text nsprefix_in, integer precision, integer options, regclass visitedTable,
text idprefix);
text AsGML(topogeometry tg, text nsprefix_in, integer precision, integer options, regclass visitedTable,
text idprefix, int gmlversion);
```

TopoGeometry GML GML3. nsprefix_in gml. nsprefix (non-qualified). (15) (1) ST_AsGML.

visitedTable (xlink:xref) 'element_type' 'element_id' (2) element_type element_id, orientation:

```
CREATE TABLE visited (
  element_type integer, element_id integer,
  unique(element_type, element_id)
);
```

idprefix, gmlver ST_AsGML. 3 2.0.0.

CreateTopoGeom

```
SELECT topology.AsGML(topo) As rdgml
FROM ri.roads
WHERE road_name = 'Unknown';

-- rdgml--
<gml:TopoCurve>
  <gml:directedEdge>
    <gml:Edge gml:id="E1">
      <gml:directedNode orientation="-">
```


Synopsis

boolean **Equals**(topogeometry tg1, topogeometry tg2);

TopoGeometry

TopoGeometry (topogeometry tg1, topogeometry tg2)



Note

This function not supported for topogeometries that are geometry collections. It also can not compare topogeometries from different topologies. Also not currently supported for hierarchical topogeometries (topogeometries composed of other topogeometries).

1.1.0



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

TopoGeometry

TopoGeometry

[GetTopoGeomElements](#), [ST_Equals](#)

9.13.2 Intersects

Intersects — TopoGeometry

Synopsis

boolean **Intersects**(topogeometry tg1, topogeometry tg2);

TopoGeometry

TopoGeometry



Note

This function not supported for topogeometries that are geometry collections. It also can not compare topogeometries from different topologies. Also not currently supported for hierarchical topogeometries (topogeometries composed of other topogeometries).

1.1.0



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

☒☒

☒☒

[ST_Intersects](#)

9.14 Importing and exporting Topologies

Once you have created topologies, and maybe associated topological layers, you might want to export them into a file-based format for backup or transfer into another database.

Using the standard dump/restore tools of PostgreSQL is problematic because topologies are composed by a set of tables (4 for primitives, an arbitrary number for layers) and records in metadata tables (topology.topology and topology.layer). Additionally, topology identifiers are not univoque across databases so that parameter of your topology will need to be changes upon restoring it.

In order to simplify export/restore of topologies a pair of executables are provided: `pgtopo_export` and `pgtopo_import`. Example usage:

```
pgtopo_export dev_db topo1 | pgtopo_import topo1 | psql staging_db
```

9.14.1 Using the Topology exporter

The `pgtopo_export` script takes the name of a database and a topology and outputs a dump file which can be used to import the topology (and associated layers) into a new database.

By default `pgtopo_export` writes the dump file to the standard output so that it can be piped to `pgtopo_import` or redirected to a file (refusing to write to terminal). You can optionally specify an output filename with the `-f` commandline switch.

By default `pgtopo_export` includes a dump of all layers defined against the given topology. This may be more data than you need, or may be non-working (in case your layer tables have complex dependencies) in which case you can request skipping the layers with the `--skip-layers` switch and deal with those separately.

Invoking `pgtopo_export` with the `--help` (or `-h` for short) switch will always print short usage string.

The dump file format is a compressed tar archive of a `pgtopo_export` directory containing at least a `pgtopo_dump_version` file with format version info. As of version 1 the directory contains tab-delimited CSV files with data of the topology primitive tables (node, edge_data, face, relation), the topology and layer records associated with it and (unless `--skip-layers` is given) a custom-format PostgreSQL dump of tables reported as being layers of the given topology.

9.14.2 Using the Topology importer

The `pgtopo_import` script takes a `pgtopo_export` format topology dump and a name to give to the topology to be created and outputs an SQL script reconstructing the topology and associated layers.

The generated SQL file will contain statements that create a topology with the given name, load primitive data in it, restores and registers all topology layers by properly linking all TopoGeometry values to their correct topology.

By default `pgtopo_import` reads the dump from the standard input so that it can be used in conjunction with `pgtopo_export` in a pipeline. You can optionally specify an input filename with the `-f` commandline switch.

By default `pgtopo_import` includes in the output SQL file the code to restore all layers found in the dump.

This may be unwanted or non-working in case your target database already have tables with the same name as the ones in the dump. In that case you can request skipping the layers with the `--skip-layers` switch and deal with those separately (or later).

SQL to only load and link layers to a named topology can be generated using the `--only-layers` switch. This can be useful to load layers AFTER resolving the naming conflicts or to link layers to a different topology (say a spatially-simplified version of the starting topology).

Chapter 10

10. Raster Data

10.1 Raster Data

The `raster2pgsql` utility 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.

10.1.1 raster2pgsql

The `raster2pgsql` is a raster loader executable that loads GDAL supported raster formats into SQL suitable for loading into a PostGIS raster table. It is capable of loading folders of raster files as well as creating overviews of rasters.

Since the `raster2pgsql` is compiled as part of PostGIS most often (unless you compile your own GDAL library), the raster types supported by the executable will be the same as those compiled in the GDAL dependency library. To get a list of raster types your particular `raster2pgsql` supports use the `-G` switch.



Note

The `-f` switch (factor) is used to specify the resolution of the raster. For more information, see <http://trac.osgeo.org/postgis/ticket/1764>.

10.1.1.1 Example Usage

Load a 100x100 raster into a table:

```
# -s use srid 4326
# -I create spatial index
# -C use standard raster constraints
# -M vacuum analyze after load
# *.tif load all these files
# -F include a filename column in the raster table
# -t tile the output 100x100
# public.demelevation load into this table
raster2pgsql -s 4326 -I -C -M -F -t 100x100 *.tif public.demelevation
> elev.sql
```

```
# -d connect to this database
# -f read this file after connecting
psql -d gisdb -f elev.sql
```



Note

If you do not specify the schema as part of the target table name, the table will be created in the default schema of the database or user you are connecting with.

UNIX `raster2pgsql` options:

```
raster2pgsql -s 4326 -I -C -M *.tif -F -t 100x100 public.demelevation | psql -d gisdb
```

`raster2pgsql` options: `-s` SRID, `-I` integer, `-C` character, `-M` multi, `-F` filename, `-t` tile size, `-l` layer name, `-l 2,4` layer names, `-l 2,4 bostonaerials2008/*.jpg` layer names and filename. `-e` extent, `-e 128x128` extent. `-F filename` filename.

```
raster2pgsql -I -C -e -Y -F -s 26986 -t 128x128 -l 2,4 bostonaerials2008/*.jpg aerials. ↵
    boston | psql -U postgres -d gisdb -h localhost -p 5432
```

--get a list of raster types supported:

```
raster2pgsql -G
```

`-G` options:

Available GDAL raster formats:

- Virtual Raster
- GeoTIFF
- National Imagery Transmission Format
- Raster Product Format TOC format
- ECRG TOC format
- Erdas Imagine Images (.img)
- CEOS SAR Image
- CEOS Image
- ...
- Arc/Info Export E00 GRID
- ZMap Plus Grid
- NOAA NGS Geoid Height Grids

10.1.1.2 raster2pgsql options

`-?` options.

`-G` options.

`c|a|d|p --` options:

- `-c` character (C) character.
- `-a` integer (I) integer.
- `-d` integer, multi (M) multi.
- `-p` filename, filename.

`raster2pgsql` options:

- `-C` raster_columns SRID, SRID.
- `-x` extent (extent) extent. `-C` character.

-r **regular blocking** (regular blocking) 选项 (选项) 选项。 -C 选项
选项。

选项: 选项

-s **<SRID>** 选项 SRID 选项。 选项 0 选项, 选项 SRID 选项
选项。

-b **BAND** 选项 (1-选项) 选项。 选项, 选项 (,) 选项
选项。

-t **TILE_SIZE** 选项。 TILE_SIZE 选项 x 选项
选项, 选项"auto" 选项。

-P 选项 (padding) 选项。

-R, --register 选项 (DB 选项) 选项。
选项 (选项) 选项。

-l **OVERVIEW_FACTOR** 选项。 选项, 选项 (,) 选项。 选项
o overview_factor_table 选项, 选项 overview_factor 选项
选项 (placeholder) 选项 table 选项。 选项
选项, -R 选项。 选项 SQL 选项

-N **NODATA** "NODATA" 选项 NODATA 选项。

选项

-f **COLUMN** 选项。 选项'rast' 选项。

-F 选项。

-n **COLUMN** 选项。 -F 选项。

-q PostgreSQL 选项。

-I 选项 GiST 选项。

-M 选项 (vacuum analyze) 选项。

-k Keeps empty tiles and skips NODATA value checks for each raster band. Note you save time
in checking, but could end up with far more junk rows in your database and those junk rows
are not marked as empty tiles.

-T **tablespace** 选项。 -X 选项 (选项
选项) 选项。

-X **tablespace** 选项。 -I 选项
选项。

-Y **max_rows_per_copy=50** Use copy statements instead of insert statements. Optionally specify
max_rows_per_copy; default 50 when not specified.

-e 选项, 选项 (transaction) 选项。

-E **ENDIAN** 选项 (endianness) 选项。 XDR 选项 0, 选项
选项 NDR 选项 1 选项。 选项, NDR 选项。

-V **version** 选项。 选项 0 选项。 选项, 0 选项。

10.1.2 PostGIS 选项

选项。 选项, 选项
选项。 选项。

1. 选项:


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

- 2. `ST_MakeEmptyRaster`, `ST_AddBand`, `ST_AsRaster`, `ST_Union`, `ST_MapAlgebra` (algebra), `ST_Transform`

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

(convex hull) `ST_ConvexHull`



Note PostGIS 2.0 (envelop) ...

- 4. `AddRasterConstraints`

10.1.3 Using "out db" cloud rasters

The raster2pgsql tool uses GDAL to access raster data, and can take advantage of a key GDAL feature: the ability to read from rasters that are stored remotely in cloud "object stores" (e.g. AWS S3, Google Cloud Storage).

Efficient use of cloud stored rasters requires the use of a "cloud optimized" format. The most well-known and widely used is the "cloud optimized GeoTIFF" format. Using a non-cloud format, like a JPEG, or an un-tiled TIFF will result in very poor performance, as the system will have to download the entire raster each time it needs to access a subset.

First, load your raster into the cloud storage of your choice. Once it is loaded, you will have a URI to access it with, either an "http" URI, or sometimes a URI specific to the service. (e.g., "s3://bucket/object"). To access non-public buckets, you will need to supply GDAL config options to authenticate your connection. Note that this command is reading from the cloud raster and writing to the database.

```
AWS_ACCESS_KEY_ID=xxxxxxxxxxxxxxxxxxxxx \
AWS_SECRET_ACCESS_KEY=xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx \
raster2pgsql \
-s 990000 \
-t 256x256 \
-I \
-R \
/vsis3/your.bucket.com/your_file.tif \
your_table \
| psql your_db
```

Once the table is loaded, you need to give the database permission to read from remote rasters, by setting two permissions, `postgis.enable_outdb_rasters` and `postgis.gdal_enabled_drivers`.

```
SET postgis.enable_outdb_rasters = true;
SET postgis.gdal_enabled_drivers TO 'ENABLE_ALL';
```

To make the changes sticky, set them directly on your database. You will need to re-connect to experience the new settings.

```
ALTER DATABASE your_db SET postgis.enable_outdb_rasters = true;
ALTER DATABASE your_db SET postgis.gdal_enabled_drivers TO 'ENABLE_ALL';
```

For non-public rasters, you may have to provide access keys to read from the cloud rasters. The same keys you used to write the raster2pgsql call can be set for use inside the database, with the [postgis.gdal_vsi_options](#) configuration. Note that multiple options can be set by space-separating the key=value pairs.

```
SET postgis.gdal_vsi_options = 'AWS_ACCESS_KEY_ID=xxxxxxxxxxxxxxxxxxxxxxx
AWS_SECRET_ACCESS_KEY=xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx';
```

Once you have the data loaded and permissions set you can interact with the raster table like any other raster table, using the same functions. The database will handle all the mechanics of connecting to the cloud data when it needs to read pixel data.

10.2

PostGIS `raster_columns` and `raster_overviews` tables. `raster_columns` table stores the metadata for each raster column in a table. `raster_overviews` table stores the metadata for each overview of a raster column. `raster_columns` and `raster_overviews` tables are created automatically when a raster column is added to a table.

1. `raster_columns` table stores the metadata for each raster column in a table.
2. `raster_overviews` table stores the metadata for each overview of a raster column. `raster_overviews` table is created automatically when a raster column is added to a table.

10.2.1

`raster_columns` table stores the metadata for each raster column in a table. `raster_columns` table is created automatically when a raster column is added to a table. `raster_columns` table has the following columns: `r_table_catalog`, `r_table_schema`, `r_table_name`, `r_raster_column`, `srid`, `scale_x`, `scale_y`, `add_raster_constraints`.

`raster_columns` table is created automatically when a raster column is added to a table. `raster_columns` table has the following columns: `r_table_catalog`, `r_table_schema`, `r_table_name`, `r_raster_column`, `srid`, `scale_x`, `scale_y`, `add_raster_constraints`.

- `r_table_catalog` table catalog name.
- `r_table_schema` table schema name.
- `r_table_name` table name.
- `r_raster_column` raster column name in the table. PostGIS `raster_columns` table has the following columns: `r_table_catalog`, `r_table_schema`, `r_table_name`, `r_raster_column`, `srid`, `scale_x`, `scale_y`, `add_raster_constraints`.
- `srid` spatial reference ID. Section 4.5
- `scale_x` raster scale in X (meters) units. `scale_x` and `scale_y` are required. `ST_ScaleX` function.

- `scale_y` 縦縮尺係数 (数) 指定。指定された `scale_y` 値、`scale_y` 値が省略された場合は `ST_ScaleY` 関数の値。
- `blocksize_x` ブロック幅 (整数) 指定。指定された `ST_Width` 関数の値。
- `blocksize_y` ブロック高さ (整数) 指定。指定された `ST_Height` 関数の値。
- `same_alignment` 縦縮尺係数とブロック幅・高さが同じかどうか指定。指定された `ST_SameAlignment` 関数の値。
- `regular_blocking` 規則的ブロック指定。指定された `ST_RegularBlocking` 関数の値。
- `num_bands` 色帯数 (整数) 指定。指定された `ST_NumBands` 関数の値。
- `pixel_types` 色帯タイプ (文字列) 指定。指定された `ST_BandPixelType` 関数の値。
- `nodata_values` ノータ値 `nodata_value` (double precision) 値 (数) 指定。指定された `ST_BandNoDataValue` 関数の値。
- `out_db` 出力データベース名指定。指定された `ST_OutDB` 関数の値。
- `extent` 範囲 (extent) 指定。指定された `DropRasterConstraints` 関数の値 `AddRasterConstraints` 関数の値。
- `spatial_index` スパチアルインデックス指定。

10.2.2 色帯タイプ

`raster_overviews` テーブルに `raster_columns` テーブルと `raster_overviews` テーブルを結合し、`raster_columns` テーブルの `band` 列に `-1` を指定して `AddOverviewConstraints` 関数を実行する。

この操作は、`raster_columns` テーブルに `band` 列が追加された後に実行する必要があります。

Note `raster_overviews` テーブルに `raster_columns` テーブルと `raster_overviews` テーブルを結合し、`raster_columns` テーブルの `band` 列に `-1` を指定して `AddOverviewConstraints` 関数を実行する。

実行方法:

1. `raster_columns` テーブルに `band` 列を追加する。
2. `raster_columns` テーブルと `raster_overviews` テーブルを結合し、`raster_columns` テーブルの `band` 列に `-1` を指定して `AddOverviewConstraints` 関数を実行する。

`raster_overviews` テーブルに `raster_columns` テーブルと `raster_overviews` テーブルを結合する。


```

        $input_srid = intval($_REQUEST['srid']);
    }
    else { $input_srid = 26986; }
    /** The set bytea_output may be needed for PostgreSQL 9.0+, but not for 8.4 */
    $sql = "set bytea_output='escape';
    SELECT ST_AsPNG(ST_Transform(
        ST_AddBand(ST_Union(rast,1), ARRAY[ST_Union(rast,2),ST_Union(rast,3)]),
        $input_srid) ) As new_rast
    FROM aerials.boston
    WHERE
        ST_Intersects(rast, ST_Transform(ST_MakeEnvelope(-71.1217, 42.227, -71.1210, 42.218,4326),26986) )");
    $result = pg_query($sql);
    $row = pg_fetch_row($result);
    pg_free_result($result);
    if ($row === false) return;
    echo pg_unescape_bytea($row[0]);
    ?>
    
```

10.3.2 ST_AsPNG ASP.NET C#

npgsql PostgreSQL .NET **ST AsGDALRaster** 1, 2, 3 PHP (request stream) PHP "img src" HTML

npgsql PostgreSQL .NET <http://npgsql.projects.postgresql.org/> ASP.NET bin

(combine) WGS84 **ST Union** (union) **ST Transform** **ST AsPNG** PNG

C# Section 10.3.1

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

```

-- web.config connection string section --
<connectionStrings>
  <add name="DSN"
    connectionString="server=localhost;database=mydb;Port=5432;User Id=myuser;password=
    mypwd"/>
</connectionStrings>
    
```

```

// Code for TestRaster.ashx
<%@ WebHandler Language="C#" Class="TestRaster" %>
using System;
using System.Data;
using System.Web;
using Npgsql;

public class TestRaster : IHttpHandler
{
    public void ProcessRequest(HttpContext context)
    {
        context.Response.ContentType = "image/png";
    }
}
    
```

```

        context.Response.BinaryWrite(GetResults(context));
    }

    public bool IsReusable {
        get { return false; }
    }

    public byte[] GetResults(HttpContext context)
    {
        byte[] result = null;
        NpgsqlCommand command;
        string sql = null;
        int input_srid = 26986;
    try {
        using (NpgsqlConnection conn = new NpgsqlConnection(System.↵
            Configuration.ConfigurationManager.ConnectionStrings["DSN"].↵
            ConnectionString)) {
            conn.Open();

            if (context.Request["srid"] != null)
            {
                input_srid = Convert.ToInt32(context.Request["srid"]);
            }
            sql = @"SELECT ST_AsPNG(
                ST_Transform(
                    ST_AddBand(
                        ST_Union(rast,1), ARRAY[ST_Union(rast,2),ST_Union(rast,3)]
                            ,:input_srid) ) As new_rast
                FROM aerials.boston
                WHERE
                    ST_Intersects(rast,
                        ST_Transform(ST_MakeEnvelope(-71.1217, 42.227, ↵
                            -71.1210, 42.218,4326),26986) )");
            command = new NpgsqlCommand(sql, conn);
            command.Parameters.Add(new NpgsqlParameter("input_srid", input_srid));

            result = (byte[]) command.ExecuteScalar();
            conn.Close();
        }
    }
    catch (Exception ex)
    {
        result = null;
        context.Response.Write(ex.Message.Trim());
    }
    return result;
}

```

10.3.3 Java

Java

<http://jdbc.postgresql.org/download.html> PostgreSQL JDBC


```

        sGetImg.close();
        conn.close();
    }
    catch (SQLException se) {
        System.out.println("Couldn't connect: print out a stack trace and exit.");
        se.printStackTrace();
        System.exit(1);
    }
}
}

```

10.3.4 PLPython SQL

PLPython is a procedural language extension to PostgreSQL. PLPythonu is a PLPythonu3u extension.

```

CREATE OR REPLACE FUNCTION write_file (param_bytes bytea, param_filepath text)
RETURNS text
AS $$
f = open(param_filepath, 'wb+')
f.write(param_bytes)
return param_filepath
$$ LANGUAGE plpythonu;

```

```

--write out 5 images to the PostgreSQL server in varying sizes
-- note the postgresql daemon account needs to have write access to folder
-- this echos back the file names created;
SELECT write_file(ST_AsPNG(
    ST_AsRaster(ST_Buffer(ST_Point(1,5),j*5, 'quad_segs=2'),150*j, 150*j, '8BUI',100)),
    'C:/temp/slices'|| j || '.png')
FROM generate_series(1,5) As j;

```

```

write_file
-----
C:/temp/slices1.png
C:/temp/slices2.png
C:/temp/slices3.png
C:/temp/slices4.png
C:/temp/slices5.png

```

10.3.5 PSQL

PostgreSQL has a PSQL extension. PSQL is a PSQL extension. PSQL is a PSQL extension.

PostgreSQL has a PSQL extension. PSQL is a PSQL extension. PSQL is a PSQL extension.

```

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);
```


4. $(a-b) = a < x < b$

'((a-b) a-b

pixeltype text ST_BandPixelType

nodataval double precision NODATA. ,

: 2 255 NODATA 8BUI

```
SELECT ROW(2, '0-100:1-10, 101-500:11-150,501 - 10000: 151-254', '8BUI', 255)::reclassarg;
```

: 1 NODATA 1BB

```
SELECT ROW(1, '0-100]:0, (100-255:1', '1BB', NULL)::reclassarg;
```

ST_Reclass

11.1.6 summarystats

summarystats — ST_SummaryStats ST_SummaryStatsAgg

ST_SummaryStats ST_SummaryStatsAgg

count integer

sum double precision

mean double precision

stddev double precision

min double precision

max double precision

ST_SummaryStats, ST_SummaryStatsAgg

11.1.7 unionarg

unionarg — UNION ST_Union

¶

UNION ST_Union

nband integer 1-

uniontype text UNION. **ST_Union**

¶

ST_Union

11.2

11.2.1 AddRasterConstraints

AddRasterConstraints — Adds raster constraints to a loaded raster table for a specific column that constrains spatial ref, scaling, blocksize, alignment, bands, band type and a flag to denote if raster column is regularly blocked. The table must be loaded with data for the constraints to be inferred. Returns true if the constraint setting was accomplished and issues a notice otherwise.

Synopsis

```
boolean AddRasterConstraints(name rasttable, name rastcolumn, boolean srid=true, boolean scale_x=true,
boolean scale_y=true, boolean blocksize_x=true, boolean blocksize_y=true, boolean same_alignment=true,
boolean regular_blocking=false, boolean num_bands=true, boolean pixel_types=true, boolean no-
data_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[] VARI-
ADIC constraints);
boolean AddRasterConstraints(name rastschema, name rasttable, name rastcolumn, boolean srid=true,
boolean scale_x=true, boolean scale_y=true, boolean blocksize_x=true, boolean blocksize_y=true,
boolean same_alignment=true, boolean regular_blocking=false, boolean num_bands=true, boolean
pixel_types=true, boolean nodata_values=true, boolean out_db=true, boolean extent=true );
```

¶

raster_columns, rastschema. srid SPATIAL_REF_SYS

raster2pgsql

Section 10.2.1

- blocksize X Y
- blocksize_x X ()
- blocksize_y Y ()
- extent
- num_bands

- `pixel_types` 指定栅格像素的数据类型。例如 `N` 表示 `NUMERIC`。
- `regular_blocking` 指定是否使用规则分块 (通常用于栅格索引) 还是非规则分块 (通常用于栅格函数)。
- `same_alignment` 确保它们都具有相同的对齐方式，意味着任何两个你比较的栅格都会返回 `true`。请参考 [ST_SameAlignment](#)。
- `srid` 指定栅格的 SRID。
- `--` 指定其他选项。



Note

如果指定了 `pixel_types`，那么 `DropRasterConstraints` 将不会删除 `pixel_types` 相关的约束。



Note

如果指定了 `DropRasterConstraints`，那么 `DropRasterConstraints` 将不会删除 `DropRasterConstraints` 相关的约束。

2.0.0 更新内容

更新内容: 添加 `DropRasterConstraints` 函数。

```
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}
```

更新内容: 添加 `DropRasterConstraints` 函数。

```
CREATE TABLE public.myrasters2(rid SERIAL primary key, rast raster);
INSERT INTO myrasters2(rast)
SELECT ST_AddBand(ST_MakeEmptyRaster(1000, 1000, 0.3, -0.3, 2, 2, 0, 0,4326), 1, '8BSI'::
  text, -129, NULL);
```

```
SELECT AddRasterConstraints('public'::name, 'myrasters2'::name, 'rast'::name, ' ←
  regular_blocking', 'blocksize');
-- get notice--
NOTICE: Adding regular blocking constraint
NOTICE: Adding blocksize-X constraint
NOTICE: Adding blocksize-Y constraint
```

Section [10.2.1, ST_AddBand, ST_MakeEmptyRaster, DropRasterConstraints, ST_BandPixelType, ST_SRID](#)

11.2.2 DropRasterConstraints

DropRasterConstraints — PostGIS .

Synopsis

boolean **DropRasterConstraints**(name rasttable, name rastcolumn, boolean srid, boolean scale_x, boolean scale_y, boolean blocksize_x, boolean blocksize_y, boolean same_alignment, boolean regular_blocking, boolean num_bands=true, boolean pixel_types=true, boolean nodata_values=true, boolean out_db=true , boolean extent=true);

boolean **DropRasterConstraints**(name rastschema, name rasttable, name rastcolumn, boolean srid=true, boolean scale_x=true, boolean scale_y=true, boolean blocksize_x=true, boolean blocksize_y=true, boolean same_alignment=true, boolean regular_blocking=false, boolean num_bands=true, boolean pixel_types=true, boolean nodata_values=true, boolean out_db=true , boolean extent=true);

boolean **DropRasterConstraints**(name rastschema, name rasttable, name rastcolumn, text[] constraints);

AddRasterConstraints , PostGIS .

```
DROP TABLE mytable
```

```
ALTER TABLE mytable DROP COLUMN rast
```

raster_columns , raster_columns .

2.0.0 .

AIG	Arc/Info Binary Grid	f
AirSAR	AirSAR Polarimetric Image	f
ARG	Azavea Raster Grid format	t
BAG	Bathymetry Attributed Grid	f
BIGGIF	Graphics Interchange Format (.gif)	f
BLX	Magellan topo (.blx)	t
BMP	MS Windows Device Independent Bitmap	f
BSB	Maptech BSB Nautical Charts	f
PAux	PCI .aux Labelled	f
PCIDSK	PCIDSK Database File	f
PCRaster	PCRaster Raster File	f
PDF	Geospatial PDF	f
PDS	NASA Planetary Data System	f
PDS4	NASA Planetary Data System 4	t
PLMOAIC	Planet Labs Mosaics API	f
PLSCENES	Planet Labs Scenes API	f
PNG	Portable Network Graphics	t
PNM	Portable Pixmap Format (netpbm)	f
PRF	Racurs PHOTOMOD PRF	f
R	R Object Data Store	t
Rasterlite	Rasterlite	t
RDA	DigitalGlobe Raster Data Access driver	f
RIK	Swedish Grid RIK (.rik)	f
RMF	Raster Matrix Format	f
ROI_PAC	ROI_PAC raster	f
RPFTOC	Raster Product Format TOC format	f
RRASTER	R Raster	f
RS2	RadarSat 2 XML Product	f
RST	Idrisi Raster A.1	t
SAFE	Sentinel-1 SAR SAFE Product	f
SAGA	SAGA GIS Binary Grid (.sdat, .sg-grd-z)	t
SAR_CEOS	CEOS SAR Image	f
SDTS	SDTS Raster	f
SENTINEL2	Sentinel 2	f
SGI	SGI Image File Format 1.0	f
SNODAS	Snow Data Assimilation System	f
SRP	Standard Raster Product (ASRP/USRP)	f
SRTMHGT	SRTMHGT File Format	t
Terragen	Terragen heightfield	f
TIL	EarthWatch .TIL	f
TSX	TerraSAR-X Product	f
USGSDEM	USGS Optional ASCII DEM (and CDED)	t
VICAR	MIPL VICAR file	f
VRT	Virtual Raster	t
WCS	OGC Web Coverage Service	f
WMS	OGC Web Map Service	t
WMTS	OGC Web Map Tile Service	t
XPM	X11 PixMap Format	t
XYZ	ASCII Gridded XYZ	t
ZMap	ZMap Plus Grid	t

Example: `CREATE TABLE`

```
-- Output the create options XML column of JPEG as a table --
-- Note you can use these creator options in ST_AsGDALRaster options argument
SELECT (xpath('@name', g.opt))[1]::text As oname,
       (xpath('@type', g.opt))[1]::text As otype,
       (xpath('@description', g.opt))[1]::text As descrip
FROM (SELECT unnest(xpath('/CreationOptionList/Option', create_options::xml)) As opt
FROM st_gdaldrivers())
```

```
WHERE short_name = 'JPEG') As g;
```

oname	otype	descrip
PROGRESSIVE	boolean	whether to generate a progressive JPEG
QUALITY	int	good=100, bad=0, default=75
WORLDFILE	boolean	whether to generate a worldfile
INTERNAL_MASK	boolean	whether to generate a validity mask
COMMENT	string	Comment
SOURCE_ICC_PROFILE	string	ICC profile encoded in Base64
EXIF_THUMBNAIL	boolean	whether to generate an EXIF thumbnail(overview). By default its max dimension will be 128
THUMBNAIL_WIDTH	int	Forced thumbnail width
THUMBNAIL_HEIGHT	int	Forced thumbnail height

(9 rows)

```
-- raw xml output for creator options for GeoTiff --
```

```
SELECT create_options
```

```
FROM st_gdaldrivers()
```

```
WHERE short_name = 'GTiff';
```

```
<CreationOptionList>
```

```
  <Option name="COMPRESS" type="string-select">
```

```
    <Value
```

```
>NONE</Value>
```

```
    <Value
```

```
>LZW</Value>
```

```
    <Value
```

```
>PACKBITS</Value>
```

```
    <Value
```

```
>JPEG</Value>
```

```
    <Value
```

```
>CCITTRLE</Value>
```

```
    <Value
```

```
>CCITTFAX3</Value>
```

```
    <Value
```

```
>CCITTFAX4</Value>
```

```
    <Value
```

```
>DEFLATE</Value>
```

```
  </Option>
```

```
  <Option name="PREDICTOR" type="int" description="Predictor Type"/>
```

```
  <Option name="JPEG_QUALITY" type="int" description="JPEG quality 1-100" default="75"/>
```

```
  <Option name="ZLEVEL" type="int" description="DEFLATE compression level 1-9" default ←  
    ="6"/>
```

```
  <Option name="NBITS" type="int" description="BITS for sub-byte files (1-7), sub-uint16 ←  
    (9-15), sub-uint32 (17-31)"/>
```

```
  <Option name="INTERLEAVE" type="string-select" default="PIXEL">
```

```
    <Value
```

```
>BAND</Value>
```

```
    <Value
```

```
>PIXEL</Value>
```

```
  </Option>
```

```
  <Option name="TILED" type="boolean" description="Switch to tiled format"/>
```

```
  <Option name="TFW" type="boolean" description="Write out world file"/>
```

```
  <Option name="RPB" type="boolean" description="Write out .RPB (RPC) file"/>
```

```
  <Option name="BLOCKXSIZE" type="int" description="Tile Width"/>
```

```
  <Option name="BLOCKYSIZE" type="int" description="Tile/Strip Height"/>
```

```
  <Option name="PHOTOMETRIC" type="string-select">
```

```
    <Value
```

```
>MINISBLACK</Value>
```

```
    <Value
```

```

>MINISWHITE</Value>
  <Value
>PALETTE</Value>
  <Value
>RGB</Value>
  <Value
>CMYK</Value>
  <Value
>YCBCR</Value>
  <Value
>CIELAB</Value>
  <Value
>ICCLAB</Value>
  <Value
>ITULAB</Value>
  </Option>
  <Option name="SPARSE_OK" type="boolean" description="Can newly created files have ↵
    missing blocks?" default="FALSE"/>
  <Option name="ALPHA" type="boolean" description="Mark first extrasample as being alpha ↵
    "/>
  <Option name="PROFILE" type="string-select" default="GDALGeoTIFF">
    <Value
>GDALGeoTIFF</Value>
    <Value
>GeoTIFF</Value>
    <Value
>BASELINE</Value>
  </Option>
  <Option name="PIXELTYPE" type="string-select">
    <Value
>DEFAULT</Value>
    <Value
>SIGNEDBYTE</Value>
  </Option>
  <Option name="BIGTIFF" type="string-select" description="Force creation of BigTIFF file ↵
    ">
    <Value
>YES</Value>
    <Value
>NO</Value>
    <Value
>IF_NEEDED</Value>
    <Value
>IF_SAFER</Value>
  </Option>
  <Option name="ENDIANNESS" type="string-select" default="NATIVE" description="Force ↵
    endianness of created file. For DEBUG purpose mostly">
    <Value
>NATIVE</Value>
    <Value
>INVERTED</Value>
    <Value
>LITTLE</Value>
    <Value
>BIG</Value>
  </Option>
  <Option name="COPY_SRC_OVERVIEWS" type="boolean" default="NO" description="Force copy ↵
    of overviews of source dataset (CreateCopy())"/>
</CreationOptionList>

-- Output the create options XML column for GTiff as a table --
SELECT (xpath('@name', g.opt))[1]::text As oname,

```

```
(xpath('@type', g.opt))[1]::text As otype,
(xpath('@description', g.opt))[1]::text As descrip,
array_to_string(xpath('Value/text()', g.opt),', ' ) As vals
FROM (SELECT unnest(xpath('/CreationOptionList/Option', create_options::xml)) As opt
FROM st_gdaldrivers()
WHERE short_name = 'GTiff') As g;
```

oname	otype	descrip	vals
COMPRESS	string-select		NONE, LZW, ↔
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, ↔
SPARSE_OK	boolean	Can newly created files have missing blocks? ↔	
ALPHA	boolean	Mark first extrasample as being alpha ↔	
PROFILE	string-select		GDALGeoTIFF, ↔
PIXELTYPE	string-select		DEFAULT, ↔
BIGTIFF	string-select	Force creation of BigTIFF file ↔	
ENDIANNESS	string-select	Force endianness of created file. For DEBUG purpose ↔	
COPY_SRC_OVERVIEWS	boolean	Force copy of overviews of source dataset (CreateCopy ↔)	

(19 rows)



[ST_AsGDALRaster](#), [ST_SRID](#), [postgis.gdal_enabled_drivers](#)

11.2.9 ST_Contour

ST_Contour — Generates a set of vector contours from the provided raster band, using the [GDAL contouring algorithm](#).

Synopsis

```
setof record ST_Contour(raster rast, integer bandnumber=1, double precision level_interval=100.0,
double precision level_base=0.0, double precision[] fixed_levels=ARRAY[], boolean polygonize=false);
```

☒☒

Generates a set of vector contours from the provided raster band, using the [GDAL contouring algorithm](#).

When the `fixed_levels` parameter is a non-empty array, the `level_interval` and `level_base` parameters are ignored.

Input parameters are:

rast The raster to generate the contour of

bandnumber The band to generate the contour of

level_interval The elevation interval between contours generated

level_base The "base" relative to which contour intervals are applied, this is normally zero, but could be different. To generate 10m contours at 5, 15, 25, ... the `LEVEL_BASE` would be 5.

fixed_levels The elevation interval between contours generated

polygonize If true, contour polygons will be created, rather than polygon lines.

Return values are a set of records with the following attributes:

geom The geometry of the contour line.

id A unique identifier given to the contour line by GDAL.

value The raster value the line represents. For an elevation DEM input, this would be the elevation of the output contour.

Availability: 3.2.0

☒☒

```
WITH c AS (
SELECT (ST_Contour(rast, 1, fixed_levels => ARRAY[100.0, 200.0, 300.0])).*
FROM dem_grid WHERE rid = 1
)
SELECT st_astext(geom), id, value
FROM c;
```

☒☒

[ST_InterpolateRaster](#)

Synopsis

raster **UpdateRasterSRID**(name schema_name, name table_name, name column_name, integer new_srid);
 raster **UpdateRasterSRID**(name table_name, name column_name, integer new_srid);

SRID. SRID (, SRID) .



Note

() .

2.1.0

UpdateGeometrySRID

11.2.12 ST_CreateOverview

ST_CreateOverview —

Synopsis

regclass **ST_CreateOverview**(regclass tab, name col, int factor, text algo='NearestNeighbor');

. (1/factor).

raster_overviews, .

'NearestNeighbor', 'Bilinear', 'Cubic', 'CubicSpline', 'Lanczos'. GDAL Warp resampling methods.

2.2.0

Output to generally better quality but slower to product format

```
SELECT ST_CreateOverview('mydata.mytable'::regclass, 'rast', 2, 'Lanczos');
```

Output to faster to process default nearest neighbor

```
SELECT ST_CreateOverview('mydata.mytable'::regclass, 'rast', 2);
```

[ST_Retile](#), [AddOverviewConstraints](#), [AddRasterConstraints](#), [Section 10.2.2](#)

11.3 [ST_AddBand](#) (constructor)

11.3.1 [ST_AddBand](#)

[ST_AddBand](#) — [ST_AddBand](#) ([ST_AddBand](#)) [ST_AddBand](#). [ST_AddBand](#) [ST_AddBand](#), [ST_AddBand](#).

Synopsis

- (1) raster **ST_AddBand**(raster rast, addbandarg[] addbandargset);
- (2) raster **ST_AddBand**(raster rast, integer index, text pixeltype, double precision initialvalue=0, double precision nodataval=NULL);
- (3) raster **ST_AddBand**(raster rast, text pixeltype, double precision initialvalue=0, double precision nodataval=NULL);
- (4) raster **ST_AddBand**(raster torast, raster fromrast, integer fromband=1, integer torastindex=at_end);
- (5) raster **ST_AddBand**(raster torast, raster[] fromrasts, integer fromband=1, integer torastindex=at_end);
- (6) raster **ST_AddBand**(raster rast, integer index, text outdbfile, integer[] outdbindex, double precision nodataval=NULL);
- (7) raster **ST_AddBand**(raster rast, text outdbfile, integer[] outdbindex, integer index=at_end, double precision nodataval=NULL);

Returns a raster with a new band added in given position (index), of given type, of given initial value, and of given no data value. If no index is specified, the band is added to the end. If no fromband is specified, band 1 is assumed. Pixel type is a string representation of one of the pixel types specified in [ST_BandPixelType](#). If an existing index is specified all subsequent bands >= that index are incremented by 1. If an initial value greater than the max of the pixel type is specified, then the initial value is set to the highest value allowed by the pixel type.

addbandarg [ST_AddBand](#) 1 [ST_AddBand](#), [ST_AddBand](#) [ST_AddBand](#) [ST_AddBand](#) [ST_AddBand](#).

[ST_AddBand](#) 5 [ST_AddBand](#), torast [ST_AddBand](#) NULL [ST_AddBand](#) fromband [ST_AddBand](#) [ST_AddBand](#) (累計) [ST_AddBand](#).

outdbfile [ST_AddBand](#) 6 [ST_AddBand](#), outdbfile [ST_AddBand](#) [ST_AddBand](#) PostgreSQL [ST_AddBand](#).

[ST_AddBand](#): 2.1.0 [ST_AddBand](#) addbandarg [ST_AddBand](#).

[ST_AddBand](#): 2.1.0 [ST_AddBand](#) DB [ST_AddBand](#).

[ST_AddBand](#): [ST_AddBand](#)

```
-- 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 | ←
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----
0 | 0 | 100 | 100 | 1 | -1 | 0 | 0 | 0 | ←
      2

```

☒☒: ☒☒☒☒☒☒☒☒

```

SELECT
  *
FROM ST_BandMetadata(
  ST_AddBand(
    ST_MakeEmptyRaster(10, 10, 0, 0, 1, -1, 0, 0, 0),
    ARRAY[
      ROW(NULL, '8BUI', 255, 0),
      ROW(NULL, '16BUI', 1, 2),
      ROW(2, '32BUI', 100, 12),
      ROW(2, '32BF', 3.14, -1)
    ]::addbandarg[]
  ),
  ARRAY[]::integer[]
);

bandnum | pixeltype | nodatavalue | isoutdb | path
-----+-----+-----+-----+-----
1 | 8BUI      | 0           | f       |
2 | 32BF     | -1          | f       |
3 | 32BUI    | 12          | f       |
4 | 16BUI    | 2           | f       |

```

```
-- Aggregate the 1st band of a table of like rasters into a single raster
-- with as many bands as there are test_types and as many rows (new rasters) as there are ←
  mice
-- NOTE: The ORDER BY test_type is only supported in PostgreSQL 9.0+
-- for 8.4 and below it usually works to order your data in a subselect (but not guaranteed ←
  )
-- The resulting raster will have a band for each test_type alphabetical by test_type
-- For mouse lovers: No mice were harmed in this exercise
SELECT
  mouse,
  ST_AddBand(NULL, array_agg(rast ORDER BY test_type), 1) As rast
FROM mice_studies
GROUP BY mouse;
```

☒☒: ☒☒☒ **DB** ☒☒☒☒

```
SELECT
  *
FROM ST_BandMetadata(
  ST_AddBand(
    ST_MakeEmptyRaster(10, 10, 0, 0, 1, -1, 0, 0, 0),
    '/home/raster/mytestraster.tif'::text, NULL::int[]
  ),
  ARRAY[]::integer[]
);
```

bandnum	pixeltype	nodatavalue	isoutdb	path
1	8BUI		t	/home/raster/mytestraster.tif
2	8BUI		t	/home/raster/mytestraster.tif
3	8BUI		t	/home/raster/mytestraster.tif

☒☒

[ST_BandMetaData](#), [ST_BandPixelType](#), [ST_MakeEmptyRaster](#), [ST_MetaData](#), [ST_NumBands](#), [ST_Reclass](#)

11.3.2 ST_AsRaster

ST_AsRaster — PostGIS ☒☒☒ PostGIS ☒☒☒☒☒☒☒☒☒.

Synopsis

raster **ST_AsRaster**(geometry geom, raster ref, text pixeltype, double precision value=1, double precision nodataval=0, boolean touched=false);

raster **ST_AsRaster**(geometry geom, raster ref, text[] pixeltype=ARRAY['8BUI'], double precision[] value=ARRAY[1], double precision[] nodataval=ARRAY[0], boolean touched=false);

raster **ST_AsRaster**(geometry geom, double precision scalex, double precision scaley, double precision gridx, double precision gridy, text pixeltype, double precision value=1, double precision nodataval=0, double precision skewx=0, double precision skewy=0, boolean touched=false);

raster **ST_AsRaster**(geometry geom, double precision scalex, double precision scaley, double precision gridx=NULL, double precision gridy=NULL, text[] pixeltype=ARRAY['8BUI'], double precision[] value=ARRAY[1], double precision[] nodataval=ARRAY[0], double precision skewx=0, double precision skewy=0, boolean touched=false);



Note

PostGIS, TIN, GDAL

PostGIS: PNG



PostGIS

```
-- this will output a black circle taking up 150 x 150 pixels --
SELECT ST_AsPNG(ST_AsRaster(ST_Buffer(ST_Point(1,5),10),150, 150));
```



PostGIS

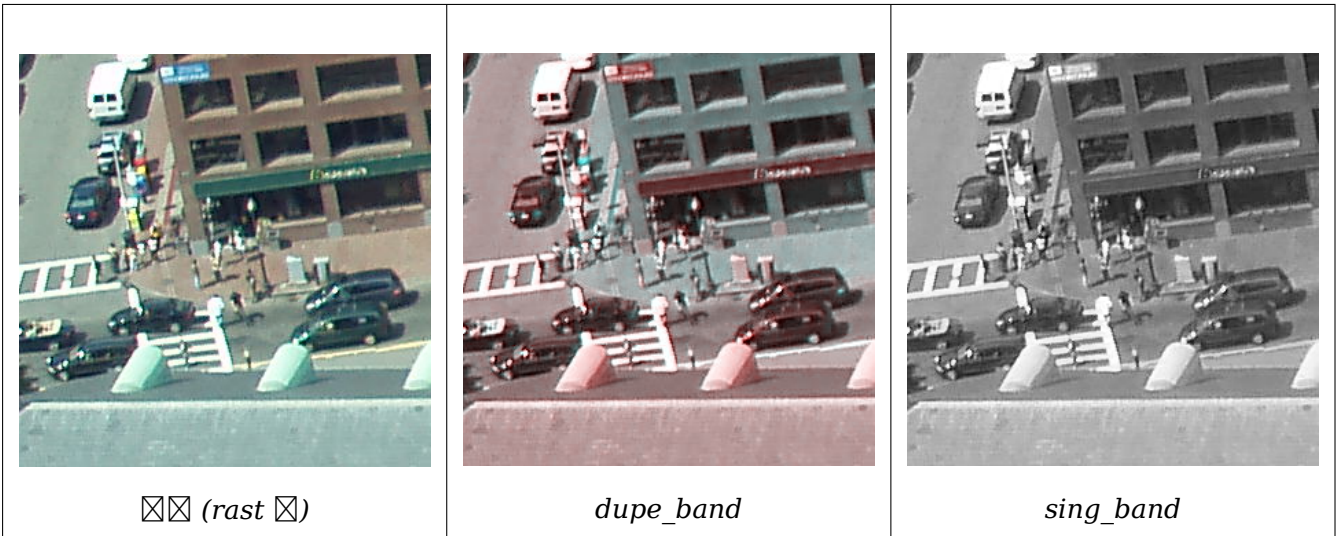
```
-- the bands map to RGB bands - the value (118,154,118) - teal --
SELECT ST_AsPNG(
  ST_AsRaster(
    ST_Buffer(
      ST_GeomFromText('LINESTRING(50 50,150 150,150 50)'), 10,'join=bevel'),
      200,200,ARRAY['8BUI', '8BUI', '8BUI'], ARRAY[118,154,118], ARRAY[0,0,0]));
```

PostGIS

[ST_BandPixelType](#), [ST_Buffer](#), [ST_GDALDrivers](#), [ST_AsGDALRaster](#), [ST_AsPNG](#), [ST_AsJPEG](#), [ST_SRID](#)

11.3.3 ST_Band

ST_Band — Returns the band number of a pixel in a raster. Returns the band number of a pixel in a raster.



```
--Make a new raster with 2nd band of original and 1st band repeated twice,
and another with just the third band
SELECT rast, ST_Band(rast, ARRAY[2,1,1]) As dupe_band,
       ST_Band(rast, 3) As sing_band
FROM samples.than_chunked
WHERE rid=35;
```

☒☒

[ST_AddBand](#), [ST_NumBands](#), [ST_Reclass](#), Chapter 11

11.3.4 ST_MakeEmptyCoverage

ST_MakeEmptyCoverage — Cover georeferenced area with a grid of empty raster tiles.

Synopsis

raster **ST_MakeEmptyCoverage**(integer tilewidth, integer tileheight, integer width, integer height, double precision upperleftx, double precision upperlefty, double precision scalex, double precision scaley, double precision skewx, double precision skewy, integer srid=unknown);

☒☒

Create a set of raster tiles with [ST_MakeEmptyRaster](#). Grid dimension is width & height. Tile dimension is tilewidth & tileheight. The covered georeferenced area is from upper left corner (upperleftx, upperlefty) to lower right corner (upperleftx + width * scalex, upperlefty + height * scaley).



Note

Note that scaley is generally negative for rasters and scalex is generally positive. So lower right corner will have a lower y value and higher x value than the upper left corner.

2.2.0 ☒☒☒☒☒☒☒☒☒☒.

Synopsis

setof raster **ST_Tile**(raster rast, int[] nband, integer width, integer height, boolean padwithnodata=FALSE, double precision nodataval=NULL);
 setof raster **ST_Tile**(raster rast, integer nband, integer width, integer height, boolean padwithnodata=FALSE, double precision nodataval=NULL);
 setof raster **ST_Tile**(raster rast, integer width, integer height, boolean padwithnodata=FALSE, double precision nodataval=NULL);

padwithnodata = FALSE, padwithnodata = TRUE, NODATA (padding) (NODATA) nodataval NODATA.



Note

DB, DB.

2.1.0

```
WITH foo AS (
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', 1, 0), 2, '8BUI', 10, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, 0, 1, -1, 0, 0, 0), 1, '8BUI', 2, 0), 2, '8BUI', 20, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, 0, 1, -1, 0, 0, 0), 1, '8BUI', 3, 0), 2, '8BUI', 30, 0) AS rast UNION ALL

  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, -3, 1, -1, 0, 0, 0), 1, '8BUI', 4, 0), 2, '8BUI', 40, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, -3, 1, -1, 0, 0, 0), 1, '8BUI', 5, 0), 2, '8BUI', 50, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, -3, 1, -1, 0, 0, 0), 1, '8BUI', 6, 0), 2, '8BUI', 60, 0) AS rast UNION ALL

  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, -6, 1, -1, 0, 0, 0), 1, '8BUI', 7, 0), 2, '8BUI', 70, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, -6, 1, -1, 0, 0, 0), 1, '8BUI', 8, 0), 2, '8BUI', 80, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, -6, 1, -1, 0, 0, 0), 1, '8BUI', 9, 0), 2, '8BUI', 90, 0) AS rast
), bar AS (
  SELECT ST_Union(rast) AS rast FROM foo
), baz AS (
  SELECT ST_Tile(rast, 3, 3, TRUE) AS rast FROM bar
)
SELECT
  ST_DumpValues(rast)
FROM baz;
```

st_dumpvalues

```

-----
(1,"{{1,1,1},{1,1,1},{1,1,1}}")
(2,"{{10,10,10},{10,10,10},{10,10,10}}")
(1,"{{2,2,2},{2,2,2},{2,2,2}}")
(2,"{{20,20,20},{20,20,20},{20,20,20}}")
(1,"{{3,3,3},{3,3,3},{3,3,3}}")
(2,"{{30,30,30},{30,30,30},{30,30,30}}")
(1,"{{4,4,4},{4,4,4},{4,4,4}}")
(2,"{{40,40,40},{40,40,40},{40,40,40}}")
(1,"{{5,5,5},{5,5,5},{5,5,5}}")
(2,"{{50,50,50},{50,50,50},{50,50,50}}")
(1,"{{6,6,6},{6,6,6},{6,6,6}}")
(2,"{{60,60,60},{60,60,60},{60,60,60}}")
(1,"{{7,7,7},{7,7,7},{7,7,7}}")
(2,"{{70,70,70},{70,70,70},{70,70,70}}")
(1,"{{8,8,8},{8,8,8},{8,8,8}}")
(2,"{{80,80,80},{80,80,80},{80,80,80}}")
(1,"{{9,9,9},{9,9,9},{9,9,9}}")
(2,"{{90,90,90},{90,90,90},{90,90,90}}")
(18 rows)

```

```

WITH foo AS (
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', ←
    1, 0), 2, '8BUI', 10, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, 0, 1, -1, 0, 0, 0), 1, '8BUI', ←
    2, 0), 2, '8BUI', 20, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, 0, 1, -1, 0, 0, 0), 1, '8BUI', ←
    3, 0), 2, '8BUI', 30, 0) AS rast UNION ALL

  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, -3, 1, -1, 0, 0, 0), 1, '8BUI ←
    ', 4, 0), 2, '8BUI', 40, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, -3, 1, -1, 0, 0, 0), 1, '8BUI ←
    ', 5, 0), 2, '8BUI', 50, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, -3, 1, -1, 0, 0, 0), 1, '8BUI ←
    ', 6, 0), 2, '8BUI', 60, 0) AS rast UNION ALL

  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, -6, 1, -1, 0, 0, 0), 1, '8BUI ←
    ', 7, 0), 2, '8BUI', 70, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 3, -6, 1, -1, 0, 0, 0), 1, '8BUI ←
    ', 8, 0), 2, '8BUI', 80, 0) AS rast UNION ALL
  SELECT ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 6, -6, 1, -1, 0, 0, 0), 1, '8BUI ←
    ', 9, 0), 2, '8BUI', 90, 0) AS rast
), bar AS (
  SELECT ST_Union(rast) AS rast FROM foo
), baz AS (
  SELECT ST_Tile(rast, 3, 3, 2) AS rast FROM bar
)
SELECT
  ST_DumpValues(rast)
FROM baz;

```

st_dumpvalues

```

-----
(1,"{{10,10,10},{10,10,10},{10,10,10}}")
(1,"{{20,20,20},{20,20,20},{20,20,20}}")
(1,"{{30,30,30},{30,30,30},{30,30,30}}")
(1,"{{40,40,40},{40,40,40},{40,40,40}}")
(1,"{{50,50,50},{50,50,50},{50,50,50}}")
(1,"{{60,60,60},{60,60,60},{60,60,60}}")
(1,"{{70,70,70},{70,70,70},{70,70,70}}")
(1,"{{80,80,80},{80,80,80},{80,80,80}}")

```


upperleftx
upperlefty

ESRI:

scalex
skewy
skewx
scaley
upperleftx + scalex*0.5
upperlefty + scaley*0.5

```
SELECT ST_GeoReference(rast, 'ESRI') As esri_ref, ST_GeoReference(rast, 'GDAL') As gdal_ref
FROM dummy_rast WHERE rid=1;
```

esri_ref	gdal_ref
2.0000000000	2.0000000000
0.0000000000	0.0000000000
0.0000000000	0.0000000000
3.0000000000	3.0000000000
1.5000000000	0.5000000000
2.0000000000	0.5000000000

[ST_SetGeoReference](#), [ST_ScaleX](#), [ST_ScaleY](#)

11.4.2 ST_Height

ST_Height —

Synopsis

integer **ST_Height**(raster rast);

```
SELECT rid, ST_Height(rast) As rastheight
FROM dummy_rast;
```

rid	rastheight
1	20
2	5

☒☒

ST_Width

11.4.3 ST_IsEmpty

ST_IsEmpty — Returns true if the raster is empty (width = 0, height = 0). Returns false otherwise.

Synopsis

boolean **ST_IsEmpty**(raster rast);

☒☒

Returns true if the raster is empty (width = 0, height = 0). Returns false otherwise.
 2.0.0 Returns true if the raster is empty.

☒☒

```
SELECT ST_IsEmpty(ST_MakeEmptyRaster(100, 100, 0, 0, 0, 0, 0, 0))
st_isempty |
-----+
f          |

SELECT ST_IsEmpty(ST_MakeEmptyRaster(0, 0, 0, 0, 0, 0, 0, 0))
st_isempty |
-----+
t          |
```

☒☒

ST_HasNoBand

11.4.4 ST_MemSize

ST_MemSize — Returns the memory size of the raster in bytes (KB) if the raster is empty.

Synopsis

integer **ST_MemSize**(raster rast);

Example:

```
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

Example: 0 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 (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

Example:

[ST_PixelWidth](#), [ST_ScaleX](#), [ST_ScaleY](#), [ST_SkewX](#), [ST_SkewY](#)

11.4.8 ST_PixelWidth

`ST_PixelWidth` — Returns the pixel width of a raster.

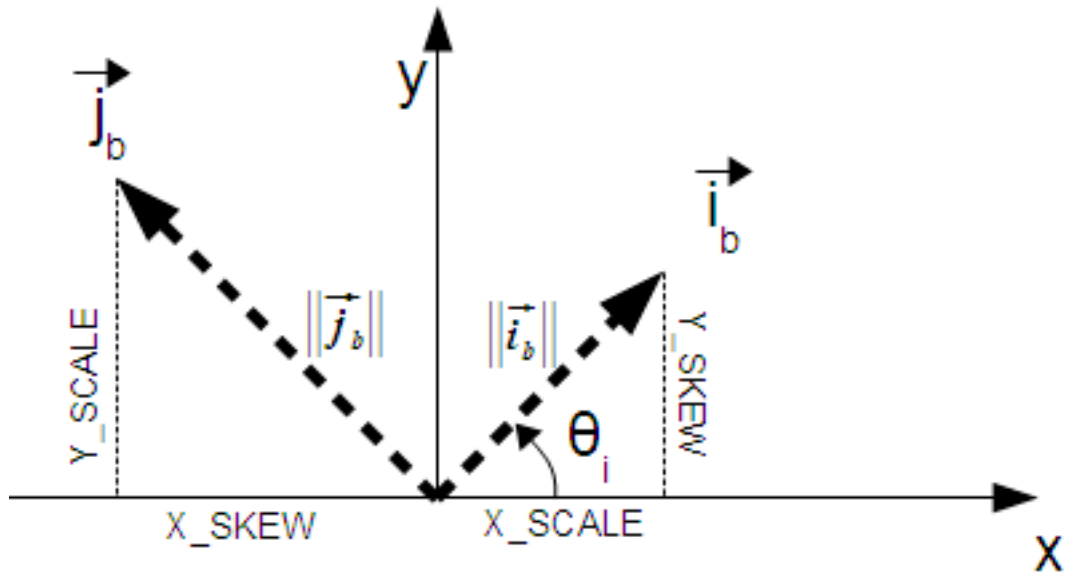
Synopsis

double precision **ST_PixelWidth**(raster rast);

Example:

`ST_PixelWidth` returns the pixel width of a raster. For a 2D raster, the pixel width is the width of the raster in pixels. For a 3D raster, the pixel width is the width of the raster in pixels along the x-axis.

`ST_PixelWidth` returns the pixel width of a raster. For a 2D raster, the pixel width is the width of the raster in pixels. For a 3D raster, the pixel width is the width of the raster in pixels along the x-axis.



i
 j

Example 1:

```
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

Example 2: 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

Functions:

[ST_PixelHeight](#), [ST_ScaleX](#), [ST_ScaleY](#), [ST_SkewX](#), [ST_SkewY](#)

11.4.9 ST_ScaleX

ST_ScaleX — X

Synopsis

float8 ST_ScaleX(raster rast);

X.
 : 2.0.0 WKTRaster ST_PixelSizeX

```
SELECT rid, ST_ScaleX(rast) As rastpixwidth
FROM dummy_rast;
```

rid	rastpixwidth
1	2
2	0.05

ST_Width

11.4.10 ST_ScaleY

ST_ScaleY — Y

Synopsis

float8 ST_ScaleY(raster rast);

Y.
 : 2.0.0 WKTRaster ST_PixelSizeY

```
SELECT rid, ST_ScaleY(rast) As rastpixheight
FROM dummy_rast;
```

rid	rastpixheight
1	3
2	-0.05

☐☐

[ST_RasterToWorldCoordX](#), [ST_RasterToWorldCoordY](#), [ST_SetSkew](#)

11.4.12 ST_RasterToWorldCoordX

ST_RasterToWorldCoordX — 返回栅格中指定列的 X 坐标。返回类型为 float8。默认返回栅格第一列的 X 坐标。

Synopsis

float8 **ST_RasterToWorldCoordX**(raster rast, integer xcolumn);
 float8 **ST_RasterToWorldCoordX**(raster rast, integer xcolumn, integer yrow);

☐☐

返回栅格中指定列的 X 坐标。返回类型为 float8。默认返回栅格第一列的 X 坐标。如果指定了 yrow，则返回指定行的 X 坐标。如果指定了 xcolumn 和 yrow，则返回指定行列的 X 坐标。



Note

ST_RasterToWorldCoordX 返回栅格中指定列的 X 坐标。返回类型为 float8。默认返回栅格第一列的 X 坐标。如果指定了 yrow，则返回指定行的 X 坐标。如果指定了 xcolumn 和 yrow，则返回指定行列的 X 坐标。ST_ScaleX, ST_SkewX, ST_SetSkew 也是栅格函数。ST_RasterToWorldCoordX 返回栅格中指定列的 X 坐标。

更新: 2.1.0 版本中 ST_Raster2WorldCoordX 函数被弃用。

☐☐

```
-- non-skewed raster providing column is sufficient
SELECT rid, ST_RasterToWorldCoordX(rast,1) As xlcoord,
       ST_RasterToWorldCoordX(rast,2) As x2coord,
       ST_ScaleX(rast) As pixelx
FROM dummy_rast;
```

rid	xlcoord	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 xlcoord,
       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	xlcoord	x2coord	pixelx
1	0.5	203.5	2
2	3427927.75	3428128.8	0.05

☒☒

[ST_ScaleX](#), [ST_RasterToWorldCoordY](#), [ST_SetSkew](#), [ST_SkewX](#)

11.4.13 ST_RasterToWorldCoordY

ST_RasterToWorldCoordY — 返回栅格中指定行 Y 的地理坐标。返回类型为 1 的浮点数组。

Synopsis

```
float8 ST_RasterToWorldCoordY(raster rast, integer yrow);
float8 ST_RasterToWorldCoordY(raster rast, integer xcolumn, integer yrow);
```

☒☒

返回栅格中指定行 Y 的地理坐标。返回类型为 1 的浮点数组。如果指定了 xcolumn，则返回指定列 X 的地理坐标。如果没有指定 xcolumn，则返回指定行 Y 的地理坐标。



Note

返回的浮点数组，Y 是栅格的行号。如果没有指定 xcolumn，则返回指定行 Y 的地理坐标。如果没有指定 yrow，则返回指定列 X 的地理坐标。

更新: 2.1.0 版本中 ST_Raster2WorldCoordY 函数被弃用。

☒☒

```
-- non-skewed raster providing row is sufficient
SELECT rid, ST_RasterToWorldCoordY(rast,1) As ylcoord,
       ST_RasterToWorldCoordY(rast,3) As y2coord,
       ST_ScaleY(rast) As pixely
FROM dummy_rast;
```

rid	ylcoord	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 ylcoord,
       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	ylcoord	y2coord	pixely
1	0.5	107	3
2	5793244	5793344.4	-0.05

[ST_ScaleY](#), [ST_RasterToWorldCoordX](#), [ST_SetSkew](#), [ST_SkewY](#)

11.4.14 ST_Rotation

ST_Rotation —

Synopsis

float8 ST_Rotation(raster rast);

... NaN ...

```
SELECT rid, ST_Rotation(ST_SetScale(ST_SetSkew(rast, sqrt(2)), sqrt(2))) as rot FROM dummy_rast;
```

rid	rot
1	0.785398163397448
2	0.785398163397448

[ST_SetRotation](#), [ST_SetScale](#), [ST_SetSkew](#)

11.4.15 ST_SkewX

ST_SkewX —

Synopsis

float8 ST_SkewX(raster rast);

... X (skew) ...

☒☒

```
SELECT rid, ST_SkewX(rast) As skewx, ST_SkewY(rast) As skewy,
       ST_GeoReference(rast) as georef
FROM dummy_rast;
```

rid	skewx	skewy	georef
1	0	0	2.0000000000 : 0.0000000000 : 0.0000000000 : 3.0000000000 : 0.5000000000 : 0.5000000000 :
2	0	0	0.0500000000 : 0.0000000000 : 0.0000000000 : -0.0500000000 : 3427927.7500000000 : 5793244.0000000000

☒☒

[ST_GeoReference](#), [ST_SkewY](#), [ST_SetSkew](#)

11.4.16 ST_SkewY

ST_SkewY — ☒☒☒☒ Y ☒☒☒ (☒☒☒☒☒☒☒☒) ☒☒☒☒☒☒.

Synopsis

float8 **ST_SkewY**(raster rast);

☒☒

☒☒☒☒ Y ☒☒☒ (☒☒☒☒☒☒☒☒) ☒☒☒☒☒☒. ☒☒☒☒☒☒ ☒☒☒☒☒☒ ☒☒☒☒☒☒☒.

☒☒

```
SELECT rid, ST_SkewX(rast) As skewx, ST_SkewY(rast) As skewy,
       ST_GeoReference(rast) as georef
FROM dummy_rast;
```

rid	skewx	skewy	georef
1	0	0	2.0000000000 : 0.0000000000 : 0.0000000000 : 3.0000000000 : 0.5000000000 : 0.5000000000 :

```

2 | 0 | 0 | 0.0500000000
   |   |   | : 0.0000000000
   |   |   | : 0.0000000000
   |   |   | : -0.0500000000
   |   |   | : 3427927.7500000000
   |   |   | : 5793244.0000000000

```

[ST_GeoReference](#), [ST_SkewX](#), [ST_SetSkew](#)

11.4.17 ST_SRID

ST_SRID — spatial_ref_sys, raster

Synopsis

integer **ST_SRID**(raster rast);

spatial_ref_sys, raster



Note

PostGIS 2.0, SRID -1 0

```

SELECT ST_SRID(rast) As srid
FROM dummy_rast WHERE rid=1;

```

```

srid
-----
0

```

Section [4.5](#), [ST_SRID](#)

11.4.18 ST_Summary

ST_Summary — raster

Synopsis

text **ST_Summary**(raster rast);

11.4.23 ST_WorldToRasterCoordX

ST_WorldToRasterCoordX — (pt) X, Y (xw, yw)

Synopsis

```
integer ST_WorldToRasterCoordX(raster rast, geometry pt);
integer ST_WorldToRasterCoordX(raster rast, double precision xw);
integer ST_WorldToRasterCoordX(raster rast, double precision xw, double precision yw);
```

(pt) X, Y (xw, yw). (xw, yw) (xw, yw) xw yw.

2.1.0 ST_World2RasterCoordX

```
SELECT rid, ST_WorldToRasterCoordX(rast,3427927.8) As xcoord,
       ST_WorldToRasterCoordX(rast,3427927.8,20.5) As xcoord_xwyw,
       ST_WorldToRasterCoordX(rast,ST_GeomFromText('POINT(3427927.8 20.5)',ST_SRID(rast))) As ptxcoord
FROM dummy_rast;
```

rid	xcoord	xcoord_xwyw	ptxcoord
1	1713964	1713964	1713964
2	1	1	1

[ST_RasterToWorldCoordX](#), [ST_RasterToWorldCoordY](#), [ST_SRID](#)

11.4.24 ST_WorldToRasterCoordY

ST_WorldToRasterCoordY — (pt) X, Y (xw, yw)

Synopsis

```
integer ST_WorldToRasterCoordY(raster rast, geometry pt);
integer ST_WorldToRasterCoordY(raster rast, double precision xw);
integer ST_WorldToRasterCoordY(raster rast, double precision xw, double precision yw);
```

¶¶

`ST_WorldToRasterCoordY` (pt) ¶¶¶¶¶¶¶¶ X, Y ¶¶¶¶ (xw, yw) ¶¶¶¶¶¶. ¶¶¶¶¶¶¶¶ (¶¶¶¶¶¶¶¶¶¶¶¶¶¶ xw ¶ yw ¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶). ¶¶¶¶¶¶¶¶¶¶¶¶¶¶ xw ¶¶¶¶¶¶¶¶¶¶¶¶. ¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶.

¶¶¶¶: 2.1.0 ¶¶¶¶¶¶¶¶ `ST_World2RasterCoordY` ¶¶¶¶¶¶¶¶¶¶.

¶¶

```
SELECT rid, ST_WorldToRasterCoordY(rast,20.5) As ycoord,
        ST_WorldToRasterCoordY(rast,3427927.8,20.5) As ycoord_xwyw,
        ST_WorldToRasterCoordY(rast,ST_GeomFromText('POINT(3427927.8 20.5)',ST_SRID(rast))) ←
        As ptycoord
FROM dummy_rast;
```

rid	ycoord	ycoord_xwyw	ptycoord
1	7	7	7
2	115864471	115864471	115864471

¶¶

[ST_RasterToWorldCoordX](#), [ST_RasterToWorldCoordY](#), [ST_SRID](#)

11.5 ¶¶¶¶¶¶¶¶¶¶

11.5.1 ST_BandMetaData

`ST_BandMetaData` — ¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶. ¶¶¶¶¶¶¶¶¶¶¶¶¶¶ 1 ¶¶¶¶¶¶¶¶¶¶.

Synopsis

- (1) record `ST_BandMetaData`(raster rast, integer band=1);
- (2) record `ST_BandMetaData`(raster rast, integer[] band);

¶¶

Returns basic meta data about a raster band. Columns returned: pixeltype, nodatavalue, isoutdb, path, outdbbandnum, filesize, filetimestamp.



Note ¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶¶.



Note If band has no NODATA value, nodatavalue are NULL.



Note

If `isoutdb` is False, `path`, `outdbbandnum`, `filesize` and `filetimestamp` are NULL. If `outdb` access is disabled, `filesize` and `filetimestamp` will also be NULL.

Enhanced: 2.5.0 to include `outdbbandnum`, `filesize` and `filetimestamp` for `outdb` rasters.

☒☒: ☒☒ 1

```
SELECT
  rid,
  (foo.md).*
FROM (
  SELECT
    rid,
    ST_BandMetaData(rast, 1) AS md
  FROM dummy_rast
  WHERE rid=2
) As foo;
```

rid	pixeltype	nodatavalue	isoutdb	path	outdbbandnum
2	8BUI		f		

☒☒: ☒☒ 2

```
WITH foo AS (
  SELECT
    ST_AddBand(NULL::raster, '/home/pele/devel/geo/postgis-git/raster/test/regress/ ↵
    loader/Projected.tif', NULL::int[]) AS rast
)
SELECT
  *
FROM ST_BandMetadadata(
  (SELECT rast FROM foo),
  ARRAY[1,3,2]::int[]
);
```

bandnum	pixeltype	nodatavalue	isoutdb	outdbbandnum	filesize	filetimestamp	path ↵
1	8BUI		t	1	12345	1521807257	/home/pele/devel/geo/postgis-git/raster/test ↵ /regress/loader/Projected.tif
3	8BUI		t	3	12345	1521807257	/home/pele/devel/geo/postgis-git/raster/test ↵ /regress/loader/Projected.tif
2	8BUI		t	2	12345	1521807257	/home/pele/devel/geo/postgis-git/raster/test ↵ /regress/loader/Projected.tif

☒☒

[ST_MetaData](#), [ST_BandPixelType](#)

11.5.2 ST_BandNoDataValue

ST_BandNoDataValue — Returns the NODATA value for a given band number. If the band number is 1, the NODATA value is the value of the first band.

Synopsis

double precision **ST_BandNoDataValue**(raster rast, integer bandnum=1);

Parameters

bandnum NODATA value for the given band number.

Return Value

```
SELECT ST_BandNoDataValue(rast,1) As bval1,
       ST_BandNoDataValue(rast,2) As bval2, ST_BandNoDataValue(rast,3) As bval3
FROM dummy_rast
WHERE rid = 2;
```

bval1	bval2	bval3
0	0	0

See Also

[ST_NumBands](#)

11.5.3 ST_BandIsNoData

ST_BandIsNoData — Returns TRUE if the NODATA value for a given band number is not NULL.


Synopsis

boolean **ST_BandIsNoData**(raster rast, integer band, boolean forceChecking=true);
 boolean **ST_BandIsNoData**(raster rast, boolean forceChecking=true);

Parameters

band NODATA value for the given band number. If the band number is 1, the NODATA value is the value of the first band. If **forceChecking** is TRUE, the NODATA value is checked for NULL. If **forceChecking** is FALSE, the NODATA value is not checked for NULL.

2.0.0 Added.

Note
 If **forceChecking** is TRUE (or if **ST_SetBandNoDataValue()** is called with **forceChecking** TRUE), **ST_SetBandIsNoData()** will return TRUE if the NODATA value is not NULL. **ST_SetBandIsNoData()** will return FALSE if the NODATA value is NULL.

☒☒

```

-- Create dummy table with one raster column
create table dummy_rast (rid integer, rast raster);

-- Add raster with two bands, one pixel/band. In the first band, nodatavalue = pixel value ←
  = 3.
-- In the second band, nodatavalue = 13, pixel value = 4
insert into dummy_rast values(1,
(
'01' -- little endian (uint8 ndr)
||
'0000' -- version (uint16 0)
||
'0200' -- nBands (uint16 0)
||
'17263529ED684A3F' -- scaleX (float64 0.000805965234044584)
||
'F9253529ED684ABF' -- scaleY (float64 -0.00080596523404458)
||
'1C9F33CE69E352C0' -- ipX (float64 -75.5533328537098)
||
'718F0E9A27A44840' -- ipY (float64 49.2824585505576)
||
'ED50EB853EC32B3F' -- skewX (float64 0.000211812383858707)
||
'7550EB853EC32B3F' -- skewY (float64 0.000211812383858704)
||
'E6100000' -- SRID (int32 4326)
||
'0100' -- width (uint16 1)
||
'0100' -- height (uint16 1)
||
'6' -- hasnodatavalue and isnodata value set to true.
||
'2' -- first band type (4BUI)
||
'03' -- novalue==3
||
'03' -- pixel(0,0)==3 (same that nodata)
||
'0' -- hasnodatavalue set to false
||
'5' -- second band type (16BSI)
||
'0D00' -- novalue==13
||
'0400' -- pixel(0,0)==4
)::raster
);

select st_bandisnodata(rast, 1) from dummy_rast where rid = 1; -- Expected true
select st_bandisnodata(rast, 2) from dummy_rast where rid = 1; -- Expected false

```

☒☒

ST_BandNoDataValue, ST_NumBands, ST_SetBandNoDataValue, ST_SetBandIsNoData

- 32BSI - 32 signed integers
- 32BUI - 32 unsigned integers
- 32BF - 32 floating point numbers
- 64BF - 64 floating point numbers

Example

```
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
```

Example

ST_NumBands

11.5.8 ST_MinPossibleValue

ST_MinPossibleValue — Returns the minimum possible value for a pixel type.

Synopsis

integer **ST_MinPossibleValue**(text pixeltype);

Example

Example: Returns the minimum possible value for a 16-bit signed integer pixel type.

Example

```
SELECT ST_MinPossibleValue('16BSI');

 st_minpossiblevalue
-----
                -32768

SELECT ST_MinPossibleValue('8BUI');

 st_minpossiblevalue
-----
                    0
```


☒☒

```
-- get raster pixel polygon
SELECT i,j, ST_AsText(ST_PixelAsPolygon(foo.rast, i,j)) As b1pgeom
FROM dummy_rast As foo
      CROSS JOIN generate_series(1,2) As i
      CROSS JOIN generate_series(1,1) As j
WHERE rid=2;
```

i	j	b1pgeom
1	1	POLYGON((3427927.75 5793244,3427927.8 5793244,3427927.8 5793243.95,...
2	1	POLYGON((3427927.8 5793244,3427927.85 5793244,3427927.85 5793243.95, ..

☒☒

[ST_DumpAsPolygons](#), [ST_PixelAsPolygons](#), [ST_PixelAsPoint](#), [ST_PixelAsPoints](#), [ST_PixelAsCentroid](#), [ST_PixelAsCentroids](#), [ST_Intersection](#), [ST_AsText](#)

11.6.2 ST_PixelAsPolygons

ST_PixelAsPolygons — Returns a set of records containing the geometry of each pixel in a raster. The geometry is a polygon representing the pixel's footprint. X, Y coordinates are returned.

Synopsis

setof record **ST_PixelAsPolygons**(raster rast, integer band=1, boolean exclude_nodata_value=TRUE);

☒☒

Each record contains the geometry of a pixel (a polygon) and its X, Y coordinates.

Return record format: *geom geometry*, *val* double precision, *x* integer, *y* integers.

Note! When *exclude_nodata_value* = TRUE, only those pixels whose values are not NODATA are returned as points.

Note! ST_PixelAsPolygons returns a set of records containing the geometry of each pixel in a raster. ST_DumpAsPolygons returns a set of records containing the geometry of each pixel in a raster.

2.0.0 Returns a set of records.

☒☒☒: 2.1.0 Returns a set of records containing the geometry of each pixel in a raster.

☒☒☒☒: 2.1.1 Returns a set of records containing the geometry of each pixel in a raster.

11.6.4 ST_PixelAsPoints

ST_PixelAsPoints — Returns a set of record (x, y, val) for each pixel in the raster. The x and y coordinates are the pixel's center coordinates.

Synopsis

setof record **ST_PixelAsPoints**(raster rast, integer band=1, boolean exclude_nodata_value=TRUE);

Parameters

rast: raster. **band**: integer. **exclude_nodata_value**: boolean. **geom geometry**, **val** double precision, **x** integer, **y** integers.

Return record format: *geom geometry*, *val* double precision, *x* integer, *y* integers.



Note

When *exclude_nodata_value* = TRUE, only those pixels whose values are not NODATA are returned as points.

2.1.0 Returns a set of record (x, y, val).

Parameters: 2.1.1 **exclude_nodata_value** boolean.

Example

```
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)

11.6.7 ST_Value

ST_Value — Returns the value of a raster at a particular geometry point. The raster is identified by column name and row number. The geometry point is identified by a geometry object. The function also takes an optional band number and a boolean flag to exclude nodata values. The function returns a double precision value.

Synopsis

double precision **ST_Value**(raster rast, geometry pt, boolean exclude_nodata_value=true);
 double precision **ST_Value**(raster rast, integer band, geometry pt, boolean exclude_nodata_value=true, text resample='nearest');
 double precision **ST_Value**(raster rast, integer x, integer y, boolean exclude_nodata_value=true);
 double precision **ST_Value**(raster rast, integer band, integer x, integer y, boolean exclude_nodata_value=true);

Parameters

columnx, **rowy** — The column and row number of the raster cell. The values must be integers and within the bounds of the raster.
band — The band number of the raster. The value must be an integer and within the range of the raster's bands.
exclude_nodata_value — A boolean flag that, when set to true, causes the function to return a null value if the raster cell contains a nodata value. When set to false, the function returns the nodata value.

The allowed values of the resample parameter are "nearest" which performs the default nearest-neighbor resampling, and "bilinear" which performs a bilinear interpolation to estimate the value between pixel centers.

2.1.0: ST_Value(rast, pt, exclude_nodata_value);
 2.0.0: ST_Value(rast, band, pt, exclude_nodata_value);

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)))
```



```

                2, 3, 0.
            ),
            3, 5, 0.
        ),
        4, 2, 0.
    ),
    5, 4, 0.
) AS rast
) AS foo

value | nearestvalue
-----+-----
1 | 1

```

```

-- pixel 2x3 is NODATA
SELECT
    ST_Value(rast, 2, 3) AS value,
    ST_NearestValue(rast, 2, 3) AS nearestvalue
FROM (
    SELECT
        ST_SetValue(
            ST_SetValue(
                ST_SetValue(
                    ST_SetValue(
                        ST_SetValue(
                            ST_AddBand(
                                ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
                                '8BUI'::text, 1, 0
                            ),
                            1, 1, 0.
                        ),
                        2, 3, 0.
                    ),
                    3, 5, 0.
                ),
                4, 2, 0.
            ),
            5, 4, 0.
        ) AS rast
    ) AS foo

value | nearestvalue
-----+-----
| 1

```



ST_Neighborhood, ST_Value

11.6.9 ST_SetZ

ST_SetZ — Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the Z dimension using the requested resample algorithm.

Synopsis

geometry **ST_SetZ**(raster rast, geometry geom, text resample=nearest, integer band=1);

☒☒

Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the Z dimensions using the requested resample algorithm.

The `resample` parameter can be set to "nearest" to copy the values from the cell each vertex falls within, or "bilinear" to use **bilinear interpolation** to calculate a value that takes neighboring cells into account also.

Availability: 3.2.0

☒☒

```
--
-- 2x2 test raster with values
--
-- 10 50
-- 40 20
--
WITH test_raster AS (
SELECT
ST_SetValues(
  ST_AddBand(
    ST_MakeEmptyRaster(width => 2, height => 2,
      upperleftx => 0, upperlefty => 2,
      scalex => 1.0, scaley => -1.0,
      skewx => 0, skewy => 0, srid => 4326),
    index => 1, pixeltype => '16BSI',
    initialvalue => 0,
    nodataval => -999),
    1,1,1,
    newvalueset =>ARRAY[ARRAY[10.0::float8, 50.0::float8], ARRAY[40.0::float8, 20.0::float8 ←
      ]) AS rast
)
SELECT
ST_AsText(
  ST_SetZ(
    rast,
    band => 1,
    geom => 'SRID=4326;LINESTRING(1.0 1.9, 1.0 0.2)::geometry,
    resample => 'bilinear'
  ))
FROM test_raster

          st_astext
-----
LINESTRING Z (1 1.9 38,1 0.2 27)
```

☒☒

ST_Value, ST_SetSRID

11.6.10 ST_SetM

ST_SetM — Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the M dimension using the requested resample algorithm.

Synopsis

geometry **ST_SetM**(raster rast, geometry geom, text resample=nearest, integer band=1);

☒☒

Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the M dimensions using the requested resample algorithm.

The resample parameter can be set to "nearest" to copy the values from the cell each vertex falls within, or "bilinear" to use **bilinear interpolation** to calculate a value that takes neighboring cells into account also.

Availability: 3.2.0

☒☒

```
--
-- 2x2 test raster with values
--
-- 10 50
-- 40 20
--
WITH test_raster AS (
SELECT
ST_SetValues(
  ST_AddBand(
    ST_MakeEmptyRaster(width => 2, height => 2,
      upperleftx => 0, upperlefty => 2,
      scalex => 1.0, scaley => -1.0,
      skewx => 0, skewy => 0, srid => 4326),
    index => 1, pixeltype => '16BSI',
    initialvalue => 0,
    nodataval => -999),
    1,1,1,
    newvalueset =>ARRAY[ARRAY[10.0::float8, 50.0::float8], ARRAY[40.0::float8, 20.0::float8 ←
      ]]) AS rast
)
SELECT
ST_AsText(
  ST_SetM(
    rast,
    band => 1,
    geom => 'SRID=4326;LINESTRING(1.0 1.9, 1.0 0.2)::geometry,
    resample => 'bilinear'
  ))
FROM test_raster

          st_astext
-----
LINESTRING M (1 1.9 38,1 0.2 27)
```

☒☒

ST_Value, ST_SetSRID

11.6.11 ST_Neighborhood

ST_Neighborhood — columnx × rowy, NODATA 2

Synopsis

```
double precision[][] ST_Neighborhood(raster rast, integer bandnum, integer columnX, integer rowY, integer distanceX, integer distanceY, boolean exclude_nodata_value=true);
double precision[][] ST_Neighborhood(raster rast, integer columnX, integer rowY, integer distanceX, integer distanceY, boolean exclude_nodata_value=true);
double precision[][] ST_Neighborhood(raster rast, integer bandnum, geometry pt, integer distanceX, integer distanceY, boolean exclude_nodata_value=true);
double precision[][] ST_Neighborhood(raster rast, geometry pt, integer distanceX, integer distanceY, boolean exclude_nodata_value=true);
```

columnx × rowy, NODATA 2

distanceX × distanceY × X × Y. 3 × Y 2 columnx × rowy

bandnum × 1. exclude_nodata_value nodata exclude_nodata_value



Note

2 * (distanceX|distanceY) + 1. distanceX × distanceY × 1, 3x3



Note

ST_Min4ma, ST_Sum4ma, ST_Mean4ma 2

2.1.0

```
-- pixel 2x2 has value
SELECT
  ST_Neighborhood(rast, 2, 2, 1, 1)
FROM (
  SELECT
    ST_SetValues(
      ST_AddBand(
        ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
        '8BUI'::text, 1, 0
      ),
```

```

        1, 1, 1, ARRAY[
            [0, 1, 1, 1, 1],
            [1, 1, 1, 0, 1],
            [1, 0, 1, 1, 1],
            [1, 1, 1, 1, 0],
            [1, 1, 0, 1, 1]
        ]::double precision[],
        1
    ) AS rast
) AS foo

    st_neighborhood
-----
{{NULL,1,1},{1,1,1},{1,NULL,1}}

```

```

-- pixel 2x3 is NODATA
SELECT
    ST_Neighborhood(rast, 2, 3, 1, 1)
FROM (
    SELECT
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
                '8BUI'::text, 1, 0
            ),
            1, 1, 1, ARRAY[
                [0, 1, 1, 1, 1],
                [1, 1, 1, 0, 1],
                [1, 0, 1, 1, 1],
                [1, 1, 1, 1, 0],
                [1, 1, 0, 1, 1]
            ]::double precision[],
            1
        ) AS rast
    ) AS foo

    st_neighborhood
-----
{{1,1,1},{1,NULL,1},{1,1,1}}

```

```

-- pixel 3x3 has value
-- exclude_nodata_value = FALSE
SELECT
    ST_Neighborhood(rast, 3, 3, 1, 1, false)
FROM ST_SetValues(
    ST_AddBand(
        ST_MakeEmptyRaster(5, 5, -2, 2, 1, -1, 0, 0, 0),
        '8BUI'::text, 1, 0
    ),
    1, 1, 1, ARRAY[
        [0, 1, 1, 1, 1],
        [1, 1, 1, 0, 1],
        [1, 0, 1, 1, 1],
        [1, 1, 1, 1, 0],
        [1, 1, 0, 1, 1]
    ]::double precision[],
    1
) AS rast

    st_neighborhood
-----

```


☒☒: ☒☒ 1

```

/*
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...

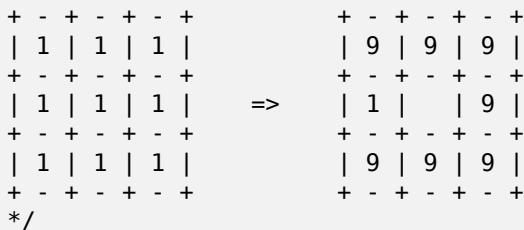
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 9 | 9 | 9 |
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           =
> | 9 | 9 | 9 |
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 9 | 9 | 9 |
+ - + - + - +           + - + - + - +
*/
SELECT
    (poly).x,

```

```
(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...



```
*/
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	9
1	3	9
2	1	9
2	2	
2	3	9
3	1	9
3	2	9
3	3	9

1	1	9
1	2	1
1	3	9
2	1	9
2	2	
2	3	9
3	1	9
3	2	9
3	3	9

```

/*
The ST_SetValues() does the following...

+ - + - + - +      + - + - + - +
| | 1 | 1 |          | | 9 | 9 |
+ - + - + - +      + - + - + - +
| 1 | 1 | 1 |      => | 1 | | 9 |
+ - + - + - +      + - + - + - +
| 1 | 1 | 1 |          | 9 | 9 | 9 |
+ - + - + - +      + - + - + - +
*/
SELECT
  (poly).x,
  (poly).y,
  (poly).val
FROM (
  SELECT
    ST_PixelAsPolygons(
      ST_SetValues(
        ST_SetValue(
          ST_AddBand(
            ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
            1, '8BUI', 1, 0
          ),
          1, 1, 1, NULL
        ),
        1, 1, 1,
        ARRAY[[9, 9, 9], [9, NULL, 9], [9, 9, 9]]::double precision[[[]],
        ARRAY[[false], [true]]::boolean[[[]],
        TRUE
      )
    ) AS poly
  ) foo
ORDER BY 1, 2;

x | y | val
---+---+---
1 | 1 |
1 | 2 | 1
1 | 3 | 9
2 | 1 | 9
2 | 2 |
2 | 3 | 9
3 | 1 | 9
3 | 2 | 9
3 | 3 | 9

```

☒☒: ☒☒ 2

```

/*
The ST_SetValues() does the following...

+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 1 | 1 | 1 |
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |   =>    | 1 | 9 | 9 |
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 1 | 9 | 9 |
+ - + - + - +           + - + - + - +
*/
SELECT
  (poly).x,
  (poly).y,
  (poly).val
FROM (
SELECT
  ST_PixelAsPolygons(
    ST_SetValues(
      ST_AddBand(
        ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
        1, '8BUI', 1, 0
      ),
      1, 1, 1, ARRAY[[-1, -1, -1], [-1, 9, 9], [-1, 9, 9]]::double precision[[]], -1
    )
  ) AS poly
) foo
ORDER BY 1, 2;

```

x	y	val
1	1	1
1	2	1
1	3	1
2	1	1
2	2	9
2	3	9
3	1	1
3	2	9
3	3	9

/*
This example is like the previous one. Instead of nosetvalue = -1, nosetvalue = NULL

The ST_SetValues() does the following...

```

+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 1 | 1 | 1 |
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |   =>    | 1 | 9 | 9 |
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 1 | 9 | 9 |
+ - + - + - +           + - + - + - +
*/

```

```

SELECT
  (poly).x,
  (poly).y,
  (poly).val
FROM (
SELECT
  ST_PixelAsPolygons(

```

```

        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                1, '8BUI', 1, 0
            ),
            1, 1, ARRAY[[NULL, NULL, NULL], [NULL, 9, 9], [NULL, 9, 9]]::double ←
                precision[[]], NULL::double precision
        )
    ) AS poly
) foo
ORDER BY 1, 2;

```

x	y	val
1	1	1
1	2	1
1	3	1
2	1	1
2	2	9
2	3	9
3	1	1
3	2	9
3	3	9

☒☒: ☒☒ 3

```

/*
The ST_SetValues() does the following...

+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 1 | 1 | 1 |
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |   =>    | 1 | 9 | 9 |
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 1 | 9 | 9 |
+ - + - + - +           + - + - + - +
*/
SELECT
    (poly).x,
    (poly).y,
    (poly).val
FROM (
SELECT
    ST_PixelAsPolygons(
        ST_SetValues(
            ST_AddBand(
                ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
                1, '8BUI', 1, 0
            ),
            1, 2, 2, 2, 2, 9
        )
    ) AS poly
) foo
ORDER BY 1, 2;

```

x	y	val
1	1	1
1	2	1
1	3	1

```

2 | 1 | 1
2 | 2 | 9
2 | 3 | 9
3 | 1 | 1
3 | 2 | 9
3 | 3 | 9

```

```

/*
The ST_SetValues() does the following...

+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 1 | 1 | 1 |
+ - + - + - +           + - + - + - +
| 1 |   | 1 |   =>    | 1 |   | 9 |
+ - + - + - +           + - + - + - +
| 1 | 1 | 1 |           | 1 | 9 | 9 |
+ - + - + - +           + - + - + - +
*/
SELECT
  (poly).x,
  (poly).y,
  (poly).val
FROM (
  SELECT
    ST_PixelAsPolygons(
      ST_SetValues(
        ST_SetValue(
          ST_AddBand(
            ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0),
            1, '8BUI', 1, 0
          ),
          1, 2, 2, NULL
        ),
        1, 2, 2, 2, 2, 9, TRUE
      )
    ) AS poly
) foo
ORDER BY 1, 2;

x | y | val
---+---+---
1 | 1 | 1
1 | 2 | 1
1 | 3 | 1
2 | 1 | 1
2 | 2 | 9
2 | 3 | 9
3 | 1 | 1
3 | 2 | 9
3 | 3 | 9

```

☒☒: ☒☒ 5

```

WITH foo AS (
  SELECT 1 AS rid, ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', ←
    0, 0) AS rast
), bar AS (
  SELECT 1 AS gid, 'SRID=0;POINT(2.5 -2.5)::geometry geom UNION ALL
  SELECT 2 AS gid, 'SRID=0;POLYGON((1 -1, 4 -1, 4 -4, 1 -4, 1 -1))::geometry geom UNION ←
    ALL

```

```

SELECT 3 AS gid, 'SRID=0;POLYGON((0 0, 5 0, 5 -1, 1 -1, 1 -4, 0 -4, 0 0))'::geometry ↔
geom UNION ALL
SELECT 4 AS gid, 'SRID=0;MULTIPOINT(0 0, 4 4, 4 -4)'::geometry
)
SELECT
rid, gid, ST_DumpValues(ST_SetValue(rast, 1, geom, gid))
FROM foo t1
CROSS JOIN bar t2
ORDER BY rid, gid;

```

rid	gid	st_dumpvalues
1	1	(1,"{ {NULL,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,1,NULL,↔ NULL},{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,NULL}}")
1	2	(1,"{ {NULL,NULL,NULL,NULL,NULL},{NULL,2,2,2,NULL},{NULL,2,2,2,NULL},{NULL,↔ ,2,2,2,NULL},{NULL,NULL,NULL,NULL,NULL}}")
1	3	(1,"{ {3,3,3,3,3},{3,NULL,NULL,NULL,NULL},{3,NULL,NULL,NULL,NULL},{3,NULL,NULL,↔ NULL,NULL},{NULL,NULL,NULL,NULL,NULL}}")
1	4	(1,"{ {4,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,↔ NULL},{NULL,NULL,NULL,NULL,NULL},{NULL,NULL,NULL,NULL,4}}")

(4 rows)

☒☒☒☒☒☒☒☒☒ geomvals ☒☒☒☒ geomvals ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

```

WITH foo AS (
SELECT 1 AS rid, ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', ↔
0, 0) AS rast
), bar AS (
SELECT 1 AS gid, 'SRID=0;POINT(2.5 -2.5)'::geometry geom UNION ALL
SELECT 2 AS gid, 'SRID=0;POLYGON((1 -1, 4 -1, 4 -4, 1 -4, 1 -1))'::geometry geom UNION ↔
ALL
SELECT 3 AS gid, 'SRID=0;POLYGON((0 0, 5 0, 5 -1, 1 -1, 1 -4, 0 -4, 0 0))'::geometry ↔
geom UNION ALL
SELECT 4 AS gid, 'SRID=0;MULTIPOINT(0 0, 4 4, 4 -4)'::geometry
)
SELECT
t1.rid, t2.gid, t3.gid, ST_DumpValues(ST_SetValues(rast, 1, ARRAY[ROW(t2.geom, t2.gid), ↔
ROW(t3.geom, t3.gid)]::geomval[]))
FROM foo t1
CROSS JOIN bar t2
CROSS JOIN bar t3
WHERE t2.gid = 1
AND t3.gid = 2
ORDER BY t1.rid, t2.gid, t3.gid;

```

rid	gid	gid	st_dumpvalues
1	1	2	(1,"{ {NULL,NULL,NULL,NULL,NULL},{NULL,2,2,2,NULL},{NULL,2,2,2,NULL},{↔ NULL,2,2,2,NULL},{NULL,NULL,NULL,NULL,NULL}}")

(1 row)

☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

```

WITH foo AS (
SELECT 1 AS rid, ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '8BUI', ↔
0, 0) AS rast
), bar AS (
SELECT 1 AS gid, 'SRID=0;POINT(2.5 -2.5)'::geometry geom UNION ALL
SELECT 2 AS gid, 'SRID=0;POLYGON((1 -1, 4 -1, 4 -4, 1 -4, 1 -1))'::geometry geom UNION ↔
ALL

```



```

SELECT 3 AS gid, 'SRID=0;POLYGON((0 0, 5 0, 5 -1, 1 -1, 1 -4, 0 -4, 0 0))'::geometry ←
  geom UNION ALL
SELECT 4 AS gid, 'SRID=0;MULTIPOINT(0 0, 4 4, 4 -4)'::geometry
)
SELECT
  t1.rid, t2.gid, t3.gid, ST_DumpValues(ST_SetValues(rast, 1, ARRAY[ROW(t2.geom, t2.gid), ←
    ROW(t3.geom, t3.gid)]::geomval[]))
FROM foo t1
CROSS JOIN bar t2
CROSS JOIN bar t3
WHERE t2.gid = 2
      AND t3.gid = 1
ORDER BY t1.rid, t2.gid, t3.gid;

```

rid	gid	gid	st_dumpvalues
1	2	1	(1,"{NULL,NULL,NULL,NULL,NULL},{NULL,2,2,2,NULL},{NULL,2,1,2,NULL},{ ← NULL,2,2,2,NULL},{NULL,NULL,NULL,NULL,NULL}")

(1 row)

☒☒

[ST_Value](#), [ST_SetValue](#), [ST_PixelAsPolygons](#)

11.6.14 ST_DumpValues

ST_DumpValues — ☒☒☒☒☒☒☒☒☒ 2 ☒☒☒☒☒☒☒☒☒☒.

Synopsis

```

setof record ST_DumpValues( raster rast , integer[] nband=NULL , boolean exclude_nodata_value=true
);
double precision[][] ST_DumpValues( raster rast , integer nband , boolean exclude_nodata_value=true
);

```

☒☒

☒☒☒☒☒☒☒☒☒ 2 ☒☒☒☒☒☒☒☒☒☒ (☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒). nband ☒ NULL ☒ ☒☒☒☒☒☒☒☒☒, ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

2.1.0 ☒☒☒☒☒☒☒☒☒☒☒☒☒.

☒☒

```

WITH foo AS (
  SELECT ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(3, 3, 0, 0, 1, -1, 0, 0, 0), ←
    1, '8BUI'::text, 1, 0), 2, '32BF'::text, 3, -9999), 3, '16BSI', 0, 0) AS rast
)
SELECT
  (ST_DumpValues(rast)).*
FROM foo;

```


11.7 地理参考

11.7.1 ST_SetGeoReference

`ST_SetGeoReference` — 将地理参考信息设置到 6 波段栅格。支持 GDAL 和 ESRI 格式。GDAL 格式。

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);

参数

栅格 `rast` 6 波段栅格。'GDAL' 或 'ESRI' 格式。GDAL 格式。6 波段栅格 NULL 值。

地理参考坐标:

GDAL:

```
scalex skewy skewx scaley upperleftx upperlefty
```

ESRI:

```
scalex skewy skewx scaley upperleftx + scalex*0.5 upperlefty + scaley*0.5
```



Note

PostGIS DB 不支持 ESRI 格式，使用 GDAL 格式。

更新: 2.1.0 版本 `ST_SetGeoReference(raster, double precision, ...)` 函数。

示例

```
WITH foo AS (
  SELECT ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0) AS rast
)
SELECT
  0 AS rid, (ST_Metadatas(rast)).*
FROM foo
UNION ALL
SELECT
  1, (ST_Metadatas(ST_SetGeoReference(rast, '10 0 0 -10 0.1 0.1', 'GDAL'))).*
FROM foo
UNION ALL
SELECT
  2, (ST_Metadatas(ST_SetGeoReference(rast, '10 0 0 -10 5.1 -4.9', 'ESRI'))).*
FROM foo
UNION ALL
SELECT
```


11.7.3 ST_SetScale

ST_SetScale — X Y $\frac{x}{y}$. $\frac{x}{y}$.

Synopsis

raster **ST_SetScale**(raster rast, float8 xy);
 raster **ST_SetScale**(raster rast, float8 x, float8 y);

X Y $\frac{x}{y}$. $\frac{x}{y}$. $\frac{x}{y}$, X Y $\frac{x}{y}$.



Note

ST_SetScale **ST_Rescale** $\frac{x}{y}$. $\frac{x}{y}$ ($\frac{x}{y}$) $\frac{x}{y}$. ST_Rescale $\frac{x}{y}$. ST_SetScale $\frac{x}{y}$.

2.0.0 WKTRaster ST_SetPixelSize **2.0.0**

```
UPDATE dummy_rast
  SET rast = ST_SetScale(rast, 1.5)
WHERE rid = 2;

SELECT ST_ScaleX(rast) As pixx, ST_ScaleY(rast) As pixy, Box3D(rast) As newbox
FROM dummy_rast
WHERE rid = 2;

  pixx | pixy | newbox
-----+-----+-----
  1.5 |  1.5 | BOX(3427927.75 5793244 0, 3427935.25 5793251.5 0)
```

```
UPDATE dummy_rast
  SET rast = ST_SetScale(rast, 1.5, 0.55)
WHERE rid = 2;

SELECT ST_ScaleX(rast) As pixx, ST_ScaleY(rast) As pixy, Box3D(rast) As newbox
FROM dummy_rast
WHERE rid = 2;

  pixx | pixy | newbox
-----+-----+-----
  1.5 | 0.55 | BOX(3427927.75 5793244 0,3427935.25 5793247 0)
```

ST_ScaleX, ST_ScaleY, Box3D

11.7.4 ST_SetSkew

ST_SetSkew — `ST_SetSkew(rast, skewx, skewy)` returns a raster with the same geometry as the input raster, but with the specified skew values. The skew values are applied to the raster's georeference information.

Synopsis

```
raster ST_SetSkew(raster rast, float8 skewxy);
raster ST_SetSkew(raster rast, float8 skewx, float8 skewy);
```

Examples

Example 1: Set skew values to 1 and 2. The output raster's georeference information is updated to reflect these values.

Example 2

```
-- 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](#)

11.7.5 ST_SetSRID

ST_SetSRID — Returns SRID of spatial_ref_sys SRID.

Synopsis

raster **ST_SetSRID**(raster rast, integer srid);

SRID.



Note

SRID. SRID.

Section 4.5, ST_SRID

11.7.6 ST_SetUpperLeft

ST_SetUpperLeft — Sets the value of the upper left corner of the pixel of the raster to projected X and Y coordinates.

Synopsis

raster **ST_SetUpperLeft**(raster rast, double precision x, double precision y);

Set the value of the upper left corner of raster to the projected X and Y coordinates

```
SELECT ST_SetUpperLeft(rast, -71.01,42.37)
FROM dummy_rast
WHERE rid = 2;
```

ST_UpperLeftX, ST_UpperLeftY

11.7.7 ST_Resample

ST_Resample — Resamples a raster to a new size and/or projection. The new raster is created by reprojecting the original raster to the new size and/or projection.

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=NearestNeighbor, double precision maxerr=0.125);
 raster **ST_Resample**(raster rast, double precision scalex=0, double precision scaley=0, double precision gridx=NULL, double precision gridy=NULL, double precision skewx=0, double precision skewy=0, text algorithm=NearestNeighbor, double precision maxerr=0.125);
 raster **ST_Resample**(raster rast, raster ref, text algorithm=NearestNeighbor, double precision maxerr=0.125, boolean usescale=true);
 raster **ST_Resample**(raster rast, raster ref, boolean usescale, text algorithm=NearestNeighbor, double precision maxerr=0.125);

Parameters

width, **height** (width & height), **gridx** & **gridy** (gridx & gridy), **scalex**, **scaley**, **skewx** & **skewy** (scalex, scaley, skewx & skewy) are optional. **SRID** is optional.

New pixel values are computed using one of the following resampling algorithms:

- NearestNeighbor (english or american spelling)
- Bilinear
- Cubic
- CubicSpline
- Lanczos
- Max
- Min

The default is NearestNeighbor which is the fastest but results in the worst interpolation.

maxerr is optional, default is 0.125.



Note

See [GDAL Warp resampling methods](#) for more details.

2.0.0: Added **max** and **min** resampling options.

Enhanced: 3.4.0 max and min resampling options added

☒☒

```

SELECT
  ST_Width(orig) AS orig_width,
  ST_Width(reduce_100) AS new_width
FROM (
  SELECT
    rast AS orig,
    ST_Resample(rast,100,100) AS reduce_100
  FROM aerials.boston
  WHERE ST_Intersects(rast,
    ST_Transform(
      ST_MakeEnvelope(-71.128, 42.2392, -71.1277, 42.2397, 4326),26986)
    )
  )
LIMIT 1
) AS foo;

orig_width | new_width
-----+-----
        200 |         100

```

☒☒

[ST_Rescale](#), [ST_Resize](#), [ST_Transform](#)

11.7.8 ST_Rescale

ST_Rescale — Resample a raster by adjusting only its scale (or pixel size). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline, Lanczos, Max or Min resampling algorithm. Default is NearestNeighbor.

Synopsis

```

raster ST_Rescale(raster rast, double precision scalexy, text algorithm=NearestNeighbor, double
precision maxerr=0.125);
raster ST_Rescale(raster rast, double precision scalex, double precision scaley, text algorithm=NearestNeighbor,
double precision maxerr=0.125);

```

☒☒

Resample a raster by adjusting only its scale (or pixel size). New pixel values are computed using one of the following resampling algorithms:

- NearestNeighbor (english or american spelling)
- Bilinear
- Cubic
- CubicSpline
- Lanczos
- Max

- Min

The default is NearestNeighbor which is the fastest but results in the worst interpolation.

scalex and scaley define the new pixel size. scaley must often be negative to get well oriented raster.

scalex scaley, ST_Resize

maxerr is the threshold for transformation approximation by the resampling algorithm (in pixel units). A default of 0.125 is used if no maxerr is specified, which is the same value used in GDAL gdalwarp utility. If set to zero, no approximation takes place.



Note

GDAL Warp resampling methods



Note

ST_Rescale ST_SetScale

2.0.0 GDAL 1.6.1

Enhanced: 3.4.0 max and min resampling options added

2.1.0 SRID

0.001 0.0015

```
-- the original raster pixel size
SELECT ST_PixelWidth(ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 0.001, -0.001, 0, 0, 4269), '8BUI'::text, 1, 0)) width

width
-----
0.001

-- the rescaled raster raster pixel size
SELECT ST_PixelWidth(ST_Rescale(ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 0.001, -0.001, 0, 0, 4269), '8BUI'::text, 1, 0), 0.0015)) width

width
-----
0.0015
```

ST_Resize, ST_Resample, ST_SetScale, ST_ScaleX, ST_ScaleY, ST_Transform

11.7.9 ST_Reskew

ST_Reskew — (raster) (double precision skewxy, text algorithm=NearestNeighbor, double precision maxerr=0.125); Bilinear, Cubic, CubicSpline Lanczos NearestNeighbor.

Synopsis

raster ST_Reskew(raster rast, double precision skewxy, text algorithm=NearestNeighbor, double precision maxerr=0.125);
raster ST_Reskew(raster rast, double precision skewx, double precision skewy, text algorithm=NearestNeighbor, double precision maxerr=0.125);

(raster) (double precision skewxy, text algorithm=NearestNeighbor, Bilinear, Cubic, CubicSpline Lanczos NearestNeighbor).

skewx skewy

maxerr 0.125



Note

GDAL Warp resampling methods



Note

ST_Reskew ST_SetSkew ST_SetSkew (skewx, skewy) ST_Reskew ST_SetSkew

2.0.0 GDAL 1.6.1

: 2.1.0 SRID

0.0 0.0015




```
-- the original raster non-rotated
SELECT ST_Rotation(ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 0.001, -0.001, 0, 0, 4269)
, '8BUI'::text, 1, 0));

-- result
0

-- the reskewed raster raster rotation
SELECT ST_Rotation(ST_Reskew(ST_AddBand(ST_MakeEmptyRaster(100, 100, 0, 0, 0.001, -0.001,
0, 0, 4269), '8BUI'::text, 1, 0), 0.0015));

-- result
-0.982793723247329
```


w_before	w_after	h_before	h_after
200	228	200	170

 <p>mass_stm</p>	 <p>WGS84 (wgs_84)</p>	 <p>NN Bilinear WGS84 (wgs_84_bilin)</p>
---	--	---

3

ST_Transform(raster, srid) ST_Transform(raster, alignto)

```
WITH foo AS (
  SELECT 0 AS rid, ST_AddBand(ST_MakeEmptyRaster(2, 2, -500000, 600000, 100, -100, 0, 0,
    2163), 1, '16BUI', 1, 0) AS rast UNION ALL
  SELECT 1, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499800, 600000, 100, -100, 0, 0, 2163),
    1, '16BUI', 2, 0) AS rast UNION ALL
  SELECT 2, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499600, 600000, 100, -100, 0, 0, 2163),
    1, '16BUI', 3, 0) AS rast UNION ALL

  SELECT 3, ST_AddBand(ST_MakeEmptyRaster(2, 2, -500000, 599800, 100, -100, 0, 0, 2163),
    1, '16BUI', 10, 0) AS rast UNION ALL
  SELECT 4, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499800, 599800, 100, -100, 0, 0, 2163),
    1, '16BUI', 20, 0) AS rast UNION ALL
  SELECT 5, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499600, 599800, 100, -100, 0, 0, 2163),
    1, '16BUI', 30, 0) AS rast UNION ALL

  SELECT 6, ST_AddBand(ST_MakeEmptyRaster(2, 2, -500000, 599600, 100, -100, 0, 0, 2163),
    1, '16BUI', 100, 0) AS rast UNION ALL
  SELECT 7, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499800, 599600, 100, -100, 0, 0, 2163),
    1, '16BUI', 200, 0) AS rast UNION ALL
  SELECT 8, ST_AddBand(ST_MakeEmptyRaster(2, 2, -499600, 599600, 100, -100, 0, 0, 2163),
    1, '16BUI', 300, 0) AS rast
), bar AS (
  SELECT
    ST_Transform(rast, 4269) AS alignto
  FROM foo
  LIMIT 1
), baz AS (
  SELECT
    rid,
    rast,
    ST_Transform(rast, 4269) AS not_aligned,
```


☒☒

```
-- Create dummy table with one raster column
create table dummy_rast (rid integer, rast raster);

-- Add raster with two bands, one pixel/band. In the first band, nodatavalue = pixel value ←
= 3.
-- In the second band, nodatavalue = 13, pixel value = 4
insert into dummy_rast values(1,
(
'01' -- little endian (uint8 ndr)
||
'0000' -- version (uint16 0)
||
'0200' -- nBands (uint16 0)
||
'17263529ED684A3F' -- scaleX (float64 0.000805965234044584)
||
'F9253529ED684ABF' -- scaleY (float64 -0.00080596523404458)
||
'1C9F33CE69E352C0' -- ipX (float64 -75.5533328537098)
||
'718F0E9A27A44840' -- ipY (float64 49.2824585505576)
||
'ED50EB853EC32B3F' -- skewX (float64 0.000211812383858707)
||
'7550EB853EC32B3F' -- skewY (float64 0.000211812383858704)
||
'E6100000' -- SRID (int32 4326)
||
'0100' -- width (uint16 1)
||
'0100' -- height (uint16 1)
||
'4' -- hasnodatavalue set to true, isnodata value set to false (when it should be true)
||
'2' -- first band type (4BUI)
||
'03' -- novalue==3
||
'03' -- pixel(0,0)==3 (same that nodata)
||
'0' -- hasnodatavalue set to false
||
'5' -- second band type (16BSI)
||
'0D00' -- novalue==13
||
'0400' -- pixel(0,0)==4
)::raster
);

select st_bandisnodata(rast, 1) from dummy_rast where rid = 1; -- Expected false
select st_bandisnodata(rast, 1, TRUE) from dummy_rast where rid = 1; -- Expected true

-- The isnodata flag is dirty. We are going to set it to true
update dummy_rast set rast = st_setbandisnodata(rast, 1) where rid = 1;

select st_bandisnodata(rast, 1) from dummy_rast where rid = 1; -- Expected true
```

☒☒

[ST_BandNoDataValue](#), [ST_NumBands](#), [ST_SetBandNoDataValue](#), [ST_BandIsNoData](#)

11.8.3 ST_SetBandPath

ST_SetBandPath — Update the external path and band number of an out-db band

Synopsis

raster **ST_SetBandPath**(raster rast, integer band, text outdbpath, integer outdbindex, boolean force=false)

☒☒

Updates an out-db band's external raster file path and external band number.

**Note**

If force is set to true, no tests are done to ensure compatibility (e.g. alignment, pixel support) between the external raster file and the PostGIS raster. This mode is intended for file system changes where the external raster resides.

Availability: 2.5.0

☒☒

```

WITH foo AS (
  SELECT
    ST_AddBand(NULL::raster, '/home/pele/devel/geo/postgis-git/raster/test/regress/ ↵
      loader/Projected.tif', NULL::int[]) AS rast
)
SELECT
  1 AS query,
  *
FROM ST_BandMetadata(
  (SELECT rast FROM foo),
  ARRAY[1,3,2]::int[]
)
UNION ALL
SELECT
  2,
  *
FROM ST_BandMetadata(
  (
    SELECT
      ST_SetBandPath(
        rast,
        2,
        '/home/pele/devel/geo/postgis-git/raster/test/regress/loader/Projected2.tif ↵
        ',
        1
      ) AS rast
    FROM foo
  ),
),

```

```

        ARRAY[1,3,2)::int[]
    )
ORDER BY 1, 2;

query | bandnum | pixeltype | nodatavalue | isoutdb | path | outdbbandnum
-----+-----+-----+-----+-----+-----+-----
1 | 1 | 8BUI | | t | /home/pele/devel/geo/postgis-git/raster/test/regress/loader/Projected.tif | 1
1 | 2 | 8BUI | | t | /home/pele/devel/geo/postgis-git/raster/test/regress/loader/Projected.tif | 2
1 | 3 | 8BUI | | t | /home/pele/devel/geo/postgis-git/raster/test/regress/loader/Projected.tif | 3
2 | 1 | 8BUI | | t | /home/pele/devel/geo/postgis-git/raster/test/regress/loader/Projected.tif | 1
2 | 2 | 8BUI | | t | /home/pele/devel/geo/postgis-git/raster/test/regress/loader/Projected2.tif | 1
2 | 3 | 8BUI | | t | /home/pele/devel/geo/postgis-git/raster/test/regress/loader/Projected.tif | 3

```



[ST_BandMetaData](#), [ST_SetBandIndex](#)

11.8.4 ST_SetBandIndex

ST_SetBandIndex — Update the external band number of an out-db band

Synopsis

raster **ST_SetBandIndex**(raster rast, integer band, integer outdbindex, boolean force=false);



Updates an out-db band’s external band number. This does not touch the external raster file associated with the out-db band



Note

If force is set to true, no tests are done to ensure compatibility (e.g. alignment, pixel support) between the external raster file and the PostGIS raster. This mode is intended for where bands are moved around in the external raster file.



Note

Internally, this method replaces the PostGIS raster’s band at index band with a new band instead of updating the existing path information.

Availability: 2.5.0

☒☒

```

WITH foo AS (
  SELECT
    ST_AddBand(NULL::raster, '/home/pele/devel/geo/postgis-git/raster/test/regress/ ↵
      loader/Projected.tif', NULL::int[]) AS rast
)
SELECT
  1 AS query,
  *
FROM ST_BandMetadata(
  (SELECT rast FROM foo),
  ARRAY[1,3,2]::int[]
)
UNION ALL
SELECT
  2,
  *
FROM ST_BandMetadata(
  (
    SELECT
      ST_SetBandIndex(
        rast,
        2,
        1
      ) AS rast
    FROM foo
  ),
  ARRAY[1,3,2]::int[]
)
ORDER BY 1, 2;

```

query	bandnum	pixeltype	nodatavalue	isoutdb	path
outdbbandnum					
1	1	8BUI		t	/home/pele/devel/geo/postgis-git/ ↵ raster/test/regress/loader/Projected.tif 1
1	2	8BUI		t	/home/pele/devel/geo/postgis-git/ ↵ raster/test/regress/loader/Projected.tif 2
1	3	8BUI		t	/home/pele/devel/geo/postgis-git/ ↵ raster/test/regress/loader/Projected.tif 3
2	1	8BUI		t	/home/pele/devel/geo/postgis-git/ ↵ raster/test/regress/loader/Projected.tif 1
2	2	8BUI		t	/home/pele/devel/geo/postgis-git/ ↵ raster/test/regress/loader/Projected.tif 1
2	3	8BUI		t	/home/pele/devel/geo/postgis-git/ ↵ raster/test/regress/loader/Projected.tif 3

☒☒

ST_BandMetaData, ST_SetBandPath

11.9

11.9.1 ST_Count

ST_Count — Returns the number of pixels in the raster that are not equal to the specified value. The value is compared to the pixel values in the raster. If the value is not found, the function returns 0. The function is implemented as a SQL aggregate function. The function is implemented as a SQL aggregate function. The function is implemented as a SQL aggregate function.

Synopsis

bigint ST_Count(raster rast, integer nband=1, boolean exclude_nodata_value=true);
bigint ST_Count(raster rast, boolean exclude_nodata_value);

The function is implemented as a SQL aggregate function. The function is implemented as a SQL aggregate function. The function is implemented as a SQL aggregate function.

Note exclude_nodata_value, nodata. The function is implemented as a SQL aggregate function. The function is implemented as a SQL aggregate function. The function is implemented as a SQL aggregate function.

2.2.0 ST_Count(rastertable, rastercolumn, ...) Returns the number of pixels in the raster that are not equal to the specified value. The function is implemented as a SQL aggregate function.

2.0.0 Returns the number of pixels in the raster that are not equal to the specified value. The function is implemented as a SQL aggregate function.

```
--example will count all pixels not 249 and one will count all pixels. --
SELECT rid, ST_Count(ST_SetBandNoDataValue(rast,249)) As exclude_nodata,
       ST_Count(ST_SetBandNoDataValue(rast,249),false) As include_nodata
FROM dummy_rast WHERE rid=2;

rid | exclude_nodata | include_nodata
-----+-----+-----
  2 |          23 |          25
```

ST_CountAgg, ST_SummaryStats, ST_SetBandNoDataValue

11.9.2 ST_CountAgg

ST_CountAgg — Returns the number of pixels in the raster that are not equal to the specified value. The function is implemented as a SQL aggregate function. The function is implemented as a SQL aggregate function. The function is implemented as a SQL aggregate function.

11.9.3 ST_Histogram

ST_Histogram — (bin; ...) returns a table with columns min, max, count, percent, nband.

Synopsis

SETOF record ST_Histogram(raster rast, integer nband=1, boolean exclude_nodata_value=true, integer bins=autocomputed, double precision[] width=NULL, boolean right=false);
SETOF record ST_Histogram(raster rast, integer nband, integer bins, double precision[] width=NULL, boolean right=false);
SETOF record ST_Histogram(raster rast, integer nband, boolean exclude_nodata_value, integer bins, boolean right);
SETOF record ST_Histogram(raster rast, integer nband, integer bins, boolean right);

min

min, max, count, percent columns. nband column 1.



Note

exclude_nodata_value option. X [a, b] (a, b) [a, b]

width width: [a, b, c] [a, b, c, a, b, c, a, b, c]

width [a, b, c] [a, b, c, a, b, c, a, b, c]

bins (breakout) [a, b, c, a, b, c, a, b, c]

right (a, b) [a, b] (a, b)

Changed: 3.1.0 Removed ST_Histogram(table_name, column_name) variant.

2.0.0

1, 2, 3

```
SELECT band, (stats).*
FROM (SELECT rid, band, ST_Histogram(rast, band) As stats
      FROM dummy_rast CROSS JOIN generate_series(1,3) As band
      WHERE rid=2) As foo;
```

band	min	max	count	percent
1	249	250	2	0.08
1	250	251	2	0.08
1	251	252	1	0.04
1	252	253	2	0.08
1	253	254	18	0.72

2	78	113.2	11	0.44
2	113.2	148.4	4	0.16
2	148.4	183.6	4	0.16
2	183.6	218.8	1	0.04
2	218.8	254	5	0.2
3	62	100.4	11	0.44
3	100.4	138.8	5	0.2
3	138.8	177.2	4	0.16
3	177.2	215.6	1	0.04
3	215.6	254	4	0.16

Example: `ST_Histogram(rast, 2,6)`

```
SELECT (stats).*
FROM (SELECT rid, ST_Histogram(rast, 2,6) As stats
      FROM dummy_rast
      WHERE rid=2) As foo;
```

min	max	count	percent
78	107.333333	9	0.36
107.333333	136.666667	6	0.24
136.666667	166	0	0
166	195.333333	4	0.16
195.333333	224.666667	1	0.04
224.666667	254	5	0.2

(6 rows)

-- Same as previous but we explicitly control the pixel value range of each bin.

```
SELECT (stats).*
FROM (SELECT rid, ST_Histogram(rast, 2,6,ARRAY[0.5,1,4,100,5]) As stats
      FROM dummy_rast
      WHERE rid=2) As foo;
```

min	max	count	percent
78	78.5	1	0.08
78.5	79.5	1	0.04
79.5	83.5	0	0
83.5	183.5	17	0.0068
183.5	188.5	0	0
188.5	254	6	0.003664

(6 rows)

Example

[ST_Count](#), [ST_SummaryStats](#), [ST_SummaryStatsAgg](#)

11.9.4 ST_Quantile

`ST_Quantile` — (population) (quantile) (percentile)

Synopsis

SETOF record **ST_Quantile**(raster rast, integer nband=1, boolean exclude_nodata_value=true, double precision[] quantiles=NULL);
 SETOF record **ST_Quantile**(raster rast, double precision[] quantiles);
 SETOF record **ST_Quantile**(raster rast, integer nband, double precision[] quantiles);
 double precision **ST_Quantile**(raster rast, double precision quantile);
 double precision **ST_Quantile**(raster rast, boolean exclude_nodata_value, double precision quantile=NULL);
 double precision **ST_Quantile**(raster rast, integer nband, double precision quantile);
 double precision **ST_Quantile**(raster rast, integer nband, boolean exclude_nodata_value, double precision quantile);
 double precision **ST_Quantile**(raster rast, integer nband, double precision quantile);

(population) (quantile) ., 25%, 50%, 75% (percentile).



Note

exclude_nodata_value, NODATA.

Changed: 3.1.0 Removed ST_Quantile(table_name, column_name) variant.

2.0.0.

```
UPDATE dummy_rast SET rast = ST_SetBandNoDataValue(rast,249) WHERE rid=2;
--Example will consider only pixels of band 1 that are not 249 and in named quantiles --
```

```
SELECT (pvq).*
FROM (SELECT ST_Quantile(rast, ARRAY[0.25,0.75]) As pvq
      FROM dummy_rast WHERE rid=2) As foo
ORDER BY (pvq).quantile;
```

```
quantile | value
-----+-----
    0.25 |   253
    0.75 |   254
```

```
SELECT ST_Quantile(rast, 0.75) As value
FROM dummy_rast WHERE rid=2;
```

```
value
-----
254
```

```
--real live example. Quantile of all pixels in band 2 intersecting a geometry
SELECT rid, (ST_Quantile(rast,2)).* As pvc
FROM o_4_boston
WHERE ST_Intersects(rast,
                    ST_GeomFromText('POLYGON((224486 892151,224486 892200,224706 892200,224706
                    892151,224486 892151))',26986)
```




Note

sample_percent 1

2.2.0 ST_SummaryStats(rastertable, rastercolumn, ...) ST_SummaryStatsAgg

2.0.0

Example 1

```
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 2

PostGIS 64 (102,000, 150x150 134,000) 574

```
WITH
-- our features of interest
feat AS (SELECT gid As building_id, geom_26986 As geom FROM buildings AS b
        WHERE gid IN(100, 103,150)
        ),
-- clip band 2 of raster tiles to boundaries of builds
-- then get stats for these clipped regions
b_stats AS
(SELECT building_id, (stats).*
FROM (SELECT building_id, ST_SummaryStats(ST_Clip(rast,2,geom)) As stats
      FROM aerials.boston
      INNER JOIN feat
      ON ST_Intersects(feats.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

SQL: `ST_SummaryStats`

```
-- 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

SQL

[summarystats](#), [ST_SummaryStatsAgg](#), [ST_Count](#), [ST_Clip](#)

11.9.6 ST_SummaryStatsAgg

`ST_SummaryStatsAgg` — `ST_SummaryStatsAgg`. `ST_SummaryStatsAgg` count, sum, mean, stddev, min, max `ST_SummaryStatsAgg`. `ST_SummaryStatsAgg` 1 `ST_SummaryStatsAgg`.

Synopsis

```
summarystats ST_SummaryStatsAgg(raster rast, integer nband, boolean exclude_nodata_value, double precision sample_percent);
summarystats ST_SummaryStatsAgg(raster rast, boolean exclude_nodata_value, double precision sample_percent);
summarystats ST_SummaryStatsAgg(raster rast, integer nband, boolean exclude_nodata_value);
```

SQL

`ST_SummaryStatsAgg` count, sum, mean, stddev, min, max `ST_SummaryStatsAgg` [summarystats](#) `ST_SummaryStatsAgg`. `ST_SummaryStatsAgg` nband `ST_SummaryStatsAgg` 1 `ST_SummaryStatsAgg`.



Note

`ST_SummaryStatsAgg` `ST_SummaryStatsAgg` `ST_SummaryStatsAgg`. `ST_SummaryStatsAgg` `ST_SummaryStatsAgg` `ST_SummaryStatsAgg`.



Note

sample_percent 0 1

2.2.0

```

WITH foo AS (
  SELECT
    rast.rast
  FROM (
    SELECT ST_SetValue(
      ST_SetValue(
        ST_SetValue(
          ST_AddBand(
            ST_MakeEmptyRaster(10, 10, 10, 10, 2, 2, 0, 0,0)
            , 1, '64BF', 0, 0
          )
          , 1, 1, 1, -10
        )
        , 1, 5, 4, 0
      )
      , 1, 5, 5, 3.14159
    ) AS rast
  ) AS rast
  FULL JOIN (
    SELECT generate_series(1, 10) AS id
  ) AS id
  ON 1 = 1
)
SELECT
  (stats).count,
  round((stats).sum::numeric, 3),
  round((stats).mean::numeric, 3),
  round((stats).stddev::numeric, 3),
  round((stats).min::numeric, 3),
  round((stats).max::numeric, 3)
FROM (
  SELECT
    ST_SummaryStatsAgg(rast, 1, TRUE, 1) AS stats
  FROM foo
) bar;

```

count	round	round	round	round	round
20	-68.584	-3.429	6.571	-10.000	3.142

(1 row)

summarystats, ST_SummaryStats, ST_Count, ST_Clip

11.9.7 ST_ValueCount

ST_ValueCount — Returns the value and count of pixels in a raster that match the searchvalues. If exclude_nodata_value is true, NODATA pixels are excluded. If nband is 1, searchvalues is a single value. If nband is greater than 1, searchvalues is an array of values.

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, in-
teger 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 ex-
clude_nodata_value=true, double precision[] searchvalues=NULL, double precision roundto=0, dou-
ble 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 pre-
cision roundto=0);
bigint ST_ValueCount(text rastertable, text rastercolumn, integer nband, double precision search-
value, double precision roundto=0);

```

Examples

SELECT ST_ValueCount(rast, 1, true, 1) AS value, count FROM rastertable;

SELECT ST_ValueCount(rast, 3, true, ARRAY[1, 2, 3]) AS value, count FROM rastertable;



Note exclude_nodata_value is true, NODATA pixels are excluded.

2.0.0 Returns the value and count of pixels in a raster that match the searchvalues.

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 count 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
```


ST_Clip

ST_Clip geom rast [options].

ST_Clip [options] NODATA [options]. NODATA [options] [options] NODATA [options], [options] NODATA [options] ST_MinPossibleValue(ST_Band [options]) [options]. [options] NODATA [options] [options] NODATA [options] NODATA [options]. NODATA [options] [options] NODATA [options]. NODATA [options] [options] NODATA [options].

If crop is not specified, true is assumed meaning the output raster is cropped to the intersection of the geom and rast extents. If crop is set to false, the new raster gets the same extent as rast. If touched is set to true, then all pixels in the rast that intersect the geometry are selected.



Note

The default behavior is touched=false, which will only select pixels where the center of the pixel is covered by the geometry.

Enhanced: 3.5.0 - touched argument added.

2.0.0

2.1.0 C

Examples here use Massachusetts aerial data available on MassGIS site [MassGIS Aerial Orthos](#).

Examples: Comparing selecting all touched vs. not all touched

```
SELECT ST_Count(rast) AS count_pixels_in_orig, ST_Count(rast_touched) AS all_touched_pixels ←
, ST_Count(rast_not_touched) AS default_clip
FROM ST_AsRaster(ST_Letters('R'), scalex =
> 1.0, scaley =
> -1.0) AS r(rast)
INNER JOIN ST_GeomFromText('LINESTRING(0 1, 5 6, 10 10)') AS g(geom)
ON ST_Intersects(r.rast,g.geom)
, ST_Clip(r.rast, g.geom, touched =
> true) AS rast_touched
, ST_Clip(r.rast, g.geom, touched =
> false) AS rast_not_touched;
```

count_pixels_in_orig	all_touched_pixels	default_clip
2605	16	10

(1 row)

Examples: 1 band clipping (not touched)

```
-- Clip the first band of an aerial tile by a 20 meter buffer.
SELECT ST_Clip(rast, 1,
ST_Buffer(ST_Centroid(ST_Envelope(rast)),20)
) from aerials.boston
WHERE rid = 4;
```




Warning

ST_SetBandNoDataValue NODATA NODATA

2.1.0

```
-- setup test raster table --
DROP TABLE IF EXISTS funky_shapes;
CREATE TABLE funky_shapes(rast raster);

INSERT INTO funky_shapes(rast)
WITH ref AS (
  SELECT ST_MakeEmptyRaster( 200, 200, 0, 200, 1, -1, 0, 0) AS rast
)
SELECT
  ST_Union(rast)
FROM (
  SELECT
    ST_AsRaster(
      ST_Rotate(
        ST_Buffer(
          ST_GeomFromText('LINESTRING(0 2,50 50,150 150,125 50)'),
          i*2
        ),
        pi() * i * 0.125, ST_Point(50,50)
      ),
      ref.rast, '8BUI'::text, i * 5
    ) AS rast
  FROM ref
  CROSS JOIN generate_series(1, 10, 3) AS i
) AS shapes;
```

```
SELECT
  ST_NumBands(rast) As n_orig,
  ST_NumBands(ST_ColorMap(rast,1, 'greyscale')) As ngrey,
  ST_NumBands(ST_ColorMap(rast,1, 'pseudocolor')) As npseudo,
  ST_NumBands(ST_ColorMap(rast,1, 'fire')) As nfire,
  ST_NumBands(ST_ColorMap(rast,1, 'bluered')) As nbluered,
  ST_NumBands(ST_ColorMap(rast,1, '
100% 255 0 0
80% 160 0 0
50% 130 0 0
30% 30 0 0
20% 60 0 0
0% 0 0 0
nv 255 255 255
')) As nred
FROM funky_shapes;
```

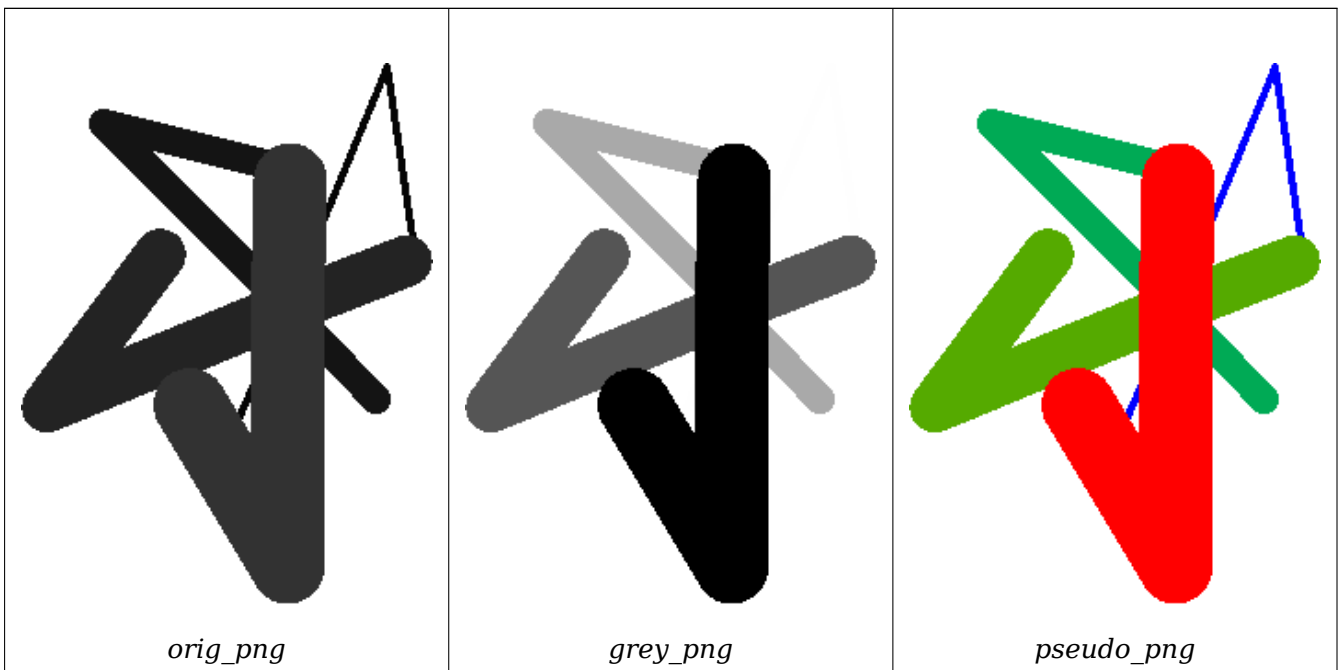
n_orig	ngrey	npseudo	nfire	nbluered	nred
1	1	4	4	4	3

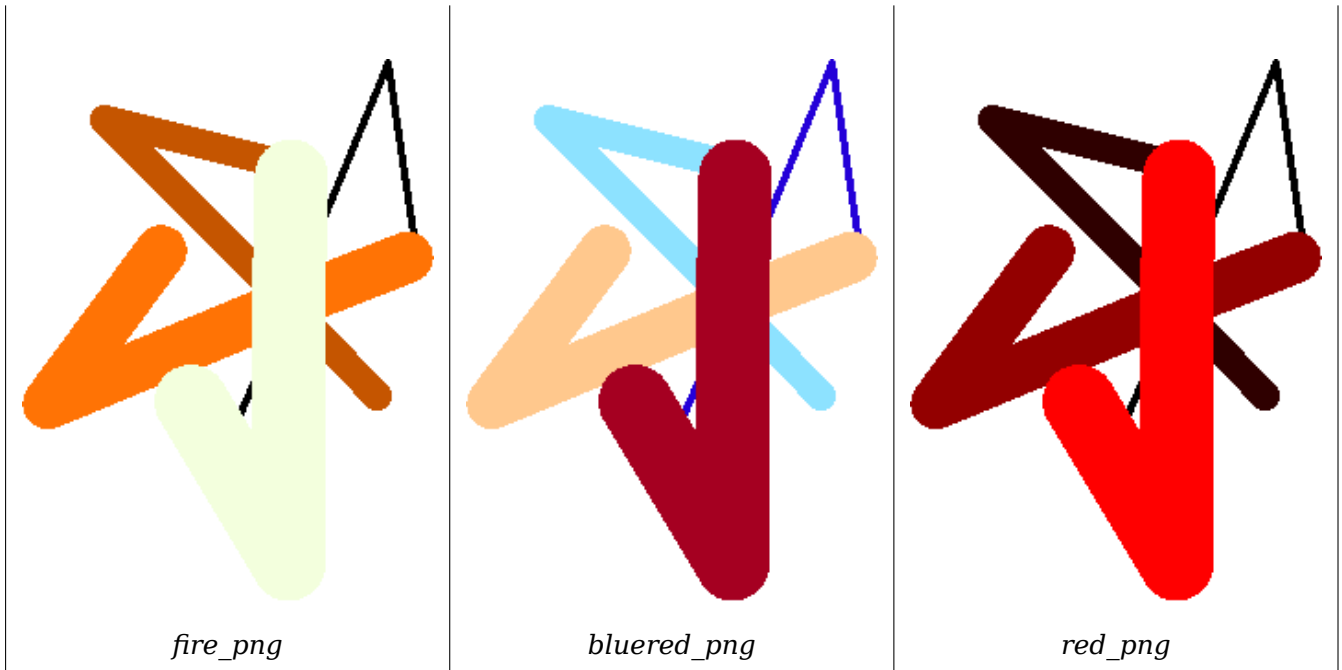
ST_AsPNG

```

SELECT
  ST_AsPNG(rast) As orig_png,
  ST_AsPNG(ST_ColorMap(rast,1,'greyscale')) As grey_png,
  ST_AsPNG(ST_ColorMap(rast,1,'pseudocolor')) As pseudo_png,
  ST_AsPNG(ST_ColorMap(rast,1,'nfire')) As fire_png,
  ST_AsPNG(ST_ColorMap(rast,1,'bluered')) As bluered_png,
  ST_AsPNG(ST_ColorMap(rast,1, '
100% 255  0  0
80%  160  0  0
50%  130  0  0
30%  30   0  0
20%  60   0  0
0%   0    0  0
nv 255 255 255
')) As red_png
FROM funky_shapes;

```





☒☒

[ST_AsPNG](#), [ST_AsRaster](#) [ST_MapAlgebra](#) (callback function version), [ST_Grayscale](#) [ST_NumBands](#), [ST_Reclass](#), [ST_SetBandNoDataValue](#), [ST_Union](#)

11.12.3 ST_Grayscale

`ST_Grayscale` — Creates a new one-8BUI band raster from the source raster and specified bands representing Red, Green and Blue

Synopsis

- (1) raster **ST_Grayscale**(raster rast, integer redband=1, integer greenband=2, integer blueband=3, text extenttype=INTERSECTION);
- (2) raster **ST_Grayscale**(rastbandarg[] rastbandargset, text extenttype=INTERSECTION);

☒☒

Create a raster with one 8BUI band given three input bands (from one or more rasters). Any input band whose pixel type is not 8BUI will be reclassified using [ST_Reclass](#).



Note

This function is not like [ST_ColorMap](#) with the `grayscale` keyword as `ST_ColorMap` operates on only one band while this function expects three bands for RGB. This function applies the following equation for converting RGB to Grayscale: $0.2989 * RED + 0.5870 * GREEN + 0.1140 * BLUE$

Availability: 2.5.0

☒☒: ☒☒ 1

```
SET postgis.gdal_enabled_drivers = 'ENABLE_ALL';
SET postgis.enable_outdb_rasters = True;

WITH apple AS (
  SELECT ST_AddBand(
    ST_MakeEmptyRaster(350, 246, 0, 0, 1, -1, 0, 0, 0),
    '/tmp/apple.png'::text,
    NULL::int[]
  ) AS rast
)
SELECT
  ST_AsPNG(rast) AS original_png,
  ST_AsPNG(ST_Grayscale(rast)) AS grayscale_png
FROM apple;
```

*original_png**grayscale_png*

☒☒: ☒☒ 2

```
SET postgis.gdal_enabled_drivers = 'ENABLE_ALL';
SET postgis.enable_outdb_rasters = True;

WITH apple AS (
  SELECT ST_AddBand(
    ST_MakeEmptyRaster(350, 246, 0, 0, 1, -1, 0, 0, 0),
    '/tmp/apple.png'::text,
    NULL::int[]
  ) AS rast
)
SELECT
  ST_AsPNG(rast) AS original_png,
  ST_AsPNG(ST_Grayscale(
    ARRAY[
      ROW(rast, 1)::rastbandarg, -- red
      ROW(rast, 2)::rastbandarg, -- green
      ROW(rast, 3)::rastbandarg, -- blue
    ]::rastbandarg[]
  )) AS grayscale_png
```

FROM apple;

[ST_AsPNG](#), [ST_Reclass](#), [ST_ColorMap](#)

11.12.4 ST_Intersection

ST_Intersection — Returns the intersection of a geometry and a raster. The geometry is converted to a polygon if necessary.

Synopsis

```

setof geomval ST_Intersection(geometry geom, raster rast, integer band_num=1);
setof geomval ST_Intersection(raster rast, geometry geom);
setof geomval ST_Intersection(raster rast, integer band, geometry geom);
raster ST_Intersection(raster rast1, raster rast2, double precision[] nodataval);
raster ST_Intersection(raster rast1, raster rast2, text returnband, double precision[] nodataval);
raster ST_Intersection(raster rast1, integer band1, raster rast2, integer band2, double precision[] nodataval);
raster ST_Intersection(raster rast1, integer band1, raster rast2, integer band2, text returnband, double precision[] nodataval);

```

ST_Intersection(geometry geom, raster rast, integer band_num) returns a geometry of the same type as geom, representing the intersection of geom and the raster band specified by band_num.

ST_Intersection(raster rast, geometry geom) returns a geometry of the same type as geom, representing the intersection of geom and the raster. If geom is a point, it is converted to a polygon. If geom is a line, it is converted to a polygon. If geom is a polygon, it is converted to a polygon. If geom is a multipolygon, it is converted to a multipolygon. If geom is a geometry collection, it is converted to a geometry collection. If geom is a null geometry, it is converted to a null geometry. If geom is a geometry with a null value, it is converted to a null geometry. WHERE ST_Intersects(geom, rast) is true.

ST_Intersection(raster rast, integer band, geometry geom) returns a geometry of the same type as geom, representing the intersection of geom and the raster band specified by band. If geom is a point, it is converted to a polygon. If geom is a line, it is converted to a polygon. If geom is a polygon, it is converted to a polygon. If geom is a multipolygon, it is converted to a multipolygon. If geom is a geometry collection, it is converted to a geometry collection. If geom is a null geometry, it is converted to a null geometry. If geom is a geometry with a null value, it is converted to a null geometry. WHERE ST_Intersects(geom, rast) is true.

ST_Intersection(raster rast1, raster rast2, double precision[] nodataval) returns a raster of the same type as rast1 and rast2, representing the intersection of rast1 and rast2. The nodataval array specifies the nodata values for the output raster.

ST_Intersection(raster rast1, raster rast2, text returnband, double precision[] nodataval) returns a raster of the same type as rast1 and rast2, representing the intersection of rast1 and rast2. The returnband parameter specifies the band to return. The nodataval array specifies the nodata values for the output raster.

ST_Intersection(raster rast1, integer band1, raster rast2, integer band2, double precision[] nodataval) returns a raster of the same type as rast1 and rast2, representing the intersection of the raster band specified by band1 from rast1 and the raster band specified by band2 from rast2. The nodataval array specifies the nodata values for the output raster.

ST_Intersection(raster rast1, integer band1, raster rast2, integer band2, text returnband, double precision[] nodataval) returns a raster of the same type as rast1 and rast2, representing the intersection of the raster band specified by band1 from rast1 and the raster band specified by band2 from rast2. The returnband parameter specifies the band to return. The nodataval array specifies the nodata values for the output raster.



Note

ST_MapAlgebraExpr NODATA



Note

ST_Clip



Note

ST_Intersects ST_Intersection

2.0.0

geomval, ST_Intersects, ST_MapAlgebraExpr, ST_Clip, ST_AsText

```

SELECT
  foo.rid,
  foo.gid,
  ST_AsText((foo.geomval).geom) As geomwkt,
  (foo.geomval).val
FROM (
  SELECT
    A.rid,
    g.gid,
    ST_Intersection(A.rast, g.geom) As geomval
  FROM dummy_rast AS A
  CROSS JOIN (
    VALUES
      (1, ST_Point(3427928, 5793243.85) ),
      (2, ST_GeomFromText('LINESTRING(3427927.85 5793243.75,3427927.8 5793243.75,3427927.8 5793243.8)')),
      (3, ST_GeomFromText('LINESTRING(1 2, 3 4)'))
    ) As g(gid,geom)
  WHERE A.rid = 2
) As foo;

```

rid	gid	geomwkt	val
2	1	POINT(3427928 5793243.85)	249
2	1	POINT(3427928 5793243.85)	253
2	2	POINT(3427927.85 5793243.75)	254
2	2	POINT(3427927.8 5793243.8)	251
2	2	POINT(3427927.8 5793243.8)	253
2	2	LINESTRING(3427927.8 5793243.75,3427927.8 5793243.8)	252
2	2	MULTILINESTRING((3427927.8 5793243.8,3427927.8 5793243.75),...)	250
2	3	GEOMETRYCOLLECTION EMPTY	

geomval

ST_Intersects, ST_MapAlgebraExpr, ST_Clip, ST_AsText

Passing a regprocedure argument to a SQL function requires the full function signature to be passed, then cast to a regprocedure type. To pass the above example PL/pgSQL function as an argument, the SQL for the argument is:

```
'sample_callbackfunc(double precision[], integer[], text[])'::regprocedure
```

Note that the argument contains the name of the function, the types of the function arguments, quotes around the name and argument types, and a cast to a regprocedure.

mask An n-dimensional array (matrix) of numbers used to filter what cells get passed to map algebra call-back function. 0 means a neighbor cell value should be treated as no-data and 1 means value should be treated as data. If weight is set to true, then the values, are used as multipliers to multiple the pixel value of that value in the neighborhood position.

weighted mask (mask) (weight) (true/false) (true/false).

pixeltype pixeltype (ST_BandPixelType) (ST_BandPixelType). pixeltype NULL (ST_BandPixelType: INTERSECTION, UNION, FIRST, CUSTOM), (ST_BandPixelType: SECOND, LAST) (ST_BandPixelType). ST_BandPixelType (ST_BandPixelType), NULL (ST_BandPixelType).

extenttype (ST_BandPixelType) INTERSECTION(1), UNION, FIRST(1), SECOND, LAST, CUSTOM.

customextent extenttype CUSTOM, customextent (1 4).

distancex The distance in pixels from the reference cell in x direction. So width of resulting matrix would be 2*distancex + 1.If not specified only the reference cell is considered (neighborhood of 0).

distancey Y distance in pixels from the reference cell. 2*distancey + 1.

userargs callbackfunc variadic text callbackfunc, userargs.

Note (VARIADIC) PostgreSQL Query Language (SQL) Functions "SQL Functions with Variable Numbers of Arguments".

Note callbackfunc text[].

1 rastbandarg.

2 3 1 2 3.

4 1 2 4.

2.2.0 mask.

2.1.0.


```

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

```

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;

```

☒☒: ☒☒ 2 ☒ 3

☒☒☒ 1 ☒, ☒☒☒☒

```

WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, ←
        0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI', 100, 0) AS rast
)
SELECT
    ST_MapAlgebra(
        rast, ARRAY[3, 1, 3, 2]::integer[],
        'sample_callbackfunc(double precision[], int[], text[])'::regprocedure
    ) AS rast
FROM foo

```

☒☒☒ 1 ☒, ☒☒ 1 ☒

```

WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, ←
        0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI', 100, 0) AS rast
)
SELECT
    ST_MapAlgebra(
        rast, 2,
        'sample_callbackfunc(double precision[], int[], text[])'::regprocedure
    ) AS rast
FROM foo

```

☒☒: ☒☒ 4

☒☒☒ 2 ☒, ☒☒ 2 ☒

```

WITH foo AS (
    SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, ←
        0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI', 100, 0) AS rast UNION ←
        ALL
    SELECT 2 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 1, 1, -1, ←
        0, 0, 0), 1, '16BUI', 2, 0), 2, '8BUI', 20, 0), 3, '32BUI', 300, 0) AS rast
)

```

```

SELECT
  ST_MapAlgebra(
    t1.rast, 2,
    t2.rast, 1,
    'sample_callbackfunc(double precision[], int[], text[])::regprocedure
  ) AS rast
FROM foo t1
CROSS JOIN foo t2
WHERE t1.rid = 1
      AND t2.rid = 2

```

mask

```

WITH foo AS (SELECT
  ST_SetBandNoDataValue(
  ST_SetValue(ST_SetValue(ST_AsRaster(
    ST_Buffer(
      ST_GeomFromText('LINESTRING(50 50,100 90,100 50)'), 5,'join=bevel'),
      200,200,ARRAY['8BUI'], ARRAY[100], ARRAY[0]), ST_Buffer('POINT(70 70):: ←
        geometry,10,'quad_segs=1') ,50),
    'LINESTRING(20 20, 100 100, 150 98)::geometry,1),0) AS rast )
  SELECT 'original' AS title, rast
FROM foo
UNION ALL
SELECT 'no mask mean value' AS title, ST_MapAlgebra(rast,1,'ST_mean4ma(double precision[], ←
  int[], text[])::regprocedure) AS rast
FROM foo
UNION ALL
SELECT 'mask only consider neighbors, exclude center' AS title, ST_MapAlgebra(rast,1,' ←
  ST_mean4ma(double precision[], int[], text[])::regprocedure,
  '{{1,1,1}, {1,0,1}, {1,1,1}}::double precision[], false) As rast
FROM foo

UNION ALL
SELECT 'mask weighted only consider neighbors, exclude center multi otehr pixel values by ←
  2' AS title, ST_MapAlgebra(rast,1,'ST_mean4ma(double precision[], int[], text[]):: ←
  regprocedure,
  '{{2,2,2}, {2,0,2}, {2,2,2}}::double precision[], true) As rast
FROM foo;

```


Synopsis

raster **ST_MapAlgebra**(raster rast, integer nband, text pixeltyp, text expression, double precision nodataval=NULL);
 raster **ST_MapAlgebra**(raster rast, text pixeltyp, text expression, double precision nodataval=NULL);
 raster **ST_MapAlgebra**(raster rast1, integer nband1, raster rast2, integer nband2, text expression, text pixeltyp=NULL, text extenttype=INTERSECTION, text nodata1expr=NULL, text nodata2expr=NULL, double precision nodatanodataval=NULL);
 raster **ST_MapAlgebra**(raster rast1, raster rast2, text expression, text pixeltyp=NULL, text extenttype=INTERSECTION, text nodata1expr=NULL, text nodata2expr=NULL, double precision nodatanodataval=NULL);

- 1 2 , , SQL 1 1

2.1.0

: 1, 2 (1)

(rast) expression PostgreSQL , 1 nband , 1 . , 1 .

pixeltyp , . pixeltyp NULL , rast

• expression .

1. [rast] -
2. [rast.val] -
3. [rast.x] - 1-
4. [rast.y] - 1-

: 3, 4 (2)

rast1, (rast2) expression 2 , PostgreSQL , 1 . band1, band2 , 1 extenttype .

expression 2 PostgreSQL PostgreSQL / . : (([rast1] + [rast2])/2.0)::integer

pixeltyp . **ST_BandPixelType** , NULL . NULL ,

extenttype

1. INTERSECTION - .
2. UNION - .
3. FIRST - .

4. SECOND - 返回栅格中非空像素的索引。

nodataexpr rast1 栅格 NODATA 值, rast2 栅格, 返回 rast2 中非空像素的索引。

nodata2expr rast2 栅格 NODATA 值, rast1 栅格, 返回 rast1 中非空像素的索引。

nodatanodataval rast1 栅格, rast2 栅格, NODATA 值, 返回 rast1 中非空像素的索引。

• expression, nodataexpr 栅格, nodata2expr 栅格。

1. [rast1] - rast1 栅格
2. [rast1.val] - rast1 栅格值
3. [rast1.x] - rast1 栅格 X 坐标
4. [rast1.y] - rast1 栅格 Y 坐标
5. [rast2] - rast2 栅格
6. [rast2.val] - rast2 栅格值
7. [rast2.x] - rast2 栅格 X 坐标
8. [rast2.y] - rast2 栅格 Y 坐标

例 1:

```
WITH foo AS (
  SELECT ST_AddBand(ST_MakeEmptyRaster(10, 10, 0, 0, 1, 1, 0, 0, 0), '32BF'::text, 1, -1) AS rast
)
SELECT
  ST_MapAlgebra(rast, 1, NULL, 'ceil([rast]*[rast.x]/[rast.y]+[rast.val])')
FROM foo;
```

例 2:

```
WITH foo AS (
  SELECT 1 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, -1, 0, 0, 0), 1, '16BUI', 1, 0), 2, '8BUI', 10, 0), 3, '32BUI'::text, 100, 0) AS rast
  UNION ALL
  SELECT 2 AS rid, ST_AddBand(ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(2, 2, 0, 0, 1, 1, -1, 0, 0), 1, '16BUI', 2, 0), 2, '8BUI', 20, 0), 3, '32BUI'::text, 300, 0) AS rast
)
SELECT
  ST_MapAlgebra(
    t1.rast, 2,
    t2.rast, 1,
    '([rast2] + [rast1.val]) / 2'
  ) AS rast
FROM foo t1
CROSS JOIN foo t2
WHERE t1.rid = 1
  AND t2.rid = 2;
```

例 3:

[rastbandarg](#), [ST_Union](#), [ST_MapAlgebra \(callback function version\)](#)


```

250 | 0
254 | 0
254 | 0

```

CREATE TABLE dummy_rast (rid integer, rast raster, map_rast2 raster);

```

ALTER TABLE dummy_rast ADD COLUMN map_rast2 raster;
UPDATE dummy_rast SET
  map_rast2 = ST_MapAlgebraExpr(rast,'2BUI'::text,'CASE WHEN [rast] BETWEEN 100 and 250
    THEN 1 WHEN [rast] = 252 THEN 2 WHEN [rast] BETWEEN 253 and 254 THEN 3 ELSE 0 END'::
    text, '0')
WHERE rid = 2;

```

```

SELECT DISTINCT
  ST_Value(rast,1,i,j) As origval,
  ST_Value(map_rast2, 1, i, j) As mapval
FROM dummy_rast
CROSS JOIN generate_series(1, 5) AS i
CROSS JOIN generate_series(1,5) AS j
WHERE rid = 2;

```

origval	mapval
249	1
250	1
251	1
252	2
253	3
254	3

```

SELECT
  ST_BandPixelType(map_rast2) As b1pixtyp
FROM dummy_rast
WHERE rid = 2;

```

```

b1pixtyp
-----
2BUI

```


sion nodatanodataval=NULL);
raster **ST_MapAlgebraExpr**(raster rast1, integer band1, raster rast2, integer band2, text expression, text pixeltype=same_as_rast1_band, text extenttype=INTERSECTION, text nodata1expr=NULL, text nodata2expr=NULL, double precision nodatanodataval=NULL);



Warning

ST_MapAlgebraExpr 2.1.0 **ST_MapAlgebra (expression version)**

rast1, (**rast2**) **expression** 2 **PostgreSQL** **band1**, **band2** **pixeltype** **extenttype**

expression 2 **PostgreSQL** **PostgreSQL**

pixeltype **ST_BandPixelType**, **NULL**

extenttype

1. INTERSECTION -
2. UNION -
3. FIRST -
4. SECOND -

nodata1expr **rast1** **NODATA** **rast2**

nodata2expr **rast2** **NODATA** **rast1**

nodatanodataval **rast1** **rast2** **NODATA**

pixeltype **NULL**

[**rast1.val**], [**rast2.val**], [**rast1.x**], [**rast1.y**]

2.0.0

2

2 (modulo) 1

```
--Create a cool set of rasters --
DROP TABLE IF EXISTS fun_shapes;
CREATE TABLE fun_shapes(rid serial PRIMARY KEY, fun_name text, rast raster);

-- Insert some cool shapes around Boston in Massachusetts state plane meters --
INSERT INTO fun_shapes(fun_name, rast)
VALUES ('ref', ST_AsRaster(ST_MakeEnvelope(235229, 899970, 237229, 901930,26986),200,200,'8 ←
  BUI',0,0));

INSERT INTO fun_shapes(fun_name,rast)
WITH ref(rast) AS (SELECT rast FROM fun_shapes WHERE fun_name = 'ref' )
SELECT 'area' AS fun_name, ST_AsRaster(ST_Buffer(ST_SetSRID(ST_Point(236229, 900930),26986) ←
  , 1000),
  ref.rast,'8BUI', 10, 0) As rast
FROM ref
UNION ALL
SELECT 'rand bubbles',
  ST_AsRaster(
    (SELECT ST_Collect(geom)
  FROM (SELECT ST_Buffer(ST_SetSRID(ST_Point(236229 + i*random()*100, 900930 + j*random() ←
    *100),26986), random()*20) As geom
    FROM generate_series(1,10) As i, generate_series(1,10) As j
    ) As foo ), ref.rast,'8BUI', 200, 0)
FROM ref;

--map them -
SELECT ST_MapAlgebraExpr(
  area.rast, bub.rast, '[rast2.val]', '8BUI', 'INTERSECTION', '[rast2.val]', '[rast1. ←
  val]') As interrast,
  ST_MapAlgebraExpr(
  area.rast, bub.rast, '[rast2.val]', '8BUI', 'UNION', '[rast2.val]', '[rast1.val ←
  ]') As unionrast
FROM
  (SELECT rast FROM fun_shapes WHERE
  fun_name = 'area') As area
CROSS JOIN (SELECT rast
FROM fun_shapes WHERE
fun_name = 'rand bubbles') As bub
```



```

-- 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;

```



XX

ST_MapAlgebraExpr, ST_AddBand, ST_AsPNG, ST_AsRaster, ST_MapAlgebraFct, ST_BandPixelType, ST_GeoReference, ST_Value, ST_Union, ST_Union

11.12.9 ST_MapAlgebraFct

ST_MapAlgebraFct — XXXX 1 XX: XXXXXXXXXXXXXXX PostgreSQL XXXXXXXXXXXXXXX, XXXXXXXXXXXXXXX, XX 1 XXXXXXXXXXXXXXX. XXXXXXXXXXXXXXX, XX 1 XXXX XX.



Note

(`ST_MapAlgebraFct`) VARIADIC `ST_MapAlgebraFct`, PostgreSQL `Query Language (SQL) Functions` "SQL Functions with Variable Numbers of Arguments".



Note

`ST_MapAlgebraFct`, `userfunction` `text[]`.

2.0.0

`ST_MapAlgebraFct` 2 `ST_MapAlgebraFct` (modulo) 1 `ST_MapAlgebraFct`.

```
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

`ST_MapAlgebraFct` NODATA `ST_MapAlgebraFct` (0) `ST_MapAlgebraFct` 2BUI, 1 `ST_MapAlgebraFct`.

```
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
```

```

        no_data := args[1];
    END IF;
    IF pixel < 251 THEN
        RETURN 1;
    ELSIF pixel = 252 THEN
        RETURN 2;
    ELSIF pixel
> 252 THEN
        RETURN 3;
    ELSE
        RETURN no_data;
    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;

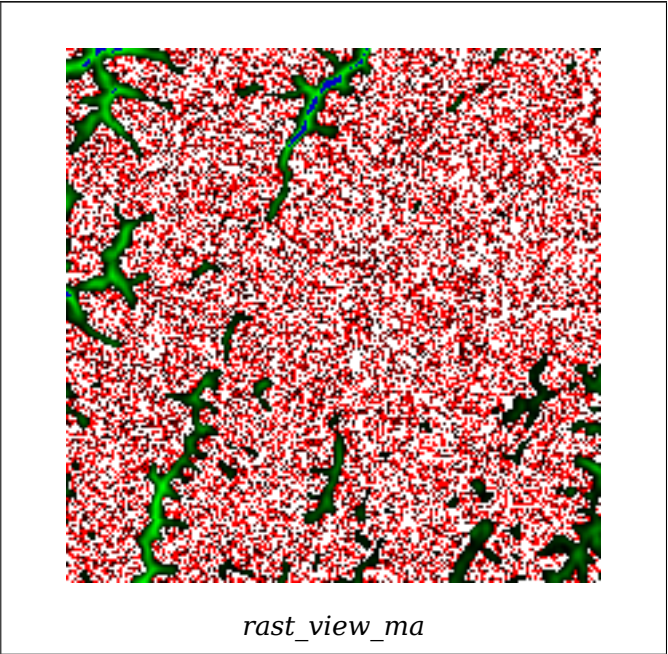
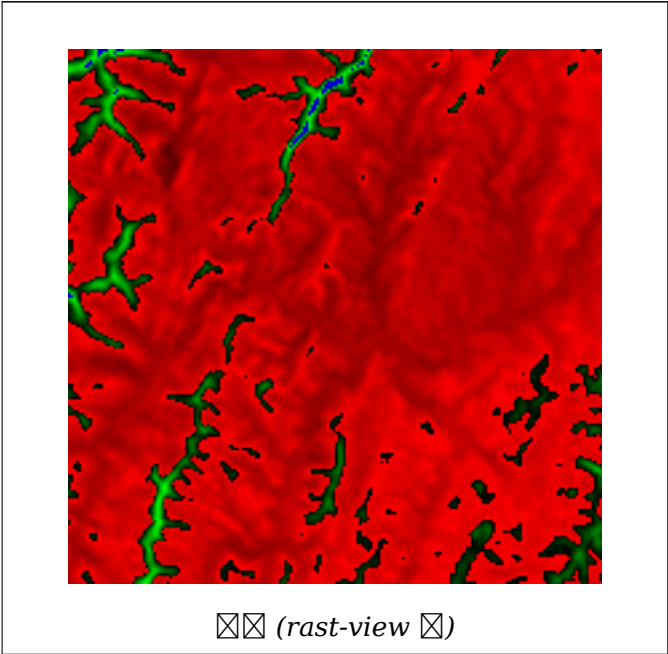
SELECT DISTINCT ST_Value(rast,1,i,j) As origval, ST_Value(map_rast2, 1, i, j) As mapval
FROM dummy_rast CROSS JOIN generate_series(1, 5) AS i CROSS JOIN generate_series(1,5) AS j
WHERE rid = 2;

origval | mapval
-----+-----
    249 |      1
    250 |      1
    251 |      1
    252 |      2
    253 |      3
    254 |      3

SELECT ST_BandPixelType(map_rast2) As b1pixtyp
FROM dummy_rast WHERE rid = 2;

b1pixtyp
-----
2BUI

```



rast1, rast2 two_rastuserfunc PostgreSQL, 1 band1 band2, 1. 1.

pixeltype, pixeltype NULL rast1.

The two_rastuserfunc 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 two_rastuserfunc 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 two_rastuserfunc.

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:

```
'simple_function(double precision, double precision, integer[], text[])::regprocedure
```

Note that the argument contains the name of the function, the types of the function arguments, quotes around the name and argument types, and a cast to a regprocedure.

The fourth argument to the two_rastuserfunc is a variadic text array. All trailing text arguments to any ST_MapAlgebraFct call are passed through to the specified two_rastuserfunc, and are contained in the userargs argument.

Note (VARIADIC) PostgreSQL Query Language (SQL) Functions "SQL Functions with Variable Numbers of Arguments"

Note two_rastuserfunc text[]

2.0.0

:

```
-- define our user defined function --
CREATE OR REPLACE FUNCTION raster_mapalgebra_union(
  rast1 double precision,
```

```

    rast2 double precision,
    pos integer[],
    VARIADIC userargs text[]
)
RETURNS double precision
AS $$
DECLARE
BEGIN
    CASE
        WHEN rast1 IS NOT NULL AND rast2 IS NOT NULL THEN
            RETURN ((rast1 + rast2)/2.);
        WHEN rast1 IS NULL AND rast2 IS NULL THEN
            RETURN NULL;
        WHEN rast1 IS NULL THEN
            RETURN rast2;
        ELSE
            RETURN rast1;
    END CASE;

    RETURN NULL;
END;
$$ LANGUAGE 'plpgsql' IMMUTABLE COST 1000;

-- prep our test table of rasters
DROP TABLE IF EXISTS map_shapes;
CREATE TABLE map_shapes(rid serial PRIMARY KEY, rast raster, bnum integer, descrip text);
INSERT INTO map_shapes(rast,bnum, descrip)
WITH mygeoms
  AS ( SELECT 2 As bnum, ST_Buffer(ST_Point(90,90),30) As geom, 'circle' As descrip
      UNION ALL
      SELECT 3 AS bnum,
         ST_Buffer(ST_GeomFromText('LINESTRING(50 50,150 150,150 50)'), 15) As geom, ←
         'big road' As descrip
      UNION ALL
      SELECT 1 As bnum,
         ST_Translate(ST_Buffer(ST_GeomFromText('LINESTRING(60 50,150 150,150 50)'), ←
         8,'join=bevel'), 10,-6) As geom, 'small road' As descrip
    ),
-- define our canvas to be 1 to 1 pixel to geometry
canvas
  AS ( SELECT ST_AddBand(ST_MakeEmptyRaster(250,
    250,
    ST_XMin(e)::integer, ST_YMax(e)::integer, 1, -1, 0, 0 ) , '8BUI'::text,0) As rast
    FROM (SELECT ST_Extent(geom) As e,
         Max(ST_SRID(geom)) As srid
         from mygeoms
        ) As foo
    )
-- return our rasters aligned with our canvas
SELECT ST_AsRaster(m.geom, canvas.rast, '8BUI', 240) As rast, bnum, descrip
  FROM mygeoms AS m CROSS JOIN canvas
UNION ALL
SELECT canvas.rast, 4, 'canvas'
FROM canvas;

-- Map algebra on single band rasters and then collect with ST_AddBand
INSERT INTO map_shapes(rast,bnum,descrip)
SELECT ST_AddBand(ST_AddBand(rasts[1], rasts[2]),rasts[3]), 4, 'map bands overlay fct union ←
  (canvas)'
  FROM (SELECT ARRAY(SELECT ST_MapAlgebraFct(m1.rast, m2.rast,
    'raster_mapalgebra_union(double precision, double precision, integer[], text[]) ←
    '::regprocedure, '8BUI', 'FIRST')

```


neighborhood (neighborhood) PostgreSQL 数据类型。 neighborhood 数据类型， neighborhood 数据类型， neighborhood 数据类型。

rast 数据类型

band 数据类型 (neighborhood 1)

pixeltype 数据类型。 **ST_BandPixelType** 数据类型， NULL 数据类型。 NULL 数据类型， rast 数据类型。

ngbwidth 数据类型 (neighborhood) 数据类型

ngbheight 数据类型 (neighborhood) 数据类型

onerastngbuserfunc 数据类型 PL/pgSQL 函数 psql 数据类型。 数据类型 2 数据类型。

nodatamode NODATA 数据类型 NULL 数据类型。

'ignore': 数据类型 NODATA 数据类型。 数据类型 NODATA 数据类型。

'NULL': 数据类型 NODATA 数据类型 NULL 数据类型。 数据类型。

'value': 数据类型 NODATA 数据类型 (数据类型) 数据类型。 数据类型 NODATA 数据类型, (数据类型) 'NULL' 数据类型。

args 数据类型

2.0.0 数据类型。

数据类型

数据类型 http://trac.osgeo.org/gdal/wiki/frmts_wtkraster.html 数据类型 **ST_Rescale** 数据类型。

```
--
-- 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 ;
```


reclassarg

pixeltype reclassargset, reclassarg

2.0.0

2 8BUI 4BUI 101 254 NODATA

```
ALTER TABLE dummy_rast ADD COLUMN reclass_rast raster;
UPDATE dummy_rast SET reclass_rast = ST_Reclass(rast,2,'0-87:1-10, 88-100:11-15, 101-254:0-0', '4BUI',0) WHERE rid = 2;

SELECT i as col, j as row, ST_Value(rast,2,i,j) As origval,
       ST_Value(reclass_rast, 2, i, j) As reclassval,
       ST_Value(reclass_rast, 2, i, j, false) As reclassval_include_nodata
FROM dummy_rast CROSS JOIN generate_series(1, 3) AS i CROSS JOIN generate_series(1,3) AS j
WHERE rid = 2;
```

col	row	origval	reclassval	reclassval_include_nodata
1	1	78	9	9
2	1	98	14	14
3	1	122		0
1	2	96	14	14
2	2	118		0
3	2	180		0
1	3	99	15	15
2	3	112		0
3	3	169		0

1, 2, 3 1BB, 4BUI, 4BUI reclassarg

```
UPDATE dummy_rast SET reclass_rast =
  ST_Reclass(rast,
    ROW(2,'0-87]:1-10, (87-100]:11-15, (101-254]:0-0', '4BUI',NULL)::reclassarg,
    ROW(1,'0-253]:1, 254:0', '1BB', NULL)::reclassarg,
    ROW(3,'0-70]:1, (70-86):2, [86-150]:3, [150-255:4', '4BUI', NULL)::reclassarg
  ) WHERE rid = 2;
```

```
SELECT i as col, j as row,ST_Value(rast,1,i,j) As ov1, ST_Value(reclass_rast, 1, i, j) As rv1,
       ST_Value(rast,2,i,j) As ov2, ST_Value(reclass_rast, 2, i, j) As rv2,
       ST_Value(rast,3,i,j) As ov3, ST_Value(reclass_rast, 3, i, j) As rv3
FROM dummy_rast CROSS JOIN generate_series(1, 3) AS i CROSS JOIN generate_series(1,3) AS j
WHERE rid = 2;
```

col	row	ov1	rv1	ov2	rv2	ov3	rv3
1	1	253	1	78	9	70	1
2	1	254	0	98	14	86	3

3	1	253	1	122	0	100	3
1	2	253	1	96	14	80	2
2	2	254	0	118	0	108	3
3	2	254	0	180	0	162	4
1	3	250	1	99	15	90	3
2	3	254	0	112	0	108	3
3	3	254	0	169	0	175	4

32BF

32BF ((8BUI,8BUI,8BUI)

```
ALTER TABLE wind ADD COLUMN rast_view raster;
UPDATE wind
  set rast_view = ST_AddBand( NULL,
    ARRAY[
      ST_Reclass(rast, 1, '0.1-10]:1-10,9-10]:11, (11-33:0'::text, '8BUI'::text,0),
      ST_Reclass(rast,1, '11-33):0-255,[0-32:0,(34-1000:0'::text, '8BUI'::text,0),
      ST_Reclass(rast,1, '0-32]:0,(32-100:100-255'::text, '8BUI'::text,0)
    ]
  );
```

[ST_AddBand](#), [ST_Band](#), [ST_BandPixelType](#), [ST_MakeEmptyRaster](#), [reclassarg](#), [ST_Value](#)

11.12.13 ST_Union

ST_Union — 1

Synopsis

```
raster ST_Union(setof raster rast);
raster ST_Union(setof raster rast, unionarg[] unionargset);
raster ST_Union(setof raster rast, integer nband);
raster ST_Union(setof raster rast, text uniontype);
raster ST_Union(setof raster rast, integer nband, text uniontype);
```

1. uniontype LAST(), FIRST, MIN, MAX, COUNT, SUM, MEAN, RANGE



Note

In order for rasters to be unioned, they must all have the same alignment. Use [ST_SameAlignment](#) and [ST_NotSameAlignmentReason](#) for more details and help. One way to fix alignment issues is to use [ST_Resample](#) and use the same reference raster for alignment.

2.0.0 简体中文

简体中文: 2.1.0 简体中文 (C 简体中文).

2.1.0 简体中文 ST_Union(rast, unionarg) 简体中文.

简体中文: 2.1.0 简体中文 ST_Union(rast) 1 简体中文. PostGIS 简体中文.

简体中文: 2.1.0 简体中文 ST_Union(rast, uniontype) 4 简体中文.

简体中文: 简体中文

```
-- 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;
```

简体中文: 简体中文

```
-- 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) ←
);
```

简体中文: 简体中文

简体中文, 简体中文.

```
-- 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) ←
);
```

简体中文

unionarg, ST_Envelope, ST_ConvexHull, ST_Clip, ST_Union

11.13 简体中文

11.13.1 ST_Distinct4ma

ST_Distinct4ma — 简体中文.

Synopsis

float8 **ST_Distinct4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision **ST_Distinct4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC user-args);



Note

1 **ST_MapAlgebraFctNgb**



Note

2 **ST_MapAlgebra (callback function version)**



Warning

2.1.0 **ST_MapAlgebraFctNgb** 1

2.0.0

: 2.1.0 2

```

SELECT
  rid,
  st_value(
    st_mapalgebrafctngb(rast, 1, NULL, 1, 1, 'st_distinct4ma(float[][],text,text[])':: ←
      regprocedure, 'ignore', NULL), 2, 2
  )
FROM dummy_rast
WHERE rid = 2;
  rid | st_value
-----+-----
    2 |          3
(1 row)

```

ST_MapAlgebraFctNgb, ST_MapAlgebra (callback function version), ST_Min4ma, ST_Max4ma, ST_Sum4ma, ST_Mean4ma, ST_Distinct4ma, ST_StdDev4ma

11.13.2 ST_InvDistWeight4ma

ST_InvDistWeight4ma —

Synopsis

double precision **ST_InvDistWeight4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

(Inverse Distance Weighted method)

userargs 2. (力率) (k). 1. 1.

$$\hat{z}(x_o) = \frac{\sum_{j=1}^m z(x_j) d_{ij}^{-k}}{\sum_{j=1}^m d_{ij}^{-k}}$$

k = (power factor), 0 1



Note

ST_MapAlgebra (callback function version)

2.1.0

-- NEEDS EXAMPLE

ST_MapAlgebra (callback function version), ST_MinDist4ma

11.13.3 ST_Max4ma

ST_Max4ma —

Synopsis

float8 ST_Max4ma(float8[][] matrix, text nodatamode, text[] VARIADIC args);
double precision ST_Max4ma(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

¶

ST_MapAlgebraFctNgb 函数。

¶ 2 参数, 参数 userargs 支持 NODATA 选项。



Note

¶ 1 ST_MapAlgebraFctNgb 函数。



Note

¶ 2 ST_MapAlgebra (callback function version) 函数。



Warning

2.1.0 版本 ST_MapAlgebraFctNgb 函数 1 参数。

2.0.0 版本。

更新: 2.1.0 版本 2 参数。

¶

```

SELECT
  rid,
  st_value(
    st_mapalgebrafctngb(rast, 1, NULL, 1, 1, 'st_max4ma(float[][],text,text[])'::
      regprocedure, 'ignore', NULL), 2, 2
  )
FROM dummy_rast
WHERE rid = 2;
  rid | st_value
-----+-----
    2 |    254
(1 row)

```

¶

ST_MapAlgebraFctNgb, ST_MapAlgebra (callback function version), ST_Min4ma, ST_Sum4ma, ST_Mean4ma, ST_Range4ma, ST_Distinct4ma, ST_StdDev4ma

11.13.4 ST_Mean4ma

ST_Mean4ma — 函数。

Synopsis

float8 **ST_Mean4ma**(float8[][] matrix, text nodatamode, text[] VARIADIC args);
 double precision **ST_Mean4ma**(double precision[][][] value, integer[][] pos, text[] VARIADIC userargs);

2 userargs NODATA



Note

1 **ST_MapAlgebraFctNgb**



Note

2 **ST_MapAlgebra (callback function version)**



Warning

2.1.0 **ST_MapAlgebraFctNgb** 1

2.0.0

: 2.1.0 2

: 1

```
SELECT
  rid,
  st_value(
    st_mapalgebrafctngb(rast, 1, '32BF', 1, 1, 'st_mean4ma(float[][],text,text[])':: ↵
    regprocedure, 'ignore', NULL), 2, 2
  )
FROM dummy_rast
WHERE rid = 2;
rid | st_value
-----+-----
  2 | 253.222229003906
(1 row)
```

: 2


```

]::double precision[][]
) AS rast
)
SELECT
  ST_DumpValues(ST_Aspect(rast, 1, '32BF'))
FROM foo
-----
(1,"{{315,341.565063476562,0,18.4349479675293,45},{288.434936523438,315,0,45,71.5650482177734},{270
2227,180,161.565048217773,135}}")
(1 row)

```

2

PostgreSQL 9.1

```

WITH foo AS (
  SELECT ST_Tile(
    ST_SetValues(
      ST_AddBand(
        ST_MakeEmptyRaster(6, 6, 0, 0, 1, -1, 0, 0, 0),
        1, '32BF', 0, -9999
      ),
      1, 1, 1, ARRAY[
        [1, 1, 1, 1, 1, 1],
        [1, 1, 1, 1, 2, 1],
        [1, 2, 2, 3, 3, 1],
        [1, 1, 3, 2, 1, 1],
        [1, 2, 2, 1, 2, 1],
        [1, 1, 1, 1, 1, 1]
      ]::double precision[]
    ),
    2, 2
  ) AS rast
)
SELECT
  t1.rast,
  ST_Aspect(ST_Union(t2.rast), 1, t1.rast)
FROM foo t1
CROSS JOIN foo t2
WHERE ST_Intersects(t1.rast, t2.rast)
GROUP BY t1.rast;

```

[ST_MapAlgebra \(callback function version\)](#), [ST_TRI](#), [ST_TPI](#), [ST_Roughness](#), [ST_HillShade](#), [ST_Slope](#)

11.14.2 ST_HillShade

ST_HillShade —

Synopsis

raster **ST_HillShade**(raster rast, integer band=1, text pixeltype=32BF, double precision azimuth=315, double precision altitude=45, double precision max_bright=255, double precision scale=1.0, boolean interpolate_nodata=FALSE);

raster **ST_HillShade**(raster rast, integer band, raster customextent, text pixeltype=32BF, double precision azimuth=315, double precision altitude=45, double precision max_bright=255, double precision scale=1.0, boolean interpolate_nodata=FALSE);

azimuth 0 360 degrees. 0 is North. 90 is East. 180 is South. 270 is West.

altitude 0 90 degrees (天頂) 0 is 0 degrees, 90 is 90 degrees.

max_bright 0 255. 0 is 0, 255 is 255.

scale 111120 370400. 111120 is 1:111120, 370400 is 1:370400.

interpolate_nodata FALSE, TRUE. TRUE uses **ST_InvDistWeight4ma** for nodata handling.

interpolate_nodata NODATA. NODATA uses NODATA for nodata handling.



Note

How hillshade works

2.0.0

2.1.0 ST_MapAlgebra() interpolate_nodata

2.1.0

1

```
WITH foo AS (
  SELECT ST_SetValues(
    ST_AddBand(ST_MakeEmptyRaster(5, 5, 0, 0, 1, -1, 0, 0, 0), 1, '32BF', 0, -9999),
    1, 1, 1, ARRAY[
      [1, 1, 1, 1, 1],
      [1, 2, 2, 2, 1],
      [1, 2, 3, 2, 1],
      [1, 2, 2, 2, 1],
      [1, 1, 1, 1, 1]
    ]::double precision[[]]
  ) AS rast
)
SELECT
  ST_DumpValues(ST_Hillshade(rast, 1, '32BF'))
FROM foo
```

```
(1,"{NULL,NULL,NULL,NULL,NULL},{NULL,251.32763671875,220.749786376953,147.224319458008, ←
NULL},{NULL,220.749786376953,180.312225341797,67.7497863769531,NULL},{NULL ←
,147.224319458008
,67.7497863769531,43.1210060119629,NULL},{NULL,NULL,NULL,NULL,NULL}}")
(1 row)
```

2

PostgreSQL 9.1

```
WITH foo AS (
  SELECT ST_Tile(
    ST_SetValues(
      ST_AddBand(
        ST_MakeEmptyRaster(6, 6, 0, 0, 1, -1, 0, 0, 0),
        1, '32BF', 0, -9999
      ),
      1, 1, 1, ARRAY[
        [1, 1, 1, 1, 1, 1],
        [1, 1, 1, 1, 2, 1],
        [1, 2, 2, 3, 3, 1],
        [1, 1, 3, 2, 1, 1],
        [1, 2, 2, 1, 2, 1],
        [1, 1, 1, 1, 1, 1]
      ]::double precision[]
    ),
    2, 2
  ) AS rast
)
SELECT
  t1.rast,
  ST_Hillshade(ST_Union(t2.rast), 1, t1.rast)
FROM foo t1
CROSS JOIN foo t2
WHERE ST_Intersects(t1.rast, t2.rast)
GROUP BY t1.rast;
```

[ST_MapAlgebra \(callback function version\)](#), [ST_TRI](#), [ST_TPI](#), [ST_Roughness](#), [ST_Aspect](#), [ST_Slope](#)

11.14.3 ST_Roughness

`ST_Roughness` — DEM (roughness)

Synopsis

raster `ST_Roughness`(raster rast, integer nband, raster customextent, text pixeltype="32BF", boolean interpolate_nodata=FALSE);

例 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},{21.5681285858154,26.5650520324707,36.8698959350586,0,36.8698959350586,26.5650520324707},{21.5681285858154,35.26438905681285858154,26.5650520324707,21.5681285858154,10.0249881744385}}")
(1 row)

```

例 2

例 2 展示了 PostgreSQL 9.1 中的 ST_Slope 函数。

```

WITH foo AS (
  SELECT ST_Tile(
    ST_SetValues(
      ST_AddBand(
        ST_MakeEmptyRaster(6, 6, 0, 0, 1, -1, 0, 0, 0),
        1, '32BF', 0, -9999
      ),
      1, 1, 1, ARRAY[
        [1, 1, 1, 1, 1, 1],
        [1, 1, 1, 1, 2, 1],
        [1, 2, 2, 3, 3, 1],
        [1, 1, 3, 2, 1, 1],
        [1, 2, 2, 1, 2, 1],
        [1, 1, 1, 1, 1, 1]
      ]::double precision[]
    ),
    2, 2
  ) AS rast
)
SELECT
  t1.rast,
  ST_Slope(ST_Union(t2.rast), 1, t1.rast)
FROM foo t1
CROSS JOIN foo t2

```

```
WHERE ST_Intersects(t1.rast, t2.rast)
GROUP BY t1.rast;
```

[ST_MapAlgebra \(callback function version\)](#), [ST_TRI](#), [ST_TPI](#), [ST_Roughness](#), [ST_HillShade](#), [ST_Aspect](#)

11.14.5 ST_TPI

ST_TPI — (Topographic Position Index)

Synopsis

raster **ST_TPI**(raster rast, integer nband, raster customextent, text pixeltype="32BF" , boolean interpolate_nodata=FALSE);

Calculates the Topographic Position Index, which is defined as the focal mean with radius of one minus the center cell.



Note

1 (focalmean radius of one)

2.1.0

```
-- needs examples
```

[ST_MapAlgebra \(callback function version\)](#), [ST_TRI](#), [ST_Roughness](#), [ST_Slope](#), [ST_HillShade](#), [ST_Aspect](#)

11.14.6 ST_TRI

ST_TRI — (Terrain Ruggedness Index)

Synopsis

raster **ST_TRI**(raster rast, integer nband, raster customextent, text pixeltype="32BF" , boolean interpolate_nodata=FALSE);

(Terrain Ruggedness Index)



Note

1 (focalmean radius of one)

2.1.0

-- needs examples

ST_MapAlgebra (callback function version), ST_Roughness, ST_TPI, ST_Slope, ST_HillShade, ST_Aspect

11.15

11.15.1 Box3D

Box3D — BOX3D

Synopsis

box3d **Box3D**(raster rast);

((MINX, MINY), (MAXX, MAXY))

2.0.0 BOX3D BOX2D. BOX2D, 2.0.0 BOX3D

```
SELECT
  rid,
  Box3D(rast) AS rastbox
FROM dummy_rast;
```

rid	rastbox
1	BOX3D(0.5 0.5 0,20.5 60.5 0)
2	BOX3D(3427927.75 5793243.5 0,3427928 5793244 0)

ST_Envelope

11.15.2 ST_ConvexHull

ST_ConvexHull — BandNoDataValue, ST_Envelope

Synopsis

geometry **ST_ConvexHull**(raster rast);

NoDataBandValue, ST_Envelope



Note

ST_Envelope (floor) ST_ConvexHull

PostGIS Raster Specification

```
-- Note envelope and convexhull are more or less the same
SELECT ST_AsText(ST_ConvexHull(rast)) As convhull,
       ST_AsText(ST_Envelope(rast)) As env
FROM dummy_rast WHERE rid=1;

convhull | env
-----+-----
POLYGON((0.5 0.5,20.5 0.5,20.5 60.5,0.5 60.5,0.5 0.5)) | POLYGON((0 0,20 0,20 60,0 60,0 0)
)
```

```
-- now we skew the raster
-- note how the convex hull and envelope are now different
SELECT ST_AsText(ST_ConvexHull(rast)) As convhull,
       ST_AsText(ST_Envelope(rast)) As env
FROM (SELECT ST_SetRotation(rast, 0.1, 0.1) As rast
      FROM dummy_rast WHERE rid=1) As foo;

convhull | env
-----+-----
POLYGON((0.5 0.5,20.5 1.5,22.5 61.5,2.5 60.5,0.5 0.5)) | POLYGON((0 0,22 0,22 61,0 61,0 0)
)
```


ORDER BY val;

val	geomwkt
249	POLYGON((3427927.95 5793243.95,3427927.95 5793243.85,3427928 5793243.85,3427928 5793243.95,3427927.95 5793243.95))
250	POLYGON((3427927.75 5793243.9,3427927.75 5793243.85,3427927.8 5793243.85,3427927.8 5793243.9,3427927.75 5793243.9))
250	POLYGON((3427927.8 5793243.8,3427927.8 5793243.75,3427927.85 5793243.75,3427927.85 5793243.8, 3427927.8 5793243.8))
251	POLYGON((3427927.75 5793243.85,3427927.75 5793243.8,3427927.8 5793243.8,3427927.8 5793243.85,3427927.75 5793243.85))

[geomval](#), [ST_Value](#), [ST_Polygon](#), [ST_ValueCount](#)

11.15.4 ST_Envelope

ST_Envelope — [ST_Envelope](#).

Synopsis

geometry **ST_Envelope**(raster rast);

[ST_Envelope](#) SRID [ST_Envelope](#). [ST_Envelope](#) float8 [ST_Envelope](#).

[ST_Envelope](#) ((MINX, MINY), (MINX, MAXY), (MAXX, MAXY), (MAXX, MINY), (MINX, MINY)).

```
SELECT rid, ST_AsText(ST_Envelope(rast)) As envgeomwkt
FROM dummy_rast;
```

rid	envgeomwkt
1	POLYGON((0 0,20 0,20 60,0 60,0 0))
2	POLYGON((3427927 5793243,3427928 5793243,3427928 5793244,3427927 5793244, 3427927 5793243))

[ST_Envelope](#), [ST_AsText](#), [ST_SRID](#)

11.15.5 ST_MinConvexHull

ST_MinConvexHull — [ST_MinConvexHull](#) NODATA [ST_MinConvexHull](#).

Synopsis

geometry **ST_MinConvexHull**(raster rast, integer nband=NULL);

NODATA . nband NULL, .

2.1.0 .

```

WITH foo AS (
  SELECT
    ST_SetValues(
      ST_SetValues(
        ST_AddBand(ST_AddBand(ST_MakeEmptyRaster(9, 9, 0, 0, 1, -1, 0, 0, 0), 1, '8 ←
          BUI', 0, 0), 2, '8BUI', 1, 0),
        1, 1, 1,
        ARRAY[
          [0, 0, 0, 0, 0, 0, 0, 0, 0],
          [0, 0, 0, 0, 0, 0, 0, 0, 0],
          [0, 0, 0, 0, 0, 0, 0, 0, 0],
          [0, 0, 0, 1, 0, 0, 0, 0, 1],
          [0, 0, 0, 1, 1, 0, 0, 0, 0],
          [0, 0, 0, 1, 0, 0, 0, 0, 0],
          [0, 0, 0, 0, 0, 0, 0, 0, 0],
          [0, 0, 0, 0, 0, 0, 0, 0, 0],
          [0, 0, 0, 0, 0, 0, 0, 0, 0]
        ]::double precision[][]
      ),
      2, 1, 1,
      ARRAY[
        [0, 0, 0, 0, 0, 0, 0, 0, 0],
        [0, 0, 0, 0, 0, 0, 0, 0, 0],
        [0, 0, 0, 0, 0, 0, 0, 0, 0],
        [1, 0, 0, 0, 0, 1, 0, 0, 0],
        [0, 0, 0, 0, 1, 1, 0, 0, 0],
        [0, 0, 0, 0, 0, 1, 0, 0, 0],
        [0, 0, 0, 0, 0, 0, 0, 0, 0],
        [0, 0, 0, 0, 0, 0, 0, 0, 0],
        [0, 0, 1, 0, 0, 0, 0, 0, 0]
      ]::double precision[][]
    ) AS rast
)
SELECT
  ST_AsText(ST_ConvexHull(rast)) AS hull,
  ST_AsText(ST_MinConvexHull(rast)) AS mhull,
  ST_AsText(ST_MinConvexHull(rast, 1)) AS mhull_1,
  ST_AsText(ST_MinConvexHull(rast, 2)) AS mhull_2
FROM foo

          hull          |          mhull          |          ←
          mhull_1       |          mhull_2       |
-----+-----+-----+-----+-----+-----
POLYGON((0 0,9 0,9 -9,0 -9,0 0)) | POLYGON((0 -3,9 -3,9 -9,0 -9,0 -3)) | POLYGON((3 -3,9 ←
-3,9 -6,3 -6,3 -3)) | POLYGON((0 -3,6 -3,6 -9,0 -9,0 -3))

```


Synopsis

boolean &>(raster A , raster B);

返回

&> 返回 A 与 B 的逐像素比较结果。如果 A 的像素值大于 B 的像素值，则返回 TRUE。



Note

返回 (operand) 返回。

返回

```
SELECT A.rid As a_rid, B.rid As b_rid, A.rast &
> B.rast As overright
FROM dummy_rast AS A CROSS JOIN dummy_rast AS B;
```

a_rid	b_rid	overright
2	2	t
2	3	t
2	1	t
3	2	f
3	3	t
3	1	f
1	2	f
1	3	t
1	1	t

11.16.4 =

= — A 与 B 的逐像素比较结果。如果 A 的像素值等于 B 的像素值，则返回 TRUE。

Synopsis

boolean =(raster A , raster B);

返回

= 返回 A 与 B 的逐像素比较结果。如果 A 的像素值等于 B 的像素值，则返回 TRUE。 PostgreSQL 的 =, <, > 运算符 (GROUP BY ORDER BY)。



Caution

返回 (operand) 返回。 ~ = 返回。

2.1.0 返回。

Synopsis

boolean **ST_ContainsProperly**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_ContainsProperly**(raster rastA , raster rastB);

ST_ContainsProperly(rastB, rastA) returns true if and only if rastA is a proper subset of rastB. If either raster is NULL, the function returns NULL. If either raster has a NODATA value, the function returns false.

ST_ContainsProperly(rastA, rastB) returns true if and only if rastA is a proper subset of rastB.



Note

ST_ContainsProperly(rastA, rastB) is the inverse of **ST_ContainsProperly**(rastB, rastA).



Note

ST_ContainsProperly(ST_Polygon(raster), geometry) is the same as **ST_ContainsProperly**(geometry, ST_Polygon(raster)).

2.1.0

```
SELECT r1.rid, r2.rid, ST_ContainsProperly(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS JOIN dummy_rast r2 WHERE r1.rid = 2;
```

rid	rid	st_containsproperly
2	1	f
2	2	f

ST_Intersects, ST_Contains

11.17.3 ST_Covers

ST_Covers — raster rastB covers raster rastA.

Synopsis

boolean **ST_Covers**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Covers**(raster rastA , raster rastB);



Note

ST_CoveredBy(geometry, ST_Polygon(raster))



Note

ST_CoveredBy(ST_Polygon(raster), geometry) ST_CoveredBy(geometry, ST_Polygon(raster))

2.1.0

ST

```
SELECT r1.rid, r2.rid, ST_CoveredBy(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS JOIN dummy_rast r2 WHERE r1.rid = 2;
```

rid	rid	st_coveredby
2	1	f
2	2	t

ST

ST_Intersects, ST_Covers

11.17.5 ST_Disjoint

ST_Disjoint — rastA rastB

Synopsis

```
boolean ST_Disjoint( raster rastA , integer nbandA , raster rastB , integer nbandB );
boolean ST_Disjoint( raster rastA , raster rastB );
```

ST

rastA rastB rastA rastB NULL (NODATA)



Note

ST



Note

ST_Disjoint(ST_Polygon(raster), geometry) ST_Polygon

2.1.0

```
-- rid = 1 has no bands, hence the NOTICE and the NULL value for st_disjoint
SELECT r1.rid, r2.rid, ST_Disjoint(r1.rast, 1, r2.rast, 1) FROM dummy_rast r1 CROSS JOIN
dummy_rast r2 WHERE r1.rid = 2;
```

NOTICE: The second raster provided has no bands

rid	rid	st_disjoint
2	1	
2	2	f

```
-- this time, without specifying band numbers
SELECT r1.rid, r2.rid, ST_Disjoint(r1.rast, r2.rast) FROM dummy_rast r1 CROSS JOIN
dummy_rast r2 WHERE r1.rid = 2;
```

rid	rid	st_disjoint
2	1	t
2	2	f

ST_Intersects

11.17.6 ST_Intersects

ST_Intersects — rastA rastB

Synopsis

```
boolean ST_Intersects( raster rastA , integer nbandA , raster rastB , integer nbandB );
boolean ST_Intersects( raster rastA , raster rastB );
boolean ST_Intersects( raster rast , integer nband , geometry geommin );
boolean ST_Intersects( raster rast , geometry geommin , integer nband=NULL );
boolean ST_Intersects( geometry geommin , raster rast , integer nband=NULL );
```

rastA rastB NULL (NODATA)



Note

PostGIS 2.0.0 introduced ST_Intersects(geometry, raster) and ST_Intersects(raster, geometry) functions.

PostGIS 2.0.0 introduced ST_Intersects(geometry, raster) and ST_Intersects(raster, geometry) functions.



Warning

PostGIS 2.1.0 introduced ST_Intersects(geometry, raster) and ST_Intersects(raster, geometry) functions.

SQL

```
-- different bands of same raster
SELECT ST_Intersects(rast, 2, rast, 3) FROM dummy_rast WHERE rid = 2;

st_intersects
-----
t
```

SQL

ST_Intersection, ST_Disjoint

11.17.7 ST_Overlaps

ST_Overlaps — Returns true if rasterA overlaps rasterB. Returns false if they do not overlap.

Synopsis

boolean **ST_Overlaps**(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean **ST_Overlaps**(raster rastA , raster rastB);

SQL

ST_Overlaps(rastA, nbandA, rastB, nbandB) returns true if rasterA overlaps rasterB. Returns false if they do not overlap. Returns NULL if either raster is NULL or either nband is out of range. Returns false if either raster has a NODATA value.



Note

PostGIS 2.0.0 introduced ST_Overlaps(raster, raster) function.



Note

ST_Overlaps(ST_Polygon(raster), geometry) ST_Polygon

2.1.0

```
-- comparing different bands of same raster
SELECT ST_Overlaps(rast, 1, rast, 2) FROM dummy_rast WHERE rid = 2;

st_overlaps
-----
f
```

ST_Intersects

11.17.8 ST_Touches

ST_Touches — rastA rastB TRUE

Synopsis

boolean ST_Touches(raster rastA , integer nbandA , raster rastB , integer nbandB);
boolean ST_Touches(raster rastA , raster rastB);

rastA rastB . rastA rastB
, NULL
, (NODATA)



Note



Note

ST_Touches(ST_Polygon(raster), geometry) ST_Polygon

2.1.0

11.17.13 ST_DFullyWithin

ST_DFullyWithin — raster rastA, raster rastB, integer nbandA, integer nbandB, double precision distance_of_srid.

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);

Notes

ST_DFullyWithin(rastA, rastB, nbandA, nbandB, distance_of_srid) returns true if the pixels of rastA are fully within the pixels of rastB. If either raster has NULL values, the result is NULL. If either raster has NODATA values, the result is false.

ST_DFullyWithin(rastA, rastB, distance_of_srid) returns true if the pixels of rastA are fully within the pixels of rastB, within a distance of distance_of_srid units. If either raster has NULL values, the result is NULL. If either raster has NODATA values, the result is false.



Note

ST_DFullyWithin(operand) returns true if the operand is a valid raster.



Note

ST_DFullyWithin(ST_Polygon(raster), geometry) is equivalent to ST_DFullyWithin(ST_Polygon(raster), ST_Polygon(geometry)).

2.1.0 ST_DFullyWithin

Notes

```
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

Notes

[ST_Within](#), [ST_DWithin](#)

11.18 Raster Tips

11.18.1 Out-DB Rasters

11.18.1.1 Directory containing many files

When GDAL opens a file, GDAL eagerly scans the directory of that file to build a catalog of other files. If this directory contains many files (e.g. thousands, millions), opening that file becomes extremely slow (especially if that file happens to be on a network drive such as NFS).

To control this behavior, GDAL provides the following environment variable: `GDAL_DISABLE_READDIR_ON_OPEN`. Set `GDAL_DISABLE_READDIR_ON_OPEN` to `TRUE` to disable directory scanning.

In Ubuntu (and assuming you are using PostgreSQL's packages for Ubuntu), `GDAL_DISABLE_READDIR_ON_OPEN` can be set in `/etc/postgresql/POSTGRESQL_VERSION/CLUSTER_NAME/environment` (where `POSTGRESQL_VERSION` is the version of PostgreSQL, e.g. 9.6 and `CLUSTER_NAME` is the name of the cluster, e.g. maindb). You can also set PostGIS environment variables here as well.

```
# environment variables for postmaster process
# This file has the same syntax as postgresql.conf:
# VARIABLE = simple_value
# VARIABLE2 = 'any value!'
# I. e. you need to enclose any value which does not only consist of letters,
# numbers, and '-', '_', '.' in single quotes. Shell commands are not
# evaluated.
POSTGIS_GDAL_ENABLED_DRIVERS = 'ENABLE_ALL'

POSTGIS_ENABLE_OUTDB_RASTERS = 1

GDAL_DISABLE_READDIR_ON_OPEN = 'TRUE'
```

11.18.1.2 Maximum Number of Open Files

The maximum number of open files permitted by Linux and PostgreSQL are typically conservative (typically 1024 open files per process) given the assumption that the system is consumed by human users. For Out-DB Rasters, a single valid query can easily exceed this limit (e.g. a dataset of 10 year's worth of rasters with one raster for each day containing minimum and maximum temperatures and we want to know the absolute min and max value for a pixel in that dataset).

The easiest change to make is the following PostgreSQL setting: `max_files_per_process`. The default is set to 1000, which is far too low for Out-DB Rasters. A safe starting value could be 65536 but this really depends on your datasets and the queries run against those datasets. This setting can only be made on server start and probably only in the PostgreSQL configuration file (e.g. `/etc/postgresql/POSTGRESQL_VERSION/CLUSTER_NAME/postgresql.conf` in Ubuntu environments).

```
...
# - Kernel Resource Usage -

max_files_per_process = 65536          # min 25
                                       # (change requires restart)
...
```

The major change to make is the Linux kernel's open files limits. There are two parts to this:

- Maximum number of open files for the entire system
- Maximum number of open files per process

11.18.1.2.1 Maximum number of open files for the entire system

You can inspect the current maximum number of open files for the entire system with the following example:

```
$ sysctl -a | grep fs.file-max
fs.file-max = 131072
```

If the value returned is not large enough, add a file to `/etc/sysctl.d/` as per the following example:

```
$ echo "fs.file-max = 6145324" >> /etc/sysctl.d/fs.conf
```

```
$ cat /etc/sysctl.d/fs.conf
fs.file-max = 6145324
```

```
$ sysctl -p --system
* Applying /etc/sysctl.d/fs.conf ...
fs.file-max = 2097152
* Applying /etc/sysctl.conf ...
```

```
$ sysctl -a | grep fs.file-max
fs.file-max = 6145324
```

11.18.1.2.2 Maximum number of open files per process

We need to increase the maximum number of open files per process for the PostgreSQL server processes.

To see what the current PostgreSQL service processes are using for maximum number of open files, do as per the following example (make sure to have PostgreSQL running):

```
$ ps aux | grep postgres
postgres 31713  0.0  0.4 179012 17564 pts/0    S   Dec26   0:03 /home/dustymugs/devel/ ↵
    postgresql/sandbox/10/usr/local/bin/postgres -D /home/dustymugs/devel/postgresql/sandbox ↵
    /10/pgdata
postgres 31716  0.0  0.8 179776 33632 ?        Ss  Dec26   0:01 postgres: checkpointer ↵
    process
postgres 31717  0.0  0.2 179144  9416 ?        Ss  Dec26   0:05 postgres: writer process
postgres 31718  0.0  0.2 179012  8708 ?        Ss  Dec26   0:06 postgres: wal writer ↵
    process
postgres 31719  0.0  0.1 179568  7252 ?        Ss  Dec26   0:03 postgres: autovacuum ↵
    launcher process
postgres 31720  0.0  0.1  34228  4124 ?        Ss  Dec26   0:09 postgres: stats collector ↵
    process
postgres 31721  0.0  0.1 179308  6052 ?        Ss  Dec26   0:00 postgres: bgworker: ↵
    logical replication launcher
```

```
$ cat /proc/31718/limits
Limit                Soft Limit            Hard Limit            Units
Max cpu time          unlimited             unlimited             seconds
Max file size         unlimited             unlimited             bytes
Max data size         unlimited             unlimited             bytes
Max stack size        8388608              unlimited             bytes
Max core file size    0                    unlimited             bytes
Max resident set      unlimited             unlimited             bytes
Max processes         15738                15738                processes
Max open files      1024                4096                files
Max locked memory     65536                65536                bytes
Max address space     unlimited             unlimited             bytes
Max file locks        unlimited             unlimited             locks
Max pending signals   15738                15738                signals
```

Max msgqueue size	819200	819200	bytes
Max nice priority	0	0	
Max realtime priority	0	0	
Max realtime timeout	unlimited	unlimited	us

In the example above, we inspected the open files limit for Process 31718. It doesn't matter which PostgreSQL process, any of them will do. The response we are interested in is *Max open files*.

We want to increase *Soft Limit* and *Hard Limit* of *Max open files* to be greater than the value we specified for the PostgreSQL setting `max_files_per_process`. In our example, we set `max_files_per_process` to 65536.

In Ubuntu (and assuming you are using PostgreSQL's packages for Ubuntu), the easiest way to change the *Soft Limit* and *Hard Limit* is to edit `/etc/init.d/postgresql` (SysV) or `/lib/systemd/system/postgresql*.service` (systemd).

Let's first address the SysV Ubuntu case where we add `ulimit -H -n 262144` and `ulimit -n 131072` to `/etc/init.d/postgresql`.

```
...
case "$1" in
  start|stop|restart|reload)
    if [ "$1" = "start" ]; then
      create_socket_directory
    fi
    if [ -z "`pg_lsclusters -h`" ]; then
      log_warning_msg 'No PostgreSQL clusters exist; see "man pg_createcluster"'
      exit 0
    fi

    ulimit -H -n 262144
    ulimit -n 131072

    for v in $versions; do
      $1 $v || EXIT=$?
    done
    exit ${EXIT:-0}
    ;;
  status)
  ...
```

Now to address the systemd Ubuntu case. We will add `LimitNOFILE=131072` to every `/lib/systemd/system/postgresql*.service` file in the `[Service]` section.

```
...
[Service]

LimitNOFILE=131072

...

[Install]
WantedBy=multi-user.target
...
```

After making the necessary systemd changes, make sure to reload the daemon

```
systemctl daemon-reload
```

Chapter 12

PostGIS Extras

This chapter documents features found in the extras folder of the PostGIS source tarballs and source repository. These are not always packaged with PostGIS binary releases, but are usually PL/pgSQL based or standard shell scripts that can be run as is.

12.1

PAGC standardizer (fork) (PAGC PostgreSQL)

(lexicon; lex) (gazetteer; gaz)

```
CREATE EXTENSION address_standardizer;
address_standardizer PostgreSQL
address_standardizer_data_us
CREATE EXTENSION address_standardizer_data_us;
```

PostGIS extensions/address_standardizer

Section 2.3

12.1.1

(macro) (micro)

/

(zip code) (Perl) parseaddress-api.c

(Perl) parseaddress-api.c

12.1.2

12.1.2.1 stdaddr

`stdaddr` — `standardize_address`.

`standardize_address`. **PAGC Postal Attributes**.

rules table.

 This method needs `address_standardizer` extension.

building (0) : .

house_num (1) : 75 State Street 75

predir (2) : North, South, East, West (STREET NAME PRE-DIRECTIONAL)

qual (3) : (STREET NAME PRE-MODIFIER) . 3715 OLD HIGHWAY 99 *OLD*

pretype (4) : (STREET PREFIX TYPE)

name (5) : (STREET NAME)

suftype (6) : St, Ave, Cir (STREET POST TYPE) . 75 State Street *STREET*

sufdir (7) : (STREET POST-DIRECTIONAL) . 3715 TENTH AVENUE WEST *WEST*

ruralroute is text (token number 8): `RURAL ROUTE` . Example 7 in `RR 7`.

extra : .

city (10) : :

state (11) : :

country (12) : : USA

postcode (13) (postal code, zip code) : : 02109

box (14, 15) (POSTAL BOX NUMBER) : : 02109

unit (17) : : APT 3B *3B*

12.1.3

12.1.3.1 rules table

`rules table` — . -1(terminator), -1, .

UNITH (16). 住所形式。例: *APT UNIT*

住所形式

QUINT (28). 住所形式。例 (Zip Code) 住所形式。

QUAD (29). 住所形式。ZIP4 住所形式。

PCH (27). 住所形式, 住所形式, 住所形式 3 住所形式。住所形式 FSA 住所形式。

PCT (26). 住所形式, 住所形式, 住所形式 3 住所形式。住所形式 LDU 住所形式。

住所形式 (不用語; stopword)

STOPWORD 住所形式 WORD 住所形式。住所形式 WORD 住所形式 STOPWORD 住所形式 WORD 住所形式。

STOPWORD (7). 住所形式。例: *THE*

住所形式

住所形式 -1(住所形式) 住所形式, 住所形式 -1 住所形式。stdaddr 住所形式。住所形式。the section called “住所形式” 住所形式。

住所形式

住所形式。住所形式 (住所形式) 0 住所形式 (住所形式) 17 住所形式。

MACRO_C

(住所形式 = "0")。PLACE STATE ZIP 住所形式 MACRO 住所形式。

MACRO_C output tokens (excerpted from <http://www.pagcgeo.org/docs/html/pagc-12.html#--r-ty-->).

CITY (住所形式"10")。例: "Albany"

STATE (住所形式"11")。例: "NY"

NATION (住所形式"12")。住所形式。例: "USA"

POSTAL (住所形式"13")。 (SADS 住所形式"ZIP CODE", "PLUS 4")。住所形式。

MICRO_C

(住所形式 = "1")。 (住所形式, 住所形式, sufdir, predir, pretyp, suftype, qualif 住所形式) 住所形式 MICRO 住所形式 (住所形式: ARC_C 住所形式: CIVIC_C)。住所形式。

MICRO_C output tokens (excerpted from <http://www.pagcgeo.org/docs/html/pagc-12.html#--r-ty-->).

HOUSE 住所形式 (住所形式 1) 住所形式: 住所形式。例: 75 State Street 住所形式

predir 住所形式 (住所形式 2) 住所形式: North, South, East, West 住所形式 (STREET NAME PRE-DIRECTIONAL) 住所形式。

qual 住所形式 (住所形式 3) 住所形式: 住所形式 (STREET NAME PRE-MODIFIER) 住所形式。例: 3715 OLD HIGHWAY 99 住所形式 OLD

pretype (4): (STREET PREFIX TYPE)

street (5): (STREET NAME)

suftype (6): St, Ave, Cir (STREET POST TYPE).
 Example: 75 State Street *STREET*

sufdir (7): (STREET POST-DIRECTIONAL).
 Example: 3715 TENTH AVENUE WEST *WEST*

ARC_C

(= "2"). HOUSE MICRO (HOUSE MICRO_C)

CIVIC_C

(= "3"). HOUSE

EXTRA_C

(= "4"). EXTRA - -

EXTRA_C output tokens (excerpted from <http://www.pagcgeo.org/docs/html/pagc-12.html#--r-typ-->.

BLDNG (0):

BOXH (token number 14): The **BOX** in BOX 3B

BOXT (15): BOX 3B **3B**

RR (8): RR 7 **RR**

UNITH (16): APT 3B **APT**

UNITT (17): APT 3B **3B**

UNKNWN (9):

12.1.3.2 lex table

lex table — (lex) (1) (the section called " " (2))

(lexicon) (1) (the section called " " (2))

id

seq

word

stdword

token: **PAGC Tokens**

12.1.3.3 gaz table

`gaz table` — (gaz) table, (1) (the section called “”) (2) .

A gaz (short for gazeteer) table is used to standardize place names and associate that input with the section called “”) and (b) standardized representations. For example if you are in US, you may load these with State Names and associated abbreviations.

. .

id :

seq : -

word :

stdword :

token : . . **PAGC Tokens** .

12.1.4

12.1.4.1 debug_standardize_address

`debug_standardize_address` — Returns a json formatted text listing the parse tokens and standardizations

Synopsis

`text debug_standardize_address(text lextab, text gaztab, text rultab, text micro, text macro=NULL);`

This is a function for debugging address standardizer rules and lex/gaz mappings. It returns a json formatted text that includes the matching rules, mapping of tokens, and best standardized address `stdaddr` form of an input address utilizing `lex table` table name, `gaz table`, and `rules table` table names and an address.

For single line addresses use just `micro`

For two line address A `micro` consisting of standard first line of postal address e.g. `house_num street`, and a `macro` consisting of standard postal second line of an address e.g. `city, state postal_code country`.

Elements returned in the json document are

input_tokens For each word in the input address, returns the position of the word, token categorization of the word, and the standard word it is mapped to. Note that for some input words, you might get back multiple records because some inputs can be categorized as more than one thing.


rules The set of rules matching the input and the corresponding score for each. The first rule (highest scoring) is what is used for standardization

stdaddr The standardized address elements **stdaddr** that would be returned when running **standardize_address**

Availability: 3.4.0

 This method needs address_standardizer extension.



address_standardizer_data_us 

```
CREATE EXTENSION address_standardizer_data_us; -- only needs to be done once
```

Variant 1: Single line address and returning the input tokens

```
SELECT it->'pos' AS position, it->'word' AS word, it->'stdword' AS standardized_word,
       it->'token' AS token, it->'token-code' AS token_code
FROM jsonb(
    debug_standardize_address('us_lex',
                              'us_gaz', 'us_rules', 'One Devonshire Place, PH 301, Boston, MA 02109')
    ) AS s, jsonb_array_elements(s->'input_tokens') AS it;
```

position	word	standardized_word	token	token_code
0	ONE	1	NUMBER	0
0	ONE	1	WORD	1
1	DEVONSHIRE	DEVONSHIRE	WORD	1
2	PLACE	PLACE	TYPE	2
3	PH	PATH	TYPE	2
3	PH	PENTHOUSE	UNITT	17
4	301	301	NUMBER	0

(7 rows)

Variant 2: Multi line address and returning first rule input mappings and score

```
SELECT (s->'rules'->0->'score')::numeric AS score, it->'pos' AS position,
       it->'input-word' AS word, it->'input-token' AS input_token, it->'mapped-word' AS ↵
       standardized_word,
       it->'output-token' AS output_token
FROM jsonb(
    debug_standardize_address('us_lex',
                              'us_gaz', 'us_rules', 'One Devonshire Place, PH 301', 'Boston, MA 02109')
    ) AS s, jsonb_array_elements(s->'rules'->0->'rule_tokens') AS it;
```

score	position	word	input_token	standardized_word	output_token
0.876250	0	ONE	NUMBER	1	HOUSE
0.876250	1	DEVONSHIRE	WORD	DEVONSHIRE	STREET
0.876250	2	PLACE	TYPE	PLACE	SUFTYP
0.876250	3	PH	UNITT	PENTHOUSE	UNITT
0.876250	4	301	NUMBER	301	UNITT

(5 rows)



[stdaddr](#), [rules table](#), [lex table](#), [gaz table](#), [Pagc_Normalize_Address](#)

12.1.4.2 parse_address

parse_address —

Synopsis

record parse_address(text address);

Returns takes an address as input, and returns a record output consisting of fields *num*, *street*, *street2*, *address1*, *city*, *state*, *zip*, *zipplus*, *country*.

2.2.0

 This method needs address_standardizer extension.

```
SELECT num, street, city, zip, zipplus
       FROM parse_address('1 Devonshire Place, Boston, MA 02109-1234') AS a;
```

num	street	city	zip	zipplus
1	Devonshire Place	Boston	02109	1234

```
-- basic table
CREATE TABLE places(addid serial PRIMARY KEY, address text);

INSERT INTO places(address)
VALUES ('529 Main Street, Boston MA, 02129'),
       ('77 Massachusetts Avenue, Cambridge, MA 02139'),
       ('25 Wizard of Oz, Walaford, KS 99912323'),
       ('26 Capen Street, Medford, MA'),
       ('124 Mount Auburn St, Cambridge, Massachusetts 02138'),
       ('950 Main Street, Worcester, MA 01610');

-- parse the addresses
-- if you want all fields you can use (a).*
SELECT addid, (a).num, (a).street, (a).city, (a).state, (a).zip, (a).zipplus
FROM (SELECT addid, parse_address(address) As a
      FROM places) AS p;
```

addid	num	street	city	state	zip	zipplus
1	529	Main Street	Boston	MA	02129	
2	77	Massachusetts Avenue	Cambridge	MA	02139	
3	25	Wizard of Oz	Walaford	KS	99912	323
4	26	Capen Street	Medford	MA		
5	124	Mount Auburn St	Cambridge	MA	02138	
6	950	Main Street	Worcester	MA	01610	

(6 rows)

key	value
box	
city	BOSTON
name	DEVONSHIRE
qual	
unit	# PENTHOUSE 301
extra	
state	MA
predir	
sufdir	
country	USA
pretype	
suftype	PL
building	
postcode	02109
house_num	1
ruralroute	

(16 rows)

2: .

```
SELECT (each(hstore(p))).*
FROM standardize_address('tiger.pagc_lex', 'tiger.pagc_gaz',
    'tiger.pagc_rules', 'One Devonshire Place, PH 301', 'Boston, MA 02109, US') As p;
```

key	value
box	
city	BOSTON
name	DEVONSHIRE
qual	
unit	# PENTHOUSE 301
extra	
state	MA
predir	
sufdir	
country	USA
pretype	
suftype	PL
building	
postcode	02109
house_num	1
ruralroute	

(16 rows)

[stdaddr](#), [rules table](#), [lex table](#), [gaz table](#), [Pagc_Normalize_Address](#)

12.2 TIGER

TIGER, PostGIS

- **Nominatim** OpenStreetMap. osm2pgsql, PostgreSQL 8.4, PostGIS 1.5. TIGER, Nominatim TIGER SQL.
- **GIS Graphy** PostGIS, Nominatim, OSM(OpenStreetMap). OSM, Nominatim, Java 1.5, Servlet apps, Solr. GIS Graphy.

12.2.1 Drop_Indexes_Generate_Script

Drop Indexes Generate Script — TIGER tiger_data

Synopsis

text Drop_Indexes_Generate_Script(text param_schema=tiger_data);

TIGER tiger_data (bloat) Install Missing Indexes 2.0.0

```
SELECT drop_indexes_generate_script() As actionsql;
actionsql
-----
DROP INDEX tiger.idx_tiger_countysub_lookup_lower_name;
DROP INDEX tiger.idx_tiger_edges_countyfp;
DROP INDEX tiger.idx_tiger_faces_countyfp;
DROP INDEX tiger.tiger_place_the_geom_gist;
DROP INDEX tiger.tiger_edges_the_geom_gist;
DROP INDEX tiger.tiger_state_the_geom_gist;
DROP INDEX tiger.idx_tiger_addr_least_address;
DROP INDEX tiger.idx_tiger_addr_tlid;
DROP INDEX tiger.idx_tiger_addr_zip;
DROP INDEX tiger.idx_tiger_county_countyfp;
DROP INDEX tiger.idx_tiger_county_lookup_lower_name;
DROP INDEX tiger.idx_tiger_county_lookup_snd_name;
DROP INDEX tiger.idx_tiger_county_lower_name;
DROP INDEX tiger.idx_tiger_county_snd_name;
DROP INDEX tiger.idx_tiger_county_the_geom_gist;
DROP INDEX tiger.idx_tiger_countysub_lookup_snd_name;
DROP INDEX tiger.idx_tiger_cousub_countyfp;
DROP INDEX tiger.idx_tiger_cousub_cousubfp;
DROP INDEX tiger.idx_tiger_cousub_lower_name;
DROP INDEX tiger.idx_tiger_cousub_snd_name;
```


Synopsis

text **Drop_State_Tables_Generate_Script**(text param_state, text param_schema=tiger_data);

Drop State Tables Generate Script (州) 脚本生成器。该脚本将 tiger_data 数据库中的所有表（州）从数据库中删除。

2.0.0 版本引入。

```
SELECT drop_state_tables_generate_script('PA');
DROP TABLE tiger_data.pa_addr;
DROP TABLE tiger_data.pa_county;
DROP TABLE tiger_data.pa_county_lookup;
DROP TABLE tiger_data.pa_cousub;
DROP TABLE tiger_data.pa_edges;
DROP TABLE tiger_data.pa_faces;
DROP TABLE tiger_data.pa_featnames;
DROP TABLE tiger_data.pa_place;
DROP TABLE tiger_data.pa_state;
DROP TABLE tiger_data.pa_zip_lookup_base;
DROP TABLE tiger_data.pa_zip_state;
DROP TABLE tiger_data.pa_zip_state_loc;
```

Loader_Generate_Script

12.2.4 Geocode

Geocode — 将地址（NAD83 坐标系）转换为几何体，并返回距离最近的地理名称。限制区域（restrict_region）默认为 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);

Geocoding

Geocoding (geocoding) is the process of converting a normalized address (addy) into geographic coordinates. It uses TIGER (edge, face, addr), PostgreSQL (soundex, levenshtein), and PostGIS (TIGER) to find the best match.

Example: 2.0.0 TIGER 2010. max_results is the number of results to return.

Example

Example (MA), (MN), (CA), (RI) TIGER PostgreSQL 9.1rc1/PostGIS 2.0 3.0 GHz 2GB 7 GB.

Example (61 results).

```
SELECT g.rating, ST_X(g.geomout) As lon, ST_Y(g.geomout) As lat,
       (addy).address As stno, (addy).streetname As street,
       (addy).streettypeabbrev As styp, (addy).location As city, (addy).stateabbrev As st,( ←
       addy).zip
FROM geocode('75 State Street, Boston MA 02109', 1) As g;
rating | lon | lat | stno | street | styp | city | st | zip
-----+-----+-----+-----+-----+-----+-----+-----+-----
0 | -71.0557505845646 | 42.35897920691 | 75 | State | St | Boston | MA | 02109
```

Example (122 ~ 150 results).

```
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
```

Example (500 results).

```
SELECT g.rating, ST_AsText(ST_SnapToGrid(g.geomout,0.00001)) As wktlonlat,
       (addy).address As stno, (addy).streetname As street,
       (addy).streettypeabbrev As styp, (addy).location As city, (addy).stateabbrev As st,( ←
       addy).zip
FROM geocode('31 - 37 Stewart Street, Boston, MA 02116',1) As g;
rating | wktlonlat | stno | street | styp | city | st | zip
-----+-----+-----+-----+-----+-----+-----+-----
70 | POINT(-71.06466 42.35114) | 31 | Stuart | St | Boston | MA | 02116
```

Example (batch) max_results = 1.

```
CREATE TABLE addresses_to_geocode(addyid 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, Waford, KS 99912323'),
('26 Capen Street, Medford, MA'),
('124 Mount Auburn St, Cambridge, Massachusetts 02138'),
('950 Main Street, Worcester, MA 01610');

-- only update the first 3 addresses (323-704 ms - there are caching and shared memory ←
  effects so first geocode you do is always slower) --
-- for large numbers of addresses you don't want to update all at once
-- since the whole geocode must commit at once
-- For this example we rejoin with LEFT JOIN
-- and set to rating to -1 rating if no match
-- to ensure we don't regeocode a bad address
UPDATE addresses_to_geocode
  SET (rating, new_address, lon, lat)
    = ( COALESCE(g.rating, -1), pprint_addy(g.addy),
        ST_X(g.geomout)::numeric(8,5), ST_Y(g.geomout)::numeric(8,5) )
FROM (SELECT addid, address
      FROM addresses_to_geocode
      WHERE rating IS NULL ORDER BY addid LIMIT 3) As a
  LEFT JOIN LATERAL geocode(a.address,1) As g ON true
WHERE a.addid = addresses_to_geocode.addid;

```

result

 Query returned successfully: 3 rows affected, 480 ms execution time.

```
SELECT * FROM addresses_to_geocode WHERE rating is not null;
```

addid	new_address	rating	lon	lat	
1	529 Main Street, Boston MA, 02129 Boston, MA 02129	0	-71.07177	42.38357	529 Main St, ←
2	77 Massachusetts Avenue, Cambridge, MA 02139 Massachusetts Ave, Cambridge, MA 02139	0	-71.09396	42.35961	77 ←
3	25 Wizard of Oz, Waford, KS 99912323 KS 67502	108	-97.92913	38.12717	Willowbrook, ←

(3 rows)

☒☒: ☒☒☒☒☒☒

```

SELECT g.rating, ST_AsText(ST_SnapToGrid(g.geomout,0.00001)) As wktlonlat,
  (addy).address As stno, (addy).streetname As street,
  (addy).streettypeabbrev As styp,
  (addy).location As city, (addy).stateabbrev As st,(addy).zip
FROM geocode('100 Federal Street, MA',
  3,
  (SELECT ST_Union(the_geom)
   FROM place WHERE statefp = '25' AND name = 'Lynn')::geometry
 ) As g;

```

rating	wktlonlat	stno	street	styp	city	st	zip
7	POINT(-70.96796 42.4659)	100	Federal	St	Lynn	MA	01905
16	POINT(-70.96786 42.46853)	NULL	Federal	St	Lynn	MA	01905

(2 rows)

Time: 622.939 ms

☐☐

[Set_Geocode_Setting](#)

12.2.7 Get_Tract

Get Tract — `get_tract(geometry loc_geom, text output_field=name)` (tract) `get_tract(geometry loc_geom, text output_field=name)` (field) `get_tract(geometry loc_geom, text output_field=name)`. `get_tract(geometry loc_geom, text output_field=name)`.

Synopsis

```
text get_tract(geometry loc_geom, text output_field=name);
```

☐☐

`get_tract(geometry loc_geom, text output_field=name)`. `get_tract(geometry loc_geom, text output_field=name)` NAD83 `get_tract(geometry loc_geom, text output_field=name)`.

Note

This function uses the census tract which is not loaded by default. If you have already loaded your state table, you can load tract as well as bg, and tabblock using the [Loader_Generate_Census_Script](#) script.



If you have not loaded your state data yet and want these additional tables loaded, do the following

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

then they will be included by the [Loader_Generate_Script](#).

2.0.0 `get_tract(geometry loc_geom, text output_field=name)`.

☐☐☐☐

```
SELECT get_tract(ST_Point(-71.101375, 42.31376) ) As tract_name;
tract_name
-----
1203.01
```

```
--this one returns the tiger geoid
SELECT get_tract(ST_Point(-71.101375, 42.31376), 'tract_id' ) As tract_id;
tract_id
-----
25025120301
```

☐☐

[Geocode](#)>

1. loader_variables - 设置, 选项, 设置 (staging) 选项。
2. loader_platform - 设置。 选项。
3. loader_lookuptables - 设置 (州, 县), 设置, 设置 选项。 设置, 设置, 设置, 设置 选项。 设置 (州名) 选项, TIGER 设置 选项。 选项: tiger.faces 设置 tiger_data.ma_faces 设置。

2.0.0 设置。



Note

Loader Generate Script 设置, PostGIS 2.0.0 alpha5 设置 TIGER 设置 设置, 设置 (州) 设置。

设置

设置。

```

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');"
:

```


3. streetName varchar.
4. streetTypeAbbrev varchar, St, Ave, Cir. street_type_lookup.
5. postdirAbbrev varchar, N, S, E, W. direction_lookup.
6. internal varchar.
7. location varchar, .
8. stateAbbrev varchar, MA, NY, MI (州名). state_lookup.
9. zip varchar. 02109.
10. parsed (boolean). normalize_address.
11. zip4 last 4 digits of a 9 digit zip code. Availability: PostGIS 2.4.0.
12. address_alphanumeric Full street number even if it has alpha characters like 17R. Parsing of this is better using [Pgcn Normalize Address](#) function. Availability: PostGIS 2.4.0.

. [Pprint_Addy](#).

```
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	

[Geocode, Pprint_Addy](#)

12.2.14 Pgcn Normalize Address

Pgcn Normalize Address — , , , norm_addy , tiger_geocoder (TIGER) address_standardizer .

Synopsis

```
norm_addy pgcn_normalize_address(varchar in_address);
```


include strnum range. TIGER, 26 Court Sq. 26 Court St. 26 Court Sq.

TIGER, 26 Court Sq. 26 Court St. 26 Court Sq.

TIGER, NULL

:

- 1. intpt:
2. addy norm_addy(addy)
3. street varchar (1) (1)

Enhanced: 2.4.1 if optional zcta5 dataset is loaded, the reverse_geocode function can resolve to state and zip even if the specific state data is not loaded. Refer to Loader_Generate_Nation_Script for details on loading zcta5 data.

2.0.0

MIT - 77 Massachusetts Ave, Cambridge, MA 02139 - 3, PostgreSQL (上限; upper bound) NULL

```
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 table with columns: st1, st2, st3, cross_streets. Row 1: 67 Massachusetts Ave, Cambridge, MA 02139, Vassar St, 67 - 127 Massachusetts Ave, 32 - 88

```
SELECT pprint_addy(r.addy[1]) As st1, pprint_addy(r.addy[2]) As st2, pprint_addy(r.addy[3]) As st3, array_to_string(r.street, ',') As cross_str FROM reverse_geocode(ST_GeomFromText('POINT(-71.06941 42.34225)',4269)) As r;
```

result

st1	st2	st3	cross_str
5 Bradford St, Boston, MA 02118	49 Waltham St, Boston, MA 02118		Waltham St

Geocode 2

```
SELECT actual_addr, lon, lat, pprint_addy((rg).addy[1]) As int_addr1,
      (rg).street[1] As cross1, (rg).street[2] As cross2
FROM (SELECT address As actual_addr, lon, lat,
      reverse_geocode( ST_SetSRID(ST_Point(lon,lat),4326) ) As rg
      FROM addresses_to_geocode WHERE rating
> -1) As foo;
```

actual_addr	int_addr1	lon	lat	cross1	cross2
529 Main Street, Boston MA, 02129 Boston, MA 02129	Medford St	-71.07181	42.38359	527 Main St,	
77 Massachusetts Avenue, Cambridge, MA 02139 Massachusetts Ave, Cambridge, MA 02139	Vassar St	-71.09428	42.35988	77	
26 Capen Street, Medford, MA Medford, MA 02155	Capen St Tesla Ave	-71.12377	42.41101	9 Edison Ave,	
124 Mount Auburn St, Cambridge, Massachusetts 02138 Rd, Cambridge, MA 02138	Mount Auburn St	-71.12304	42.37328	3 University	
950 Main Street, Worcester, MA 01610 Worcester, MA 01603	Main St	-71.82368	42.24956	3 Maywood St,	Maywood Pl

Pprint_Addy, Pprint_Addy, ST_AsText

12.2.17 Topology_Load_Tiger

Topology_Load_Tiger — PostGIS TIGER

Synopsis

```
text Topology_Load_Tiger(varchar topo_name, varchar region_type, varchar region_id);
```

PostGIS TIGER. , , TIGER , ID , TIGER .

, , ,



Note

此 TIGER 數據集在 PostGIS 3.5.0alpha2 中可用。請參閱 [Chapter 9 Section 2.2.3](#) 以獲取更多資訊。此數據集包含美國所有縣、市鎮、村莊、普查區、以及未編制地區。



Note

此數據集包含美國所有縣、市鎮、村莊、普查區、以及未編制地區。此數據集包含美國所有縣、市鎮、村莊、普查區、以及未編制地區。

參見：

1. topo_name - 此數據集在 PostGIS 3.5.0alpha2 中可用。
2. region_type - 此數據集包含美國所有縣、市鎮、村莊、普查區、以及未編制地區。參見 tiger.place, tiger.county 以獲取更多資訊。
3. region_id - TIGER 唯一 ID(geoid) 參見 tiger.place 中的 plcidfp 欄位。county 參見 tiger.county 中的 cntyidfp 欄位。

2.0.0 數據集。

參見：數據集

數據集 (2249) 數據集 0.25 精度，包含 TIGER 數據。

```

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:

Topology (26986) with precision 0.25, TIGER, county, 25025.

```

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

Example

[CreateTopology](#), [CreateTopoGeom](#), [TopologySummary](#), [ValidateTopology](#)

12.2.18 Set_Geocode_Setting

Set_Geocode_Setting —

Synopsis

text **Set_Geocode_Setting**(text setting_name, text setting_value);

Example

tiger.geocode_settings. [Get_Geocode_Setting](#)

2.1.0

注意: 在 3.5.0alpha2 中

在 **Geocode** 表中, NOTICE 消息将被记录。

```
SELECT set_geocode_setting('debug_geocode_address', 'true') As result;
result
-----
true
```

注意

[Get_Geocode_Setting](#)

Chapter 13

PostGIS Special Functions Index

13.1 PostGIS Aggregate Functions

The functions below are spatial aggregate functions that are used in the same way as SQL aggregate function such as sum and average.

- **CG_3DUnion** - Perform 3D union.
 - **ST_3DExtent** - Aggregate function that returns the 3D bounding box of geometries.
 - **ST_3DUnion** - Perform 3D union.
 - **ST_AsFlatGeobuf** - Return a FlatGeobuf representation of a set of rows.
 - **ST_AsGeobuf** - Return a Geobuf representation of a set of rows.
 - **ST_AsMVT** - Aggregate function returning a MVT representation of a set of rows.
 - **ST_ClusterDBSCAN** - Window function that returns a cluster id for each input geometry using the DBSCAN algorithm.
 - **ST_ClusterIntersecting** - Aggregate function that clusters input geometries into connected sets.
 - **ST_ClusterIntersectingWin** - Window function that returns a cluster id for each input geometry, clustering input geometries into connected sets.
 - **ST_ClusterKMeans** - Window function that returns a cluster id for each input geometry using the K-means algorithm.
 - **ST_ClusterWithin** - Aggregate function that clusters geometries by separation distance.
 - **ST_ClusterWithinWin** - Window function that returns a cluster id for each input geometry, clustering using separation distance.
 - **ST_Collect** - Creates a GeometryCollection or Multi* geometry from a set of geometries.
 - **ST_CoverageInvalidEdges** - Window function that finds locations where polygons fail to form a valid coverage.
 - **ST_CoverageSimplify** - Window function that simplifies the edges of a polygonal coverage.
 - **ST_CoverageUnion** - Computes the union of a set of polygons forming a coverage by removing shared edges.
 - **ST_Extent** - Aggregate function that returns the bounding box of geometries.
-

- **ST_MakeLine** - Returns a line from a set of points.
- **ST_MemUnion** - Aggregate function which unions geometries in a memory-efficient but slower way.
- **ST_Polygonize** - Computes a collection of polygons formed from the linework of a set of geometries.
- **ST_SameAlignment** - Returns true if two lines are parallel, false otherwise. (Returns true if two lines are parallel, false otherwise.)
- **ST_Union** - Computes a geometry representing the point-set union of the input geometries.
- **ST_Union** - Returns the union of two geometries.
- **TopoElementArray_Agg** - Returns a topoelementarray for a set of element_id, type arrays (topoelements).

13.2 PostGIS Window Functions

The functions below are spatial window functions that are used in the same way as SQL window functions such as `row_number()`, `lead()`, and `lag()`. They must be followed by an `OVER()` clause.

- **ST_ClusterDBSCAN** - Window function that returns a cluster id for each input geometry using the DBSCAN algorithm.
- **ST_ClusterIntersectingWin** - Window function that returns a cluster id for each input geometry, clustering input geometries into connected sets.
- **ST_ClusterKMeans** - Window function that returns a cluster id for each input geometry using the K-means algorithm.
- **ST_ClusterWithinWin** - Window function that returns a cluster id for each input geometry, clustering using separation distance.
- **ST_CoverageInvalidEdges** - Window function that finds locations where polygons fail to form a valid coverage.
- **ST_CoverageSimplify** - Window function that simplifies the edges of a polygonal coverage.

13.3 PostGIS SQL-MM Compliant Functions

The functions given below are PostGIS functions that conform to the SQL/MM 3 standard

- **CG_3DArea** - 3D area of a geometry.
- **CG_3DDifference** - 3D difference of two geometries.
- **CG_3DIntersection** - 3D intersection of two geometries.
- **CG_3DUnion** - Perform 3D union.
- **CG_Volume** - 3D volume of a geometry.
- **ST_3DArea** - 3D area of a geometry.
- **ST_3DDWithin** - Tests if two 3D geometries are within a given 3D distance.
- **ST_3DDifference** - 3D difference of two geometries.

- **ST_3DDistance** - 返回两个 3D 几何体 (SRS 指定) 之间的最短距离。
- **ST_3DIntersection** - 返回两个 3D 几何体的交集。
- **ST_3DIntersects** - Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)
- **ST_3DLength** - 返回 3D 几何体的长度。
- **ST_3DPerimeter** - 返回 3D 几何体的周长。
- **ST_3DUnion** - Perform 3D union.
- **ST_AddEdgeModFace** - 添加边并修改面。
- **ST_AddEdgeNewFaces** - 添加边并创建新面。
- **ST_AddIsoEdge** - 添加孤立边 (anode 和 anothernode 指定) 到 alinestring 中。
- **ST_AddIsoNode** - 添加孤立节点 (isolated) 到 ID 指定的几何体中。返回 NULL。
- **ST_Area** - 返回 3D 几何体的面积。
- **ST_AsBinary** - Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- **ST_AsGML** - 返回 GML 2 或 GML 3 格式的几何体。
- **ST_AsText** - 返回 WKT(Well-Known Text) 格式的几何体 (SRID 指定)。
- **ST_Boundary** - 返回几何体的边界。
- **ST_Buffer** - Computes a geometry covering all points within a given distance from a geometry.
- **ST_Centroid** - 返回几何体的质心。
- **ST_ChangeEdgeGeom** - 修改几何体的边。
- **ST_Contains** - Tests if every point of B lies in A, and their interiors have a point in common
- **ST_ConvexHull** - Computes the convex hull of a geometry.
- **ST_CoordDim** - ST_Geometry 的坐标维度。
- **ST_CreateTopoGeo** - 创建 TopoGeo 对象。
- **ST_Crosses** - Tests if two geometries have some, but not all, interior points in common
- **ST_CurveN** - Returns the Nth component curve geometry of a CompoundCurve.
- **ST_CurveToLine** - Converts a geometry containing curves to a linear geometry.
- **ST_Difference** - Computes a geometry representing the part of geometry A that does not intersect geometry B.
- **ST_Dimension** - ST_Geometry 的维度。
- **ST_Disjoint** - Tests if two geometries have no points in common
- **ST_Distance** - 返回两个 3D 几何体 (最长) 之间的距离。

- **ST_EndPoint** - ST_LineString | ST_CircularString
- **ST_Envelope** - (double precision; float8)
- **ST_Equals** - Tests if two geometries include the same set of points
- **ST_ExteriorRing**
- **ST_GMLToSQL** - GML | ST_Geometry | ST_GeomFromGML
- **ST_GeomCollFromText** - Makes a collection Geometry from collection WKT with the given SRID. If SRID is not given, it defaults to 0.
- **ST_GeomFromText** - WKT | ST_Geometry
- **ST_GeomFromWKB** - WKB(Well-Known Binary) | SRID
- **ST_GeometryFromText** - WKT(Well-Known Text) | ST_Geometry | ST_GeomFromText
- **ST_GeometryN** - ST_Geometry
- **ST_GeometryType** - ST_Geometry
- **ST_GetFaceEdges** - aface
- **ST_GetFaceGeometry** - ID
- **ST_InitTopoGeo** - Creates a new topology schema and registers it in the topology.topology table.
- **ST_InteriorRingN**
- **ST_Intersection** - Computes a geometry representing the shared portion of geometries A and B.
- **ST_Intersects** - Tests if two geometries intersect (they have at least one point in common)
- **ST_IsClosed** - LINESTRING | TRUE |
- **ST_IsEmpty** - Tests if a geometry is empty.
- **ST_IsRing** - Tests if a LineString is closed and simple.
- **ST_IsSimple** - TRUE |
- **ST_IsValid** - Tests if a geometry is well-formed in 2D.
- **ST_Length**
- **ST_LineFromText** - SRID | WKT | SRID | 0
- **ST_LineFromWKB** - SRID | WKB | LINESTRING
- **ST_LinestringFromWKB** - SRID | WKB
- **ST_LocateAlong** - Returns the point(s) on a geometry that match a measure value.
- **ST_LocateBetween** - Returns the portions of a geometry that match a measure range.
- **ST_M** - Returns the M coordinate of a Point.
- **ST_MLineFromText** - WKT | ST_MultiLineString

- **ST_MPointFromText** - Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.
- **ST_MPolyFromText** - Makes a MultiPolygon Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.
- **ST_ModEdgeHeal** - Heals two edges by deleting the node connecting them, modifying the first edge and deleting the second edge. Returns the id of the deleted node.
- **ST_ModEdgeSplit** - `ST_ModEdgeSplit(geom, edge_id, new_geom)`, `ST_ModEdgeSplit(geom, edge_id, new_geom, id)`.
- **ST_MoveIsoNode** - Moves an isolated node in a topology from one point to another. If new a point geometry exists as a node an error is thrown. Returns description of move.
- **ST_NewEdgeHeal** - Heals two edges by deleting the node connecting them, deleting both edges, and replacing them with an edge whose direction is the same as the first edge provided.
- **ST_NewEdgesSplit** - `ST_NewEdgesSplit(geom, edge_id, new_geom, 2, new_geom)`, `ST_NewEdgesSplit(geom, edge_id, new_geom, id)`.
- **ST_NumCurves** - Return the number of component curves in a CompoundCurve.
- **ST_NumGeometries** - `ST_NumGeometries(geom)`. `ST_NumGeometries(geom, id)`.
- **ST_NumInteriorRings** - `ST_NumInteriorRings(geom)`.
- **ST_NumPatches** - `ST_NumPatches(geom)`. `ST_NumPatches(geom, id)` NULL `ST_NumPatches(geom, id, id)`.
- **ST_NumPoints** - `ST_NumPoints(ST_LineString geom)` `ST_NumPoints(ST_CircularString geom)`.
- **ST_OrderingEquals** - Tests if two geometries represent the same geometry and have points in the same directional order
- **ST_Overlaps** - Tests if two geometries have the same dimension and intersect, but each has at least one point not in the other
- **ST_PatchN** - `ST_PatchN(ST_Geometry geom, id)`.
- **ST_Perimeter** - Returns the length of the boundary of a polygonal geometry or geography.
- **ST_Point** - Creates a Point with X, Y and SRID values.
- **ST_PointFromText** - `ST_PointFromText(SRID geom WKT geom SRID geom)`. `ST_PointFromText(geom, SRID)`, `ST_PointFromText(geom, SRID, id)`.
- **ST_PointFromWKB** - `ST_PointFromWKB(SRID geom WKB geom)`.
- **ST_PointN** - `ST_PointN(ST_LineString geom)` `ST_PointN(ST_CircularString geom)`.
- **ST_PointOnSurface** - Computes a point guaranteed to lie in a polygon, or on a geometry.
- **ST_Polygon** - Creates a Polygon from a LineString with a specified SRID.
- **ST_PolygonFromText** - Makes a Geometry from WKT with the given SRID. If SRID is not given, it defaults to 0.
- **ST_Relate** - Tests if two geometries have a topological relationship matching an Intersection Matrix pattern, or computes their Intersection Matrix
- **ST_RemEdgeModFace** - Removes an edge, and if the edge separates two faces deletes one face and modifies the other face to cover the space of both.
- **ST_RemEdgeNewFace** - `ST_RemEdgeNewFace(geom, edge_id, new_geom)`, `ST_RemEdgeNewFace(geom, edge_id, new_geom, id)`.

- **ST_RemoveIsoEdge** - Removes an isolated edge and returns description of action. If the edge is not isolated, then an exception is thrown.
- **ST_RemoveIsoNode** - Removes an isolated node and returns description of action. If the node is not isolated, then an exception is thrown.
- **ST_SRID** - Returns the spatial reference identifier for a geometry.
- **ST_StartPoint** - Returns the first point of a LineString.
- **ST_SymDifference** - Computes a geometry representing the portions of geometries A and B that do not intersect.
- **ST_Touches** - Tests if two geometries have at least one point in common, but their interiors do not intersect.
- **ST_Transform** - Return a new geometry with coordinates transformed to a different spatial reference system.
- **ST_Union** - Computes a geometry representing the point-set union of the input geometries.
- **ST_Volume** - Returns the volume of a 3D geometry.
- **ST_WKBToSQL** - WKB(Well-Known Binary) representation of a ST_Geometry object. Returns the SRID of the geometry.
- **ST_WKTToSQL** - WKT(Well-Known Text) representation of a ST_Geometry object. Returns the SRID of the geometry.
- **ST_Within** - Tests if every point of A lies in B, and their interiors have a point in common.
- **ST_X** - Returns the X coordinate of a Point.
- **ST_Y** - Returns the Y coordinate of a Point.
- **ST_Z** - Returns the Z coordinate of a Point.
- **TG_ST_SRID** - Returns the spatial reference identifier for a topogeometry.

13.4 PostGIS Geography Support Functions

The functions and operators given below are PostGIS functions/operators that take as input or return as output a **geography** data type object.



Note

Functions with a (T) are not native geodetic functions, and use a ST_Transform call to and from geometry to do the operation. As a result, they may not behave as expected when going over dateline, poles, and for large geometries or geometry pairs that cover more than one UTM zone. Basic transform - (favoring UTM, Lambert Azimuthal (North/South), and falling back on mercator in worst case scenario)

- **ST_Area** - Returns the area of a geometry.
- **ST_AsBinary** - Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- **ST_AsEWKT** - Returns the WKT(Well-Known Text) representation of a geometry/geography with SRID meta data.
- **ST_AsGML** - Returns the GML 2 or GML 3 representation of a geometry/geography.

- **ST_AsGeoJSON** - Return a geometry or feature in GeoJSON format.
- **ST_AsKML** - GML 2 GML 3
- **ST_AsSVG** - Returns SVG path data for a geometry.
- **ST_AsText** - WKT(Well-Known Text) SRID
- **ST_Azimuth** - 2
- **ST_Buffer** - Computes a geometry covering all points within a given distance from a geometry.
- **ST_Centroid**
- **ST_ClosestPoint** - Returns the 2D point on g1 that is closest to g2. This is the first point of the shortest line from one geometry to the other.
- **ST_CoveredBy** - Tests if every point of A lies in B
- **ST_Covers** - Tests if every point of B lies in A
- **ST_DWithin** - Tests if two geometries are within a given distance
- **ST_Distance** - 3 (longest)
- **ST_GeogFromText** - WKT (GEOGRAPHY) EWKB(EWKB) WKB(WKB)
- **ST_GeogFromWKB** - WKB EWKB(WKB) WKB(WKB)
- **ST_GeographyFromText** - WKT (GEOGRAPHY) EWKB(EWKB) WKB(WKB)
- **=** - Returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B.
- **ST_Intersection** - Computes a geometry representing the shared portion of geometries A and B.
- **ST_Intersects** - Tests if two geometries intersect (they have at least one point in common)
- **ST_Length**
- **ST_LineInterpolatePoint** - Returns a point interpolated along a line at a fractional location.
- **ST_LineInterpolatePoints** - Returns points interpolated along a line at a fractional interval.
- **ST_LineLocatePoint** - Returns the fractional location of the closest point on a line to a point.
- **ST_LineSubstring** - Returns the part of a line between two fractional locations.
- **ST_Perimeter** - Returns the length of the boundary of a polygonal geometry or geography.
- **ST_Project** - Returns a point projected from a start point by a distance and bearing (azimuth).
- **ST_Segmentize** - Returns a modified geometry/geography having no segment longer than a given distance.
- **ST_ShortestLine** - 2
- **ST_Summary**
- **<->** - A B 2
- **&&** - A 2D B 2D TRUE

- **ST_BandNoDataValue** - 返回栅格 NODATA 值的带编号。返回栅格带编号 1 的 NODATA 值。
- **ST_BandPath** - 返回栅格带的路径。bandnum 返回栅格带编号 1 的路径。
- **ST_BandPixelType** - 返回栅格带编号 1 的像素类型。
- **ST_Clip** - 使用指定的裁剪框和裁剪选项对栅格进行裁剪。crop 选项包括 ST_ClipByRect 和 ST_ClipByRectNG。
- **ST_ColorMap** - 返回栅格带的 8BUI 值 (grayscale, RGB, RGBA) 的 4 个颜色映射带编号 1 的栅格。
- **ST_Contains** - 栅格 rastA 是否包含栅格 rastB。栅格 rastB 是否包含栅格 rastA 的栅格。
- **ST_ContainsProperly** - rastB 是否包含在 rastA 的栅格内部。
- **ST_Contour** - Generates a set of vector contours from the provided raster band, using the GDAL contouring algorithm.
- **ST_ConvexHull** - BandNoDataValue 返回栅格带的凸包。返回栅格带的凸包，ST_Envelope 返回栅格带的边界框。
- **ST_Count** - 返回栅格带中非 NODATA 值的数量。返回栅格带中非 NODATA 值的数量 1 的栅格。exclude_nodata_value 返回栅格带的 NODATA 值的数量。
- **ST_CountAgg** - 返回栅格带的聚合值。返回栅格带的聚合值 1 的栅格。exclude_nodata_value 返回栅格带的 NODATA 值的数量。
- **ST_CoveredBy** - 栅格 rastA 是否被栅格 rastB 覆盖。
- **ST_Covers** - 栅格 rastB 是否覆盖栅格 rastA。
- **ST_DFullyWithin** - 栅格 rastA 是否完全在栅格 rastB 的指定距离内。
- **ST_DWithin** - 栅格 rastA 是否在栅格 rastB 的指定距离内。
- **ST_Disjoint** - 栅格 rastA 是否与栅格 rastB 不相交。
- **ST_DumpAsPolygons** - 返回栅格带的多边形。geomval(geom, val) 返回栅格带的多边形。返回栅格带的多边形 1 的栅格。
- **ST_DumpValues** - 返回栅格带的值。返回栅格带的值 2 的栅格。
- **ST_Envelope** - 返回栅格带的边界框。
- **ST_FromGDALRaster** - 从 GDAL 栅格创建 PostGIS 栅格。
- **ST_GeoReference** - 栅格 (world) 是否地理参考。返回栅格是否地理参考 GDAL 栅格 ESRI 栅格。返回栅格是否地理参考 GDAL 栅格。
- **ST_Grayscale** - Creates a new one-8BUI band raster from the source raster and specified bands representing Red, Green and Blue
- **ST_HasNoBand** - 返回栅格是否没有带。返回栅格是否没有带 1 的栅格。
- **ST_Height** - 返回栅格带的高度。

- **ST_HillShade** - 计算栅格的地形阴影，使用输入栅格中的高程值。需要指定光照的方向。
- **ST_Histogram** - 计算栅格的直方图。需要指定栅格的名称、列名、bin 大小和聚合函数。
- **ST_InterpolateRaster** - 基于输入点集插值生成栅格表面。使用 X 和 Y 值定位点，Z 值作为表面高程。
- **ST_Intersection** - 计算两个栅格的交集。返回与两个输入栅格具有相同 SRID 的栅格。
- **ST_Intersects** - 检查两个栅格是否相交。返回布尔值。
- **ST_IsEmpty** - 检查栅格是否为空（width = 0, height = 0）。返回布尔值。
- **ST_MakeEmptyCoverage** - 用空栅格瓦片覆盖地理参考区域。
- **ST_MakeEmptyRaster** - 创建空栅格。需要指定宽度、高度、SRID、比例尺、偏斜和瓦片大小。
- **ST_MapAlgebra (callback function version)** - 使用回调函数对两个栅格进行逐像素操作。
- **ST_MapAlgebraExpr** - 使用 PostgreSQL 表达式对两个栅格进行逐像素操作。
- **ST_MapAlgebraExpr** - 使用 PostgreSQL 表达式对两个栅格进行逐像素操作，并指定扩展类型。
- **ST_MapAlgebraFct** - 使用 PostgreSQL 函数对两个栅格进行逐像素操作。
- **ST_MapAlgebraFct** - 使用 PostgreSQL 函数对两个栅格进行逐像素操作，并指定扩展类型。
- **ST_MapAlgebraFctNgb** - 使用 PostgreSQL 函数对两个栅格进行逐像素操作，并指定邻域。
- **ST_MapAlgebra (expression version)** - 使用 PostgreSQL 表达式对两个栅格进行逐像素操作。
- **ST_MemSize** - 计算栅格的内存大小。
- **ST_MetaData** - 获取栅格的元数据，包括偏斜、比例尺和瓦片大小。
- **ST_MinConvexHull** - 计算栅格的最小凸包。
- **ST_NearestValue** - 计算栅格中最近非空单元的值。
- **ST_Neighborhood** - 计算栅格的邻域。

- **ST_NotSameAlignmentReason** - Returns the reason why two rasters do not have the same alignment.
- **ST_NumBands** - Returns the number of bands in a raster.
- **ST_Overlaps** - Returns true if two rasters overlap. `rastA` and `rastB` are the rasters to be compared.
- **ST_PixelAsCentroid** - Returns the centroid of a pixel in a raster.
- **ST_PixelAsCentroids** - Returns a table of centroids for each pixel in a raster. Columns: `x`, `y`.
- **ST_PixelAsPoint** - Returns a point for each pixel in a raster.
- **ST_PixelAsPoints** - Returns a table of points for each pixel in a raster. Columns: `x`, `y`.
- **ST_PixelAsPolygon** - Returns a polygon for each pixel in a raster.
- **ST_PixelAsPolygons** - Returns a table of polygons for each pixel in a raster. Columns: `x`, `y`.
- **ST_PixelHeight** - Returns the height of a pixel in a raster.
- **ST_PixelOfValue** - Returns the column and row of a pixel with a specific value. Columns: `columnx`, `rowy`.
- **ST_PixelWidth** - Returns the width of a pixel in a raster.
- **ST_Polygon** - Returns a polygon for a NODATA pixel in a raster.
- **ST_Quantile** - Returns the quantile of a raster. Parameters: `population`, `quantile`. Example: `25%`, `50%`, `75%` (percentile).
- **ST_RastFromHexWKB** - Return a raster value from a Hex representation of Well-Known Binary (WKB) raster.
- **ST_RastFromWKB** - Return a raster value from a Well-Known Binary (WKB) raster.
- **ST_RasterToWorldCoord** - Returns the world coordinates (X, Y) for a pixel in a raster. Column: `1`.
- **ST_RasterToWorldCoordX** - Returns the X world coordinate for a pixel in a raster. Column: `1`.
- **ST_RasterToWorldCoordY** - Returns the Y world coordinate for a pixel in a raster. Column: `1`.
- **ST_Reclass** - Reclassify a raster. Parameters: `nband`, `1`.
- **ST_Resample** - Resample a raster. Parameters: `16BUI`, `8BUI`.
- **ST_Rescale** - Resample a raster by adjusting only its scale (or pixel size). New pixel values are computed using the NearestNeighbor (english or american spelling), Bilinear, Cubic, CubicSpline, Lanczos, Max or Min resampling algorithm. Default is NearestNeighbor.
- **ST_Resize** - Resize a raster.
- **ST_Reskew** - Reskew a raster. Parameters: `NearestNeighbor`, `Bilinear`, `Cubic`, `CubicSpline`, `Lanczos`, `NearestNeighbor`.

- **ST_Rotation** - 返回指定栅格的旋转角度。
- **ST_Roughness** - DEM 栅格的“粗糙度” (roughness) 值。
- **ST_SRID** - spatial_ref_sys 表中的 SRID 值。
- **ST_SameAlignment** - 检查两个栅格是否具有相同的对齐方式 (即是否都是行优先或列优先)。
- **ST_ScaleX** - 返回栅格的 X 轴缩放比例。
- **ST_ScaleY** - 返回栅格的 Y 轴缩放比例。
- **ST_SetBandIndex** - Update the external band number of an out-db band
- **ST_SetBandIsNoData** - 设置 isnodata 标志。
- **ST_SetBandNoDataValue** - NODATA 值。如果为 1，则 NODATA 值 = NULL。
- **ST_SetBandPath** - Update the external path and band number of an out-db band
- **ST_SetGeoReference** - 设置栅格的地理参考信息 (GDAL ESRI 格式)。
- **ST_SetM** - Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the M dimension using the requested resample algorithm.
- **ST_SetRotation** - 设置栅格的旋转角度。
- **ST_SetSRID** - 设置 SRID 值。
- **ST_SetScale** - X 和 Y 轴缩放比例。
- **ST_SetSkew** - 设置 X 和 Y 轴的偏斜 (skew) 值。
- **ST_SetUpperLeft** - Sets the value of the upper left corner of the pixel of the raster to projected X and Y coordinates.
- **ST_SetValue** - 设置指定行列 (columnx, rowy) 的像素值。
- **ST_SetValues** - 设置指定行列范围的像素值。
- **ST_SetZ** - Returns a geometry with the same X/Y coordinates as the input geometry, and values from the raster copied into the Z dimension using the requested resample algorithm.
- **ST_SkewX** - 设置 X 轴的偏斜 (skew) 值。
- **ST_SkewY** - 设置 Y 轴的偏斜 (skew) 值。
- **ST_Slope** - 计算栅格的坡度 (slope)。
- **ST_SnapToGrid** - 将栅格对齐到指定的栅格。NearestNeighbor, Bilinear, Cubic, CubicSpline, Lanczos, NearestNeighbor。
- **ST_Summary** - 返回栅格的摘要信息。
- **ST_SummaryStats** - 返回栅格的统计信息 (count, sum, mean, stddev, min, max)。
- **ST_SummaryStatsAgg** - 聚合统计信息 (count, sum, mean, stddev, min, max)。

- **ST_TPI** - (Topographic Position Index)
- **ST_TRI** - (Terrain Ruggedness Index)
- **ST_Tile** -
- **ST_Touches** - rastA rastB, TRUE
- **ST_Transform** - NearestNeighbor, Bilinear, Cubic, CubicSpline, Lanczos. NearestNeighbor
- **ST_Union** - 1
- **ST_UpperLeftX** - X
- **ST_UpperLeftY** - Y
- **ST_Value** - columnx, rowy, exclude_nodata_value, nodata
- **ST_ValueCount** - (frequency) 1 NODATA
- **ST_Width** -
- **ST_Within** - rastB rastA, rastA rastB
- **ST_WorldToRasterCoord** - X, Y(xw, yw)
- **ST_WorldToRasterCoordX** - (pt) X, Y(xw, yw)
- **ST_WorldToRasterCoordY** - (pt) X, Y(xw, yw)
- **UpdateRasterSRID** - SRID

13.6 PostGIS Geometry / Geography / Raster Dump Functions

The functions given below are PostGIS functions that take as input or return as output a set of or single **geometry_dump** or **geomval** data type object.

- **ST_DumpAsPolygons** - geomval(geom, val)
- **ST_Intersection** -
- **ST_Dump** - Returns a set of geometry_dump rows for the components of a geometry.
- **ST_DumpPoints** -
- **ST_DumpRings** - Returns a set of geometry_dump rows for the exterior and interior rings of a Polygon.
- **ST_DumpSegments** -

13.7 PostGIS Box Functions

The functions given below are PostGIS functions that take as input or return as output the box* family of PostGIS spatial types. The box family of types consists of **box2d**, and **box3d**

- **Box2D** - Returns a BOX2D representing the 2D extent of a geometry.
- **Box3D** - Returns a BOX3D representing the 3D extent of a geometry.
- **Box3D** - `BOX3D`
- **ST_3DExtent** - Aggregate function that returns the 3D bounding box of geometries.
- **ST_3DMakeBox** - Creates a BOX3D defined by two 3D point geometries.
- **ST_AsMVTGeom** - Transforms a geometry into the coordinate space of a MVT tile.
- **ST_AsTWKB** - `TWKB`(Tiny Well-Known Binary)
- **ST_Box2dFromGeoHash** - GeoHash `BOX2D`
- **ST_ClipByBox2D** - Computes the portion of a geometry falling within a rectangle.
- **ST_EstimatedExtent** - Returns the estimated extent of a spatial table.
- **ST_Expand** - Returns a bounding box expanded from another bounding box or a geometry.
- **ST_Extent** - Aggregate function that returns the bounding box of geometries.
- **ST_MakeBox2D** - Creates a BOX2D defined by two 2D point geometries.
- **ST_RemoveIrrelevantPointsForView** - Removes points that are irrelevant for rendering a specific rectangular view of a geometry.
- **ST_XMax** - Returns the X maxima of a 2D or 3D bounding box or a geometry.
- **ST_XMin** - Returns the X minima of a 2D or 3D bounding box or a geometry.
- **ST_YMax** - Returns the Y maxima of a 2D or 3D bounding box or a geometry.
- **ST_YMin** - Returns the Y minima of a 2D or 3D bounding box or a geometry.
- **ST_ZMax** - Returns the Z maxima of a 2D or 3D bounding box or a geometry.
- **ST_ZMin** - Returns the Z minima of a 2D or 3D bounding box or a geometry.
- **RemoveUnusedPrimitives** - Removes topology primitives which not needed to define existing Topo-Geometry objects.
- **ValidateTopology** - Returns a set of `validatetopology_returntype` objects detailing issues with topology.
- **~(box2df,box2df)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).
- **~(box2df,geometry)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bonding box.
- **~(geometry,box2df)** - Returns TRUE if a geometry's 2D bonding box contains a 2D float precision bounding box (BOX2DF).
- **@(box2df,box2df)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.

- **@(box2df,geometry)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.
- **@(geometry,box2df)** - Returns TRUE if a geometry's 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).
- **&&(box2df,box2df)** - Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.
- **&&(box2df,geometry)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.
- **&&(geometry,box2df)** - Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).

13.8 PostGIS Functions that support 3D

The functions given below are PostGIS functions that do not throw away the Z-Index.

- **AddGeometryColumn** - Add a geometry column to a table.
- **Box3D** - Returns a BOX3D representing the 3D extent of a geometry.
- **CG_3DArea** - 3D area of a geometry. Returns 0 for non-polygons.
- **CG_3DConvexHull** - 3D convex hull of a geometry.
- **CG_3DDifference** - 3D difference of two geometries.
- **CG_3DIntersection** - 3D intersection of two geometries.
- **CG_3DUnion** - Perform 3D union.
- **CG_ApproximateMedialAxis** - Approximate medial axis of a geometry.
- **CG_ConstrainedDelaunayTriangles** - Return a constrained Delaunay triangulation around the given input geometry.
- **CG_Extrude** - Extrude a 2D geometry into 3D.
- **CG_ForceLHR** - LHR(Left Hand Reverse; `force_lhr`) flag for `CG_3DUnion`.
- **CG_IsPlanar** - Check if a 3D geometry is planar.
- **CG_IsSolid** - Check if a 3D geometry is a solid.
- **CG_MakeSolid** - Make a 3D geometry a solid. Returns NULL if the input is not a TIN.
- **CG_Orientation** - Orientation (orientation) of a 3D geometry.
- **CG_StraightSkeleton** - Straight skeleton (straight skeleton) of a 3D geometry.
- **CG_Tessellate** - Tessellation (tessellation) of a 3D geometry into TINs.
- **CG_Visibility** - Compute a visibility polygon from a point or a segment in a polygon geometry.
- **CG_Volume** - 3D volume of a geometry. Returns 0 for non-polyhedrons.
- **DropGeometryColumn** - Drop a geometry column from a table.
- **GeometryType** - ST_GeometryType function.

- **ST_3DArea** - 3D area of a geometry. Returns 0 for non-3D geometries.
- **ST_3DClosestPoint** - g2 3D closest point to g1 3D geometry. Returns 3D geometry.
- **ST_3DConvexHull** - 3D convex hull of a geometry.
- **ST_3DDFullyWithin** - Tests if two 3D geometries are entirely within a given 3D distance
- **ST_3DDWithin** - Tests if two 3D geometries are within a given 3D distance
- **ST_3DDifference** - 3D difference of two geometries.
- **ST_3DDistance** - 3D distance between two geometries (SRS optional) 3D distance.
- **ST_3DExtent** - Aggregate function that returns the 3D bounding box of geometries.
- **ST_3DIntersection** - 3D intersection of two geometries.
- **ST_3DIntersects** - Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)
- **ST_3DLength** - 3D length of a geometry.
- **ST_3DLineInterpolatePoint** - Returns a point interpolated along a 3D line at a fractional location.
- **ST_3DLongestLine** - 3D longest line (longest) of a geometry.
- **ST_3DMaxDistance** - 3D maximum distance between two geometries (SRS optional) 3D maximum distance.
- **ST_3DPerimeter** - 3D perimeter of a geometry.
- **ST_3DShortestLine** - 3D shortest line (shortest) of a geometry.
- **ST_3DUnion** - Perform 3D union.
- **ST_AddMeasure** - Interpolates measures along a linear geometry.
- **ST_AddPoint** - 3D add point to a geometry.
- **ST_Affine** - Apply a 3D affine transformation to a geometry.
- **ST_ApproximateMedialAxis** - 3D approximate medial axis of a geometry.
- **ST_AsBinary** - Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- **ST_AsEWKB** - Return the Extended Well-Known Binary (EWKB) representation of the geometry with SRID meta data.
- **ST_AsEWKT** - 3D WKT(Well-Known Text) with SRID 3D WKT.
- **ST_AsGML** - 3D GML 2 or GML 3 3D GML.
- **ST_AsGeoJSON** - Return a geometry or feature in GeoJSON format.
- **ST_AsHEXEWKB** - 3D (NDR) 3D (XDR) 3D HEXEWKB (3D) 3D 3D.
- **ST_AsKML** - 3D GML 2 or GML 3 3D KML.
- **ST_AsX3D** - 3D X3D XML 3D X3D: ISO-IEC-19776-1.2-X3DEncodings-XML 3D X3D.
- **ST_Boundary** - 3D boundary of a geometry.

- **ST_BoundingDiagonal** - Returns the bounding diagonal of a geometry.
- **ST_CPAWithin** - Tests if the closest point of approach of two trajectories is within the specified distance.
- **ST_ChaikinSmoothing** - Returns a smoothed version of a geometry, using the Chaikin algorithm.
- **ST_ClosestPointOfApproach** - Returns a measure at the closest point of approach of two trajectories.
- **ST_Collect** - Creates a GeometryCollection or Multi* geometry from a set of geometries.
- **ST_ConstrainedDelaunayTriangles** - Return a constrained Delaunay triangulation around the given input geometry.
- **ST_ConvexHull** - Computes the convex hull of a geometry.
- **ST_CoordDim** - ST_Geometry dimension.
- **ST_CurveN** - Returns the Nth component curve geometry of a CompoundCurve.
- **ST_CurveToLine** - Converts a geometry containing curves to a linear geometry.
- **ST_DelaunayTriangles** - Returns the Delaunay triangulation of the vertices of a geometry.
- **ST_Difference** - Computes a geometry representing the part of geometry A that does not intersect geometry B.
- **ST_DistanceCPA** - Returns the distance between the closest point of approach of two trajectories.
- **ST_Dump** - Returns a set of geometry_dump rows for the components of a geometry.
- **ST_DumpPoints** - Returns a set of geometry_dump rows for the points of a geometry.
- **ST_DumpRings** - Returns a set of geometry_dump rows for the exterior and interior rings of a Polygon.
- **ST_DumpSegments** - Returns a set of geometry_dump rows for the segments of a geometry.
- **ST_EndPoint** - ST_LineString endpoint; ST_CircularString endpoint.
- **ST_ExteriorRing** - Returns the exterior ring of a polygon.
- **ST_Extrude** - Extrudes a 2D geometry into 3D.
- **ST_FlipCoordinates** - Returns a version of a geometry with X and Y axis flipped.
- **ST_Force2D** - Forces a geometry to be 2D.
- **ST_ForceCurve** - Forces a geometry to be a curve.
- **ST_ForceLHR** - LHR(Left Hand Reverse; counter-clockwise) orientation.
- **ST_ForcePolygonCCW** - Orients all exterior rings counter-clockwise and all interior rings clockwise.
- **ST_ForcePolygonCW** - Orients all exterior rings clockwise and all interior rings counter-clockwise.
- **ST_ForceRHR** - RHR(Right Hand Rule; clockwise) orientation.
- **ST_ForceSFS** - SFS 1.1 standard.
- **ST_Force_3D** - Forces a geometry to be 3D. ST_Force3DZ forces Z coordinate.
- **ST_Force_3DZ** - Forces a geometry to be 3D with Z coordinate.
- **ST_Force_4D** - Forces a geometry to be 4D with Z and M coordinates.
- **ST_Force_Collection** - Forces a geometry to be a collection.

- **ST_GeomFromEWKB** - EWKB(Extended Well-Known Binary) ST_Geometry.
- **ST_GeomFromEWKT** - EWKT(Extended Well-Known Text) ST_Geometry.
- **ST_GeomFromGML** - GML PostGIS.
- **ST_GeomFromGeoJSON** - GeoJSON PostGIS.
- **ST_GeomFromKML** - KML PostGIS.
- **ST_GeometricMedian** - (median).
- **ST_GeometryN** - ST_Geometry.
- **ST_GeometryType** - ST_Geometry.
- **ST_HasArc** - Tests if a geometry contains a circular arc
- **ST_HasM** - Checks if a geometry has an M (measure) dimension.
- **ST_HasZ** - Checks if a geometry has a Z dimension.
- **ST_InteriorRingN** -.
- **ST_InterpolatePoint** - (M) .
- **ST_Intersection** - Computes a geometry representing the shared portion of geometries A and B.
- **ST_IsClosed** - LINESTRING TRUE. () TRUE.
- **ST_IsCollection** - , , TRUE.
- **ST_IsPlanar** -.
- **ST_IsPolygonCCW** - Tests if Polygons have exterior rings oriented counter-clockwise and interior rings oriented clockwise.
- **ST_IsPolygonCW** - Tests if Polygons have exterior rings oriented clockwise and interior rings oriented counter-clockwise.
- **ST_IsSimple** - TRUE.
- **ST_IsSolid** -.
- **ST_IsValidTrajectory** - Tests if the geometry is a valid trajectory.
- **ST_Length_Spheroid** -.
- **ST_LineFromMultiPoint** -.
- **ST_LineInterpolatePoint** - Returns a point interpolated along a line at a fractional location.
- **ST_LineInterpolatePoints** - Returns points interpolated along a line at a fractional interval.
- **ST_LineSubstring** - Returns the part of a line between two fractional locations.
- **ST_LineToCurve** - Converts a linear geometry to a curved geometry.
- **ST_LocateBetweenElevations** - Returns the portions of a geometry that lie in an elevation (Z) range.
- **ST_M** - Returns the M coordinate of a Point.
- **ST_MakeLine** - , .
- **ST_MakePoint** - Creates a 2D, 3DZ or 4D Point.

- **ST_MakePolygon** - Creates a Polygon from a shell and optional list of holes.
- **ST_MakeSolid** - `ST_MakeSolid(geometry, tolerance)`. `ST_MakeSolid(geometry, tolerance, TIN)`.
- **ST_MakeValid** - Attempts to make an invalid geometry valid without losing vertices.
- **ST_MemSize** - `ST_MemSize(geometry)`.
- **ST_MemUnion** - Aggregate function which unions geometries in a memory-efficient but slower way.
- **ST_NDims** - `ST_NDims(geometry)`.
- **ST_NPoints** - `ST_NPoints(geometry)` (`geometry`) `ST_NPoints(geometry)`.
- **ST_NRings** - `ST_NRings(geometry)`.
- **ST_Node** - Nodes a collection of lines.
- **ST_NumCurves** - Return the number of component curves in a CompoundCurve.
- **ST_NumGeometries** - `ST_NumGeometries(geometry)`. `ST_NumGeometries(geometry)`.
- **ST_NumPatches** - `ST_NumPatches(geometry)`. `ST_NumPatches(geometry) NULL`.
- **ST_Orientation** - `ST_Orientation(geometry)` (orientation) `ST_Orientation(geometry)`.
- **ST_PatchN** - `ST_PatchN(geometry)`.
- **ST_PointFromWKB** - `ST_PointFromWKB(SRID, WKB)`.
- **ST_PointN** - `ST_PointN(geometry, n)` `ST_PointN(geometry, n)`.
- **ST_PointOnSurface** - Computes a point guaranteed to lie in a polygon, or on a geometry.
- **ST_Points** - `ST_Points(geometry)`.
- **ST_Polygon** - Creates a Polygon from a LineString with a specified SRID.
- **ST_RemovePoint** - Remove a point from a linestring.
- **ST_RemoveRepeatedPoints** - Returns a version of a geometry with duplicate points removed.
- **ST_Reverse** - `ST_Reverse(geometry)`.
- **ST_Rotate** - Rotates a geometry about an origin point.
- **ST_RotateX** - Rotates a geometry about the X axis.
- **ST_RotateY** - Rotates a geometry about the Y axis.
- **ST_RotateZ** - Rotates a geometry about the Z axis.
- **ST_Scale** - Scales a geometry by given factors.
- **ST_Scroll** - Change start point of a closed LineString.
- **ST_SetPoint** - `ST_SetPoint(geometry, point, index)`.
- **ST_ShiftLongitude** - Shifts the longitude coordinates of a geometry between -180..180 and 0..360.
- **ST_SnapToGrid** - `ST_SnapToGrid(geometry, snap)`.
- **ST_StartPoint** - Returns the first point of a LineString.
- **ST_StraightSkeleton** - `ST_StraightSkeleton(geometry)` (straight skeleton) `ST_StraightSkeleton(geometry)`.
- **ST_SwapOrdinates** - `ST_SwapOrdinates(geometry)`.

- **ST_SymDifference** - Computes a geometry representing the portions of geometries A and B that do not intersect.
 - **ST_Tessellate** - (tessellation) TIN TIN.
 - **ST_TransScale** - Translates and scales a geometry by given offsets and factors.
 - **ST_Translate** - Translates a geometry by given offsets.
 - **ST_UnaryUnion** - Computes the union of the components of a single geometry.
 - **ST_Union** - Computes a geometry representing the point-set union of the input geometries.
 - **ST_Volume** - 3 (0).
 - **ST_WrapX** - X.
 - **ST_X** - Returns the X coordinate of a Point.
 - **ST_XMax** - Returns the X maxima of a 2D or 3D bounding box or a geometry.
 - **ST_XMin** - Returns the X minima of a 2D or 3D bounding box or a geometry.
 - **ST_Y** - Returns the Y coordinate of a Point.
 - **ST_YMax** - Returns the Y maxima of a 2D or 3D bounding box or a geometry.
 - **ST_YMin** - Returns the Y minima of a 2D or 3D bounding box or a geometry.
 - **ST_Z** - Returns the Z coordinate of a Point.
 - **ST_ZMax** - Returns the Z maxima of a 2D or 3D bounding box or a geometry.
 - **ST_ZMin** - Returns the Z minima of a 2D or 3D bounding box or a geometry.
 - **ST_Zmflag** - ST_Geometry.
 - **TG_Equals** - TopoGeometry.
 - **TG_Intersects** - TopoGeometry.
 - **UpdateGeometrySRID** - Updates the SRID of all features in a geometry column, and the table meta-data.
 - **geometry_overlaps_nd** - A n B n TRUE.
 - **overlaps_nd_geometry_gidx** - Returns TRUE if a geometry's (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).
 - **overlaps_nd_gidx_geometry** - Returns TRUE if a n-D float precision bounding box (GIDX) intersects a geometry's (cached) n-D bounding box.
 - **overlaps_nd_gidx_gidx** - Returns TRUE if two n-D float precision bounding boxes (GIDX) intersect each other.
-

- **ST_Force2D** - Forces 2D geometry.
- **ST_ForceCurve** - Forces geometry to be a curve (upcast).
- **ST_ForceSFS** - Forces geometry to SFS 1.1.
- **ST_Force3D** - Forces XYZ geometry. **ST_Force3DZ** forces Z.
- **ST_Force3DM** - Forces XYM geometry.
- **ST_Force3DZ** - Forces XYZ geometry.
- **ST_Force4D** - Forces XYZM geometry.
- **ST_ForceCollection** - Forces geometry to be a collection.
- **ST_GeoHash** - Returns GeoHash for geometry.
- **ST_GeogFromWKB** - WKB to EWKB (Extended WKB).
- **ST_GeomFromEWKB** - EWKB(Extended Well-Known Binary) to ST_Geometry.
- **ST_GeomFromEWKT** - EWKT(Extended Well-Known Text) to ST_Geometry.
- **ST_GeomFromText** - WKT to ST_Geometry.
- **ST_GeomFromWKB** - WKB(Well-Known Binary) to ST_Geometry with SRID.
- **ST_GeometryN** - Returns Nth geometry from a collection.
- **=** - Returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B.
- **&<|** - Returns TRUE if geometry A is contained within geometry B.
- **ST_HasArc** - Tests if a geometry contains a circular arc.
- **ST_Intersects** - Tests if two geometries intersect (they have at least one point in common).
- **ST_IsClosed** - Tests if a LINESTRING is closed.
- **ST_IsCollection** - Tests if a geometry is a collection.
- **ST_IsEmpty** - Tests if a geometry is empty.
- **ST_LineToCurve** - Converts a linear geometry to a curved geometry.
- **ST_MemSize** - Returns memory size of a geometry.
- **ST_NPoints** - Returns number of points in a geometry.
- **ST_NRings** - Returns number of rings in a geometry.
- **ST_PointFromWKB** - WKB to ST_Point.
- **ST_PointN** - Returns Nth point from a geometry.
- **ST_Points** - Returns array of points from a geometry.
- **ST_Rotate** - Rotates a geometry about an origin point.
- **ST_RotateZ** - Rotates a geometry about the Z axis.
- **ST_SRID** - Returns the spatial reference identifier for a geometry.





- **ST_Scale** - Scales a geometry by given factors.
- **ST_SetSRID** - Set the SRID on a geometry.
- **ST_StartPoint** - Returns the first point of a LineString.
- **ST_Summary** - `ST_Summary(geometry)`.
- **ST_SwapOrdinates** - `ST_SwapOrdinates(geometry)`.
- **ST_TransScale** - Translates and scales a geometry by given offsets and factors.
- **ST_Transform** - Return a new geometry with coordinates transformed to a different spatial reference system.
- **ST_Translate** - Translates a geometry by given offsets.
- **ST_XMax** - Returns the X maxima of a 2D or 3D bounding box or a geometry.
- **ST_XMin** - Returns the X minima of a 2D or 3D bounding box or a geometry.
- **ST_YMax** - Returns the Y maxima of a 2D or 3D bounding box or a geometry.
- **ST_YMin** - Returns the Y minima of a 2D or 3D bounding box or a geometry.
- **ST_ZMax** - Returns the Z maxima of a 2D or 3D bounding box or a geometry.
- **ST_ZMin** - Returns the Z minima of a 2D or 3D bounding box or a geometry.
- **ST_Zmflag** - `ST_Zmflag(geometry)`.
- **UpdateGeometrySRID** - Updates the SRID of all features in a geometry column, and the table meta-data.
- **~(box2df,box2df)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).
- **~(box2df,geometry)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bonding box.
- **~(geometry,box2df)** - Returns TRUE if a geometry's 2D bonding box contains a 2D float precision bounding box (GIDX).
- **&&** - `A && B` - A 2D BOX2DF B 2D BOX2DF TRUE BOX2DF.
- **&&&** - `A &&& B` - A n BOX2DF B n BOX2DF TRUE BOX2DF.
- **@(box2df,box2df)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.
- **@(box2df,geometry)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.
- **@(geometry,box2df)** - Returns TRUE if a geometry's 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).
- **&&(box2df,box2df)** - Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.
- **&&(box2df,geometry)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.
- **&&(geometry,box2df)** - Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).
- **&&&(geometry,gidx)** - Returns TRUE if a geometry's (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).

- **ST_Points** - Returns a set of points from a geometry.
- **ST_Rotate** - Rotates a geometry about an origin point.
- **ST_RotateZ** - Rotates a geometry about the Z axis.
- **ST_SRID** - Returns the spatial reference identifier for a geometry.
- **ST_Scale** - Scales a geometry by given factors.
- **ST_SetSRID** - Set the SRID on a geometry.
- **ST_StartPoint** - Returns the first point of a LineString.
- **ST_Summary** - Returns a text summary of a geometry.
- **ST_SwapOrdinates** - Swaps the X and Y ordinates of a geometry.
- **ST_TransScale** - Translates and scales a geometry by given offsets and factors.
- **ST_Transform** - Return a new geometry with coordinates transformed to a different spatial reference system.
- **ST_Translate** - Translates a geometry by given offsets.
- **ST_XMax** - Returns the X maxima of a 2D or 3D bounding box or a geometry.
- **ST_XMin** - Returns the X minima of a 2D or 3D bounding box or a geometry.
- **ST_YMax** - Returns the Y maxima of a 2D or 3D bounding box or a geometry.
- **ST_YMin** - Returns the Y minima of a 2D or 3D bounding box or a geometry.
- **ST_ZMax** - Returns the Z maxima of a 2D or 3D bounding box or a geometry.
- **ST_ZMin** - Returns the Z minima of a 2D or 3D bounding box or a geometry.
- **ST_Zmflag** - ST_Geometry returns TRUE if the geometry is 3D.
- **UpdateGeometrySRID** - Updates the SRID of all features in a geometry column, and the table metadata.
- **~(box2df,box2df)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).
- **~(box2df,geometry)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bounding box.
- **~(geometry,box2df)** - Returns TRUE if a geometry's 2D bounding box contains a 2D float precision bounding box (BOX2DF).
- **&&** - A 2D bounding box B contains A TRUE if A is within B.
- **&&&** - A n-dimensional bounding box B contains A n-dimensional bounding box A TRUE if A is within B.
- **@(box2df,box2df)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.
- **@(box2df,geometry)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.
- **@(geometry,box2df)** - Returns TRUE if a geometry's 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).
- **&&(box2df,box2df)** - Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.

- **&&(box2df,geometry)** - Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.
- **&&(geometry,box2df)** - Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).
- **&&&(geometry,gidx)** - Returns TRUE if a geometry's (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).
- **&&&(gidx,geometry)** - Returns TRUE if a n-D float precision bounding box (GIDX) intersects a geometry's (cached) n-D bounding box.
- **&&&(gidx,gidx)** - Returns TRUE if two n-D float precision bounding boxes (GIDX) intersect each other.

13.11 PostGIS Function Support Matrix

Below is an alphabetical listing of spatial specific functions in PostGIS and the kinds of spatial types they work with or OGC/SQL compliance they try to conform to.

- A  means the function works with the type or subtype natively.
- A  means it works but with a transform cast built-in using cast to geometry, transform to a "best srid" spatial ref and then cast back. Results may not be as expected for large areas or areas at poles and may accumulate floating point junk.
- A  means the function works with the type because of a auto-cast to another such as to box3d rather than direct type support.
- A  means the function only available if PostGIS compiled with SFCGAL support.
- geom - Basic 2D geometry support (x,y).
- geog - Basic 2D geography support (x,y).
- 2.5D - basic 2D geometries in 3 D/4D space (has Z or M coord).
- PS - Polyhedral surfaces
- T - Triangles and Triangulated Irregular Network surfaces (TIN)

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_Collect	✓		✓	✓			
ST_LineFromMPoint	✓		✓				
ST_MakeEnvelope	✓						
ST_MakeLine	✓		✓				
ST_MakePoint	✓		✓				
ST_MakePointM	✓						
ST_MakePolygon	✓		✓				
ST_Point	✓				✓		

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_PointZ	✓						
ST_PointM	✓						
ST_PointZM	✓						
ST_Polygon	✓		✓		✓		
ST_TileEnvelope	✓						
ST_HexagonGrid	✓						
ST_Hexagon	✓						
ST_SquareGrid	✓						
ST_Square	✓						
ST_Letters	✓						
GeometryType	✓		✓	✓		✓	✓
ST_Boundary	✓		✓		✓		
ST_BoundingDiagonal	✓		✓				
ST_CoordDim	✓		✓	✓	✓	✓	✓
ST_Dimension	✓				✓	✓	✓
ST_Dump	✓		✓	✓		✓	✓
ST_DumpPoints	✓		✓	✓		✓	✓
ST_DumpSegments	✓		✓				✓
ST_DumpRings	✓		✓				
ST_EndPoint	✓		✓	✓	✓		
ST_Envelope	✓				✓		
ST_ExteriorRing	✓		✓		✓		
ST_GeometryN	✓		✓	✓	✓	✓	✓
ST_GeometryType	✓		✓		✓	✓	
ST_HasArc	✓		✓	✓			
ST_InteriorRing	✓		✓		✓		
ST_NumCurves	✓		✓		✓		
ST_CurveN	✓		✓		✓		
ST_IsClosed	✓		✓	✓	✓	✓	
ST_IsCollection	✓		✓	✓			
ST_IsEmpty	✓			✓	✓		
ST_IsPolygonCCW	✓		✓				
ST_IsPolygonCW	✓		✓				
ST_IsRing	✓				✓		

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_IsSimple	✓		✓		✓		
ST_M	✓		✓		✓		
ST_MemSize	✓		✓	✓		✓	✓
ST_NDims	✓		✓				
ST_NPoints	✓		✓	✓		✓	
ST_NRings	✓		✓	✓			
ST_NumGeometries	✓		✓		✓	✓	✓
ST_NumInteriorRings	✓				✓		
ST_NumInteriorRing	✓						
ST_NumPatches	✓		✓		✓	✓	
ST_NumPoints	✓				✓		
ST_PatchN	✓		✓		✓	✓	
ST_PointN	✓		✓	✓	✓		
ST_Points	✓		✓	✓			
ST_StartPoint	✓		✓	✓	✓		
ST_Summary	✓	✓		✓		✓	✓
ST_X	✓		✓		✓		
ST_Y	✓		✓		✓		
ST_Z	✓		✓		✓		
ST_Zmflag	✓		✓	✓			
ST_HasZ	✓		✓				
ST_HasM	✓		✓				
ST_AddPoint	✓		✓				
ST_CollectionExtract	✓						
ST_CollectionHomogenize	✓						
ST_CurveToLine	✓		✓	✓	✓		
ST_Scroll	✓		✓				
ST_FlipCoordinates	✓		✓	✓		✓	✓
ST_Force2D	✓		✓	✓		✓	
ST_Force3D	✓		✓	✓		✓	
ST_Force3DZ	✓		✓	✓		✓	
ST_Force3DM	✓			✓			
ST_Force4D	✓		✓	✓			
ST_ForceCollection	✓		✓	✓		✓	

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_ForceCurve	✓		✓	✓			
ST_ForcePolygonCW	✓		✓				
ST_ForcePolygonW	✓		✓				
ST_ForceSFS	✓		✓	✓		✓	✓
ST_ForceRHR	✓		✓			✓	
ST_LineExtend	✓						
ST_LineToCurve	✓		✓	✓			
ST_Multi	✓						
ST_Normalize	✓						
ST_Project	✓	✓					
ST_QuantizeCoordinates	✓						
ST_RemovePoint	✓		✓				
ST_RemoveRepeatedPoints	✓		✓			✓	
ST_RemoveIrrelevantPointsForView	✓						
ST_RemoveSmallParts	✓						
ST_Reverse	✓		✓			✓	
ST_Segmentize	✓	✓					
ST_SetPoint	✓		✓				
ST_ShiftLongitude	✓		✓			✓	✓
ST_WrapX	✓		✓				
ST_SnapToGrid	✓		✓				
ST_Snap	✓						
ST_SwapOrdinates	✓		✓	✓		✓	✓
ST_IsValid	✓				✓		
ST_IsValidDetail	✓						
ST_IsValidReason	✓						
ST_MakeValid	✓		✓				
ST_InverseTransformPipeline	✓						
ST_SetSRID	✓			✓			
ST_SRID	✓			✓	✓		
ST_Transform	✓			✓	✓	✓	
ST_TransformPipeline	✓						
postgis_srs_codes							
postgis_srs							
postgis_srs_all							

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
postgis_srs_seal	✓						
ST_BdPolyFromText	✓						
ST_BdMPolyFromText	✓						
ST_GeogFromText		✓					
ST_GeographyFromText		✓					
ST_GeomCollFromText	✓				✓		
ST_GeomFromEWKT	✓		✓	✓		✓	✓
ST_GeomFromMRC21	✓						
ST_GeometryFromText	✓				✓		
ST_GeomFromI	✓			✓	✓		
ST_LineFromText	✓				✓		
ST_MLineFromText	✓				✓		
ST_MPointFromText	✓				✓		
ST_MPolyFromText	✓				✓		
ST_PointFromText	✓				✓		
ST_PolygonFromText	✓				✓		
ST_WKTToSQL	✓				✓		
ST_GeogFromWKB		✓		✓			
ST_GeomFromEWKB	✓		✓	✓		✓	✓
ST_GeomFromV3	✓			✓	✓		
ST_LineFromWKB	✓				✓		
ST_LinestringFromWKB	✓				✓		
ST_PointFromWKB	✓		✓	✓	✓		
ST_WKBToSQL	✓				✓		
ST_Box2dFromGeoHash	✓						
ST_GeomFromGeoHash	✓						
ST_GeomFromC	✓		✓			✓	✓
ST_GeomFromCJSON	✓		✓				
ST_GeomFromkml	✓		✓				
ST_GeomFromI3B	✓						
ST_GMLToSQL	✓				✓		
ST_LineFromEncodedPolyline	✓						
ST_PointFromGeoHash							
ST_FromFlatGeobufToTable							
ST_FromFlatGeobuf							

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_AsEWKT	✓	✓	✓	✓		✓	✓
ST_AsText	✓	✓		✓	✓		
ST_AsBinary	✓	✓	✓	✓	✓	✓	✓
ST_AsEWKB	✓		✓	✓		✓	✓
ST_AsHEXEWKB	✓		✓	✓			
ST_AsEncodedPolyline	✓ line						
ST_AsFlatGeobuf	<input checked="" type="checkbox"/>						
ST_AsGeobuf	<input checked="" type="checkbox"/>						
ST_AsGeoJSON	✓	✓	✓				
ST_AsGML	✓	✓	✓		✓	✓	✓
ST_AsKML	✓	✓	✓				
ST_AsLatLonText	✓						
ST_AsMARC21	✓						
ST_AsMVTGeom	✓						
ST_AsMVT	<input checked="" type="checkbox"/>						
ST_AsSVG	✓	✓		✓			
ST_AsTWKB	✓						
ST_AsX3D	✓		✓			✓	✓
ST_GeoHash	✓			✓			
&&	✓	✓		✓		✓	
&&(geometry,box2df)	✓			✓		✓	
&&(box2df,geometry)	✓			✓		✓	
&&(box2df,box2df)	<input checked="" type="checkbox"/>			✓		✓	
&&&	✓		✓	✓		✓	✓
&&&(geometry,box2df)	✓		✓	✓		✓	✓
&&&(gidx,geometry)	✓		✓	✓		✓	✓
&&&(gidx,gidx)			✓	✓		✓	✓
&<	✓						
&<	✓			✓		✓	
&>	✓						
<<	✓						
<<	✓						
=	✓	✓		✓		✓	
>>	✓						

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
@	✓						
@(geometry,box2df)	✓			✓		✓	
@(box2df,geometry)	✓			✓		✓	
@(box2df,box2df)	✓			✓		✓	
&>	✓						
>>	✓						
~	✓						
~(geometry,box2df)	✓			✓		✓	
~(box2df,geometry)	✓			✓		✓	
~(box2df,box2df)	✓			✓		✓	
~=	✓					✓	
<->	✓	✓					
=	✓						
<#>	✓						
<<->>	✓						
ST_3DIntersects	✓		✓		✓	✓	✓
ST_Contains	✓				✓		
ST_ContainsProperly	✓						
ST_CoveredBy	✓	✓					
ST_Covers	✓	✓					
ST_Crosses	✓				✓		
ST_Disjoint	✓				✓		
ST_Equals	✓				✓		
ST_Intersects	✓	✓		✓	✓		✓
ST_LineCrossingDirection	✓						
ST_OrderingEquivalent	✓				✓		
ST_Overlaps	✓				✓		
ST_Relate	✓				✓		
ST_RelateMatch	✓						
ST_Touches	✓				✓		
ST_Within	✓				✓		
ST_3DDWithin	✓		✓		✓	✓	
ST_3DDFullyWithin	✓		✓			✓	
ST_DFullyWithin	✓						

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_DWithin	✓	✓					
ST_PointInsideCircle	✓						
ST_Area	✓	✓			✓	✓	
ST_Azimuth	✓	✓					
ST_Angle	✓						
ST_ClosestPoint	✓	✓					
ST_3DClosestPoint	✓		✓			✓	
ST_Distance	✓	✓		✓	✓		
ST_3DDistance	✓		✓		✓	✓	
ST_DistanceSphere	✓						
ST_DistanceSphereoid	✓						
ST_FrechetDistance	✓						
ST_HausdorffDistance	✓						
ST_Length	✓	✓			✓		
ST_Length2D	✓						
ST_3DLength	✓		✓		✓		
ST_LengthSphereoid	✓		✓				
ST_LongestLine	✓						
ST_3DLongestLine	✓		✓			✓	
ST_MaxDistance	✓						
ST_3DMaxDistance	✓		✓			✓	
ST_MinimumClearance	✓						
ST_MinimumClearanceLine	✓						
ST_Perimeter	✓	✓			✓		
ST_Perimeter2D	✓						
ST_3DPerimeter	✓		✓		✓		
ST_ShortestLine	✓	✓					
ST_3DShortestLine	✓		✓			✓	
ST_ClipByBox2D	✓						
ST_Difference	✓		✓		✓		
ST_Intersection	✓	☺	✓		✓		
ST_MemUnion	✓		✓				
ST_Node	✓		✓				
ST_Split	✓						

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_Subdivide	✓						
ST_SymDifferen	✓		✓		✓		
ST_UnaryUnion	✓		✓				
ST_Union	✓		✓		✓		
ST_Buffer	✓	😄			✓		
ST_BuildArea	✓						
ST_Centroid	✓	✓			✓		
ST_ChaikinSmo	✓		✓				
ST_ConcaveHul	✓						
ST_ConvexHull	✓		✓		✓		
ST_DelaunayTri	✓		✓				✓
ST_FilterByM	✓						
ST_GeneratePoi	✓						
ST_GeometricM	✓		✓				
ST_LineMerge	✓						
ST_MaximumIn	✓						
ST_LargestEmp	✓						
ST_MinimumBo	✓						
ST_MinimumBo	✓						
ST_OrientedEnv	✓						
ST_OffsetCurve	✓						
ST_PointOnSurf	✓		✓		✓		
ST_Polygonize	✓						
ST_ReducePrec	✓						
ST_SharedPaths	✓						
ST_Simplify	✓						
ST_SimplifyPres	✓						
ST_SimplifyPoly	✓						
ST_SimplifyVW	✓						
ST_SetEffective	✓						
ST_Triangulate	✓						
ST_VoronoiLine	✓						
ST_VoronoiPoly	✓						
ST_CoverageInv	✓						

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_CoverageSimplify	✓						
ST_CoverageUnion	✓						
ST_Affine	✓		✓	✓		✓	✓
ST_Rotate	✓		✓	✓		✓	✓
ST_RotateX	✓		✓			✓	✓
ST_RotateY	✓		✓			✓	✓
ST_RotateZ	✓		✓	✓		✓	✓
ST_Scale	✓		✓	✓		✓	✓
ST_Translate	✓		✓	✓			
ST_TransScale	✓		✓	✓			
ST_ClusterDBSCAN	✓			✓			
ST_ClusterIntersecting	✓						
ST_ClusterIntersectingWin	✓						
ST_ClusterKMeans	✓						
ST_ClusterWithin	✓			✓			
ST_ClusterWithin/n	✓			✓			
Box2D	✓			✓		✓	✓
Box3D	✓		✓	✓		✓	✓
ST_EstimatedExtent	✗			✓			
ST_Expand	✓					✓	✓
ST_Extent	✓					✓	✓
ST_3DExtent	✓		✓	✓		✓	✓
ST_MakeBox2D	✓						
ST_3DMakeBox	✓						
ST_XMax	✗		✓	✓			
ST_XMin	✗		✓	✓			
ST_YMax	✗		✓	✓			
ST_YMin	✗		✓	✓			
ST_ZMax	✗		✓	✓			
ST_ZMin	✗		✓	✓			
ST_LineInterpolatePoint	✓	✓	✓				
ST_3DLineInterpolatePoint	✓		✓				
ST_LineInterpolatePoints	✓	✓	✓				
ST_LineLocatePoint	✓	✓					

Function	geom	geog	2.5D	Curves	SQL MM	PS	T
ST_LineSubstrin	✓	✓	✓				
ST_LocateAlong	✓				✓		
ST_LocateBetw	✓				✓		
ST_LocateBetw	✓ Elevations		✓				
ST_InterpolateF	✓ t		✓				
ST_AddMeasure	✓		✓				
ST_IsValidTraje	✓ ry		✓				
ST_ClosestPoint	✓ Approach		✓				
ST_DistanceCP	✓		✓				
ST_CPAWithin	✓		✓				
postgis.backend							
postgis.gdal_datapath							
postgis.gdal_enabled_drivers							
postgis.enable_outdb_rasters							
postgis.gdal_vsi_options							
PostGIS_AddBB	✓			✓			
PostGIS_DropBB	✓			✓			
PostGIS_HasBB	✓			✓			

13.12 New, Enhanced or changed PostGIS Functions

13.12.1 PostGIS Functions new or enhanced in 3.5

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.5

- **ST_HasM** - Availability: 3.5.0 Checks if a geometry has an M (measure) dimension.
- **ST_HasZ** - Availability: 3.5.0 Checks if a geometry has a Z dimension.
- **ST_RemoveIrrelevantPointsForView** - Availability: 3.5.0 Removes points that are irrelevant for rendering a specific rectangular view of a geometry.
- **ST_RemoveSmallParts** - Availability: 3.5.0 Removes small parts (polygon rings or linestrings) of a geometry.

Functions changed in PostGIS 3.5

- **ST_AsGeoJSON** - Changed: 3.5.0 allow specifying the column containing the feature id Return a geometry or feature in GeoJSON format.
- **ST_DFullyWithin** - Changed: 3.5.0 : the logic behind the function now uses a test of containment within a buffer, rather than the ST_MaxDistance algorithm. Results will differ from prior versions, but should be closer to user expectations. Tests if a geometry is entirely inside a distance of another

13.12.2 PostGIS Functions new or enhanced in 3.4

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.4

- **PostGIS_GEOS_Compiled_Version** - Availability: 3.4.0 Returns the version number of the GEOS library against which PostGIS was built.
- **PostGIS_PROJ_Compiled_Version** - Availability: 3.5.0 Returns the version number of the PROJ library against which PostGIS was built.
- **ST_ClusterIntersectingWin** - Availability: 3.4.0 Window function that returns a cluster id for each input geometry, clustering input geometries into connected sets.
- **ST_ClusterWithinWin** - Availability: 3.4.0 Window function that returns a cluster id for each input geometry, clustering using separation distance.
- **ST_CoverageInvalidEdges** - Availability: 3.4.0 Window function that finds locations where polygons fail to form a valid coverage.
- **ST_CoverageSimplify** - Availability: 3.4.0 Window function that simplifies the edges of a polygonal coverage.
- **ST_CoverageUnion** - Availability: 3.4.0 - requires GEOS >= 3.8.0 Computes the union of a set of polygons forming a coverage by removing shared edges.
- **ST_InverseTransformPipeline** - Availability: 3.4.0 Return a new geometry with coordinates transformed to a different spatial reference system using the inverse of a defined coordinate transformation pipeline.
- **ST_LargestEmptyCircle** - Availability: 3.4.0. Computes the largest circle not overlapping a geometry.
- **ST_LineExtend** - Availability: 3.4.0 Returns a line extended forwards and backwards by specified distances.
- **ST_TransformPipeline** - Availability: 3.4.0 Return a new geometry with coordinates transformed to a different spatial reference system using a defined coordinate transformation pipeline.
- **postgis_srs** - Availability: 3.4.0 Return a metadata record for the requested authority and srid.
- **postgis_srs_all** - Availability: 3.4.0 Return metadata records for every spatial reference system in the underlying Proj database.
- **postgis_srs_codes** - Availability: 3.4.0 Return the list of SRS codes associated with the given authority.
- **postgis_srs_search** - Availability: 3.4.0 Return metadata records for projected coordinate systems that have areas of useage that fully contain the bounds parameter.

Functions enhanced in PostGIS 3.4

- **PostGIS_Full_Version** - Enhanced: 3.4.0 now includes extra PROJ configurations NETWORK_ENABLED, URL_ENDPOINT and DATABASE_PATH of proj.db location Reports full PostGIS version and build configuration infos.
 - **PostGIS_PROJ_Version** - Enhanced: 3.4.0 now includes NETWORK_ENABLED, URL_ENDPOINT and DATABASE_PATH of proj.db location Returns the version number of the PROJ4 library.
 - **ST_AsSVG** - Enhanced: 3.4.0 to support all curve types Returns SVG path data for a geometry.
-

- **ST_ClosestPoint** - Enhanced: 3.4.0 - Support for geography. Returns the 2D point on g1 that is closest to g2. This is the first point of the shortest line from one geometry to the other.
- **ST_LineSubstring** - Enhanced: 3.4.0 - Support for geography was introduced. Returns the part of a line between two fractional locations.
- **ST_Project** - Enhanced: 3.4.0 Allow geometry arguments and two-point form omitting azimuth. Returns a point projected from a start point by a distance and bearing (azimuth).
- **ST_ShortestLine** - Enhanced: 3.4.0 - support for geography. ☒☒☒☒☒☒ 2 ☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒☒.

Functions changed in PostGIS 3.4

- **PostGIS_Extensions_Upgrade** - Changed: 3.4.0 to add target_version argument. Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.

13.12.3 PostGIS Functions new or enhanced in 3.3

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.3

- **ST_AsMARC21** - Availability: 3.3.0 Returns geometry as a MARC21/XML record with a geographic datafield (034).
- **ST_GeomFromMARC21** - Availability: 3.3.0, requires libxml2 2.6+ Takes MARC21/XML geographic data as input and returns a PostGIS geometry object.
- **ST_Letters** - Availability: 3.3.0 Returns the input letters rendered as geometry with a default start position at the origin and default text height of 100.
- **ST_SimplifyPolygonHull** - Availability: 3.3.0. Computes a simplified topology-preserving outer or inner hull of a polygonal geometry.
- **ST_TriangulatePolygon** - Availability: 3.3.0. Computes the constrained Delaunay triangulation of polygons

Functions enhanced in PostGIS 3.3

- **ST_ConcaveHull** - Enhanced: 3.3.0, GEOS native implementation enabled for GEOS 3.11+ Computes a possibly concave geometry that contains all input geometry vertices
- **ST_LineMerge** - Enhanced: 3.3.0 accept a directed parameter. Return the lines formed by sewing together a MultiLineString.

Functions changed in PostGIS 3.3

- **PostGIS_Extensions_Upgrade** - Changed: 3.3.0 support for upgrades from any PostGIS version. Does not work on all systems. Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.

13.12.4 PostGIS Functions new or enhanced in 3.2

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.2

- **ST_AsFlatGeobuf** - Availability: 3.2.0 Return a FlatGeobuf representation of a set of rows.
- **ST_DumpSegments** - Availability: 3.2.0
- **ST_FromFlatGeobuf** - Availability: 3.2.0 Reads FlatGeobuf data.
- **ST_FromFlatGeobufToTable** - Availability: 3.2.0 Creates a table based on the structure of FlatGeobuf data.
- **ST_Scroll** - Availability: 3.2.0 Change start point of a closed LineString.
- **postgis.gdal_vsi_options** - Availability: 3.2.0 DB

Functions enhanced in PostGIS 3.2

- **ST_ClusterKMeans** - Enhanced: 3.2.0 Support for max_radius Window function that returns a cluster id for each input geometry using the K-means algorithm.
- **ST_MakeValid** - Enhanced: 3.2.0, added algorithm options, 'linework' and 'structure' which requires GEOS >= 3.10.0. Attempts to make an invalid geometry valid without losing vertices.
- **ST_Point** - Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry. Creates a Point with X, Y and SRID values.
- **ST_PointM** - Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry. Creates a Point with X, Y, M and SRID values.
- **ST_PointZ** - Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry. Creates a Point with X, Y, Z and SRID values.
- **ST_PointZM** - Enhanced: 3.2.0 srid as an extra optional argument was added. Older installs require combining with ST_SetSRID to mark the srid on the geometry. Creates a Point with X, Y, Z, M and SRID values.
- **ST_RemovePoint** - Enhanced: 3.2.0 Remove a point from a linestring.
- **ST_RemoveRepeatedPoints** - Enhanced: 3.2.0 Returns a version of a geometry with duplicate points removed.
- **ST_StartPoint** - Enhanced: 3.2.0 returns a point for all geometries. Prior behavior returns NULLs if input was not a LineString. Returns the first point of a LineString.

Functions changed in PostGIS 3.2

- **ST_Boundary** - Changed: 3.2.0 support for TIN, does not use geos, does not linearize curves

13.12.5 PostGIS Functions new or enhanced in 3.1

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.1

- **ST_Hexagon** - 2.1.0. Returns a single hexagon, using the provided edge size and cell coordinate within the hexagon grid space.
- **ST_HexagonGrid** - 2.1.0. Returns a set of hexagons and cell indices that completely cover the bounds of the geometry argument.
- **ST_MaximumInscribedCircle** - Availability: 3.1.0. Returns the maximum inscribed circle of a geometry.
- **ST_ReducePrecision** - Availability: 3.1.0. Returns a valid geometry with points rounded to a grid tolerance.
- **ST_Square** - 2.1.0. Returns a single square, using the provided edge size and cell coordinate within the square grid space.
- **ST_SquareGrid** - 2.1.0. Returns a set of grid squares and cell indices that completely cover the bounds of the geometry argument.

Functions enhanced in PostGIS 3.1

- **ST_AsEWKT** - Enhanced: 3.1.0 support for optional precision parameter. Returns WKT(Well-Known Text) with SRID.
- **ST_ClusterKMeans** - Enhanced: 3.1.0 Support for 3D geometries and weights Window function that returns a cluster id for each input geometry using the K-means algorithm.
- **ST_Difference** - Enhanced: 3.1.0 accept a gridSize parameter. Computes a geometry representing the part of geometry A that does not intersect geometry B.
- **ST_Intersection** - Enhanced: 3.1.0 accept a gridSize parameter. Computes a geometry representing the shared portion of geometries A and B.
- **ST_MakeValid** - Enhanced: 3.1.0, added removal of Coordinates with NaN values. Attempts to make an invalid geometry valid without losing vertices.
- **ST_Subdivide** - Enhanced: 3.1.0 accept a gridSize parameter. Computes a rectilinear subdivision of a geometry.
- **ST_SymDifference** - Enhanced: 3.1.0 accept a gridSize parameter. Computes a geometry representing the portions of geometries A and B that do not intersect.
- **ST_TileEnvelope** - 2.0.0. Creates a rectangular Polygon in Web Mercator (SRID:3857) using the XYZ tile system.
- **ST_UnaryUnion** - Enhanced: 3.1.0 accept a gridSize parameter. Computes the union of the components of a single geometry.
- **ST_Union** - Enhanced: 3.1.0 accept a gridSize parameter. Computes a geometry representing the point-set union of the input geometries.

Functions changed in PostGIS 3.1

- **ST_Force3D** - Changed: 3.1.0. Added support for supplying a non-zero Z value. ST_Force3DZ.
- **ST_Force3DM** - Changed: 3.1.0. Added support for supplying a non-zero M value. ST_Force3DM.

- **ST_Force3DZ** - Changed: 3.1.0. Added support for supplying a non-zero Z value. `ST_Force3DZ(geometry, float)`.
- **ST_Force4D** - Changed: 3.1.0. Added support for supplying non-zero Z and M values. `ST_Force4D(geometry, float, float)`.

13.12.6 PostGIS Functions new or enhanced in 3.0

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 3.0

- **ST_3DLineInterpolatePoint** - 2.1.0 `ST_3DLineInterpolatePoint(geometry, float)`. Returns a point interpolated along a 3D line at a fractional location.
- **ST_TileEnvelope** - 2.1.0 `ST_TileEnvelope(float, float, float, float)`. Creates a rectangular Polygon in Web Mercator (SRID:3857) using the XYZ tile system.

Functions enhanced in PostGIS 3.0

- **ST_AsMVT** - Enhanced: 3.0 - added support for Feature ID. Aggregate function returning a MVT representation of a set of rows.
- **ST_Contains** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of B lies in A, and their interiors have a point in common
- **ST_ContainsProperly** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of B lies in the interior of A
- **ST_CoveredBy** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of A lies in B
- **ST_Covers** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of B lies in A
- **ST_Crosses** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have some, but not all, interior points in common
- **ST_CurveToLine** - Enhanced: 3.0.0 implemented a minimum number of segments per linearized arc to prevent topological collapse. Converts a geometry containing curves to a linear geometry.
- **ST_Disjoint** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have no points in common
- **ST_Equals** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries include the same set of points
- **ST_GeneratePoints** - Enhanced: 3.0.0, added seed parameter Generates a multipoint of random points contained in a Polygon or MultiPolygon.
- **ST_GeomFromGeoJSON** - Enhanced: 3.0.0 parsed geometry defaults to SRID=4326 if not specified otherwise. `ST_GeomFromGeoJSON(geojson)` PostGIS `ST_GeomFromGeoJSON(geojson, integer)`.
- **ST_LocateBetween** - Enhanced: 3.0.0 - added support for POLYGON, TIN, TRIANGLE. Returns the portions of a geometry that match a measure range.
- **ST_LocateBetweenElevations** - Enhanced: 3.0.0 - added support for POLYGON, TIN, TRIANGLE. Returns the portions of a geometry that lie in an elevation (Z) range.
- **ST_Overlaps** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have the same dimension and intersect, but each has at least one point not in the other

- **ST_Relate** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have a topological relationship matching an Intersection Matrix pattern, or computes their Intersection Matrix
- **ST_Segmentize** - Enhanced: 3.0.0 Segmentize geometry now produces equal-length subsegments Returns a modified geometry/geography having no segment longer than a given distance.
- **ST_Touches** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if two geometries have at least one point in common, but their interiors do not intersect
- **ST_Within** - Enhanced: 3.0.0 enabled support for GEOMETRYCOLLECTION Tests if every point of A lies in B, and their interiors have a point in common

Functions changed in PostGIS 3.0

- **PostGIS_Extensions_Upgrade** - Changed: 3.0.0 to repackage loose extensions and support postgis_raster. Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.
- **ST_3DDistance** - Changed: 3.0.0 - SFCGAL version removed, GEOS backend (SRS 3D) 3D longest distance.
- **ST_3DIntersects** - Changed: 3.0.0 SFCGAL backend removed, GEOS backend supports TINs. Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area)
- **ST_Area** - Changed: 3.0.0 - does not depend on SFCGAL anymore.
- **ST_AsGeoJSON** - Changed: 3.0.0 support records as input Return a geometry or feature in GeoJSON format.
- **ST_AsGeoJSON** - Changed: 3.0.0 output SRID if not EPSG:4326. Return a geometry or feature in GeoJSON format.
- **ST_AsKML** - Changed: 3.0.0 - Removed the "versioned" variant signature GML 2 GML 3
- **ST_Distance** - Changed: 3.0.0 - does not depend on SFCGAL anymore. 3D longest distance.
- **ST_Intersection** - Changed: 3.0.0 does not depend on SFCGAL. Computes a geometry representing the shared portion of geometries A and B.
- **ST_Intersects** - Changed: 3.0.0 SFCGAL version removed and native support for 2D TINs added. Tests if two geometries intersect (they have at least one point in common)
- **ST_Union** - Changed: 3.0.0 does not depend on SFCGAL. Computes a geometry representing the point-set union of the input geometries.

13.12.7 PostGIS Functions new or enhanced in 2.5

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.5

- **PostGIS_Extensions_Upgrade** - Availability: 2.5.0 Packages and upgrades PostGIS extensions (e.g. postgis_raster, postgis_topology, postgis_sfcgal) to given or latest version.
- **ST_Angle** - Availability: 2.5.0 3D longest distance.

- **ST_ChaikinSmoothing** - Availability: 2.5.0 Returns a smoothed version of a geometry, using the Chaikin algorithm
- **ST_FilterByM** - Availability: 2.5.0 Removes vertices based on their M value
- **ST_LineInterpolatePoints** - Availability: 2.5.0 Returns points interpolated along a line at a fractional interval.
- **ST_OrientedEnvelope** - Availability: 2.5.0. Returns a minimum-area rectangle containing a geometry.
- **ST_QuantizeCoordinates** - Availability: 2.5.0 Sets least significant bits of coordinates to zero

Functions enhanced in PostGIS 2.5

- **ST_AsMVT** - Enhanced: 2.5.0 - added support parallel query. Aggregate function returning a MVT representation of a set of rows.
- **ST_AsText** - Enhanced: 2.5 - optional parameter precision introduced. `ST_AsText(geometry, precision)` WKT(Well-Known Text) `ST_AsText(geometry, precision, SRID)`
- **ST_Buffer** - Enhanced: 2.5.0 - `ST_Buffer` geometry support was enhanced to allow for side buffering specification `side=both|left|right`. Computes a geometry covering all points within a given distance from a geometry.
- **ST_GeomFromGeoJSON** - Enhanced: 2.5.0 can now accept json and jsonb as inputs. `ST_GeomFromGeoJSON(json)` PostGIS `ST_GeomFromGeoJSON(json, SRID)`
- **ST_GeometricMedian** - Enhanced: 2.5.0 Added support for M as weight of points. `ST_GeometricMedian(geometry, weight)` (median) `ST_GeometricMedian(geometry, weight, SRID)`
- **ST_Intersects** - Enhanced: 2.5.0 Supports GEOMETRYCOLLECTION. Tests if two geometries intersect (they have at least one point in common)
- **ST_OffsetCurve** - Enhanced: 2.5 - added support for GEOMETRYCOLLECTION and MULTILINESTRING Returns an offset line at a given distance and side from an input line.
- **ST_Scale** - Enhanced: 2.5.0 support for scaling relative to a local origin (origin parameter) was introduced. Scales a geometry by given factors.
- **ST_Split** - Enhanced: 2.5.0 support for splitting a polygon by a multiline was introduced. Returns a collection of geometries created by splitting a geometry by another geometry.
- **ST_Subdivide** - Enhanced: 2.5.0 reuses existing points on polygon split, vertex count is lowered from 8 to 5. Computes a rectilinear subdivision of a geometry.

13.12.8 PostGIS Functions new or enhanced in 2.4

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.4

- **ST_AsGeobuf** - 2.2.0 `ST_AsGeobuf(geometry)`. Return a Geobuf representation of a set of rows.
- **ST_AsMVT** - 2.2.0 `ST_AsMVT(geometry, name)`. Aggregate function returning a MVT representation of a set of rows.
- **ST_AsMVTGeom** - 2.2.0 `ST_AsMVTGeom(geometry, tile)`. Transforms a geometry into the coordinate space of a MVT tile.
- **ST_Centroid** - Availability: 2.4.0 support for geography was introduced. `ST_Centroid(geometry)`

- **ST_ForcePolygonCCW** - 2.2.0. Orients all exterior rings counter-clockwise and all interior rings clockwise.
- **ST_ForcePolygonCW** - 2.2.0. Orients all exterior rings clockwise and all interior rings counter-clockwise.
- **ST_FrechetDistance** - Availability: 2.4.0 - requires GEOS >= 3.7.0 (shortest).
- **ST_IsPolygonCCW** - 2.2.0. Tests if Polygons have exterior rings oriented counter-clockwise and interior rings oriented clockwise.
- **ST_IsPolygonCW** - 2.2.0. Tests if Polygons have exterior rings oriented clockwise and interior rings oriented counter-clockwise.

Functions enhanced in PostGIS 2.4

- **ST_AsTWKB** - Enhanced: 2.4.0 memory and speed improvements. TWKB(Tiny Well-Known Binary).
- **ST_Covers** - Enhanced: 2.4.0 Support for polygon in polygon and line in polygon added for geography type Tests if every point of B lies in A
- **ST_CurveToLine** - Enhanced: 2.4.0 added support for max-deviation and max-angle tolerance, and for symmetric output. Converts a geometry containing curves to a linear geometry.
- **ST_Project** - Enhanced: 2.4.0 Allow negative distance and non-normalized azimuth. Returns a point projected from a start point by a distance and bearing (azimuth).
- **ST_Reverse** - Enhanced: 2.4.0 support for curves was introduced.

Functions changed in PostGIS 2.4

- **=** - Changed: 2.4.0, in prior versions this was bounding box equality not a geometric equality. If you need bounding box equality, use `ST_Equals`. Returns TRUE if the coordinates and coordinate order geometry/geography A are the same as the coordinates and coordinate order of geometry/geography B.
- **ST_Node** - Changed: 2.4.0 this function uses GEOSNode internally instead of GEOSUnaryUnion. This may cause the resulting linestrings to have a different order and direction compared to PostGIS < 2.4. Nodes a collection of lines.

13.12.9 PostGIS Functions new or enhanced in 2.3

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.3

- **ST_Contains**(geometry,gidx) - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a geometry's (cached) n-D bounding box intersects a n-D float precision bounding box (GIDX).
- **ST_Contains**(gidx,geometry) - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a n-D float precision bounding box (GIDX) intersects a geometry's (cached) n-D bounding box.
- **ST_Contains**(gidx,gidx) - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if two n-D float precision bounding boxes (GIDX) intersect each other.

- **&&(box2df,box2df)** - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if two 2D float precision bounding boxes (BOX2DF) intersect each other.
- **&&(box2df,geometry)** - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) intersects a geometry's (cached) 2D bounding box.
- **&&(geometry,box2df)** - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a geometry's (cached) 2D bounding box intersects a 2D float precision bounding box (BOX2DF).
- **@(box2df,box2df)** - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into another 2D float precision bounding box.
- **@(box2df,geometry)** - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) is contained into a geometry's 2D bounding box.
- **@(geometry,box2df)** - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a geometry's 2D bounding box is contained into a 2D float precision bounding box (BOX2DF).
- **ST_ClusterDBSCAN** - 2.3.0 `ST_ClusterDBSCAN(geometry, float, boolean)`. Window function that returns a cluster id for each input geometry using the DBSCAN algorithm.
- **ST_ClusterKMeans** - 2.3.0 `ST_ClusterKMeans(geometry, float, boolean)`. Window function that returns a cluster id for each input geometry using the K-means algorithm.
- **ST_GeneratePoints** - 2.3.0 `ST_GeneratePoints(geometry, integer)`. Generates a multipoint of random points contained in a Polygon or MultiPolygon.
- **ST_GeometricMedian** - 2.3.0 `ST_GeometricMedian(geometry)`. `ST_GeometricMedian(geometry, float)` (median) `ST_GeometricMedian(geometry, float, float)`.
- **ST_MakeLine** - 2.0.0 `ST_MakeLine(geometry, geometry)`. `ST_MakeLine(geometry, geometry, float)`. `ST_MakeLine(geometry, geometry, float, float)`.
- **ST_MinimumBoundingRadius** - 2.3.0 `ST_MinimumBoundingRadius(geometry)`. Returns the center point and radius of the smallest circle that contains a geometry.
- **ST_MinimumClearance** - 2.3.0 `ST_MinimumClearance(geometry)`. `ST_MinimumClearance(geometry, float)` (robustness) `ST_MinimumClearance(geometry, float, float)` (clearance) `ST_MinimumClearance(geometry, float, float, float)`.
- **ST_MinimumClearanceLine** - 2.3.0 `ST_MinimumClearanceLine(geometry)`. GEOS 3.6.0 `ST_MinimumClearanceLine(geometry, float)`. `ST_MinimumClearanceLine(geometry, float, float)`.
- **ST_Normalize** - 2.3.0 `ST_Normalize(geometry)`. `ST_Normalize(geometry, float)`.
- **ST_Points** - 2.3.0 `ST_Points(geometry)`. `ST_Points(geometry, float)`.
- **ST_VoronoiLines** - 2.3.0 `ST_VoronoiLines(geometry)`. Returns the boundaries of the Voronoi diagram of the vertices of a geometry.
- **ST_VoronoiPolygons** - 2.3.0 `ST_VoronoiPolygons(geometry)`. Returns the cells of the Voronoi diagram of the vertices of a geometry.
- **ST_WrapX** - Availability: 2.3.0 requires GEOS X `ST_WrapX(geometry)`.
- **~(box2df,box2df)** - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) contains another 2D float precision bounding box (BOX2DF).

- `~(box2df,geometry)` - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a 2D float precision bounding box (BOX2DF) contains a geometry's 2D bonding box.
- `~(geometry,box2df)` - Availability: 2.3.0 support for Block Range INdices (BRIN) was introduced. Requires PostgreSQL 9.5+. Returns TRUE if a geometry's 2D bonding box contains a 2D float precision bounding box (GIDX).

Functions enhanced in PostGIS 2.3

- `ST_Contains` - Enhanced: 2.3.0 Enhancement to PIP short-circuit extended to support MultiPoints with few points. Prior versions only supported point in polygon. Tests if every point of B lies in A, and their interiors have a point in common
- `ST_Covers` - Enhanced: 2.3.0 Enhancement to PIP short-circuit for geometry extended to support MultiPoints with few points. Prior versions only supported point in polygon. Tests if every point of B lies in A
- `ST_Expand` - Enhanced: 2.3.0 support was added to expand a box by different amounts in different dimensions. Returns a bounding box expanded from another bounding box or a geometry.
- `ST_Intersects` - Enhanced: 2.3.0 Enhancement to PIP short-circuit extended to support MultiPoints with few points. Prior versions only supported point in polygon. Tests if two geometries intersect (they have at least one point in common)
- `ST_Segmentize` - Enhanced: 2.3.0 Segmentize geography now produces equal-length subsegments Returns a modified geometry/geography having no segment longer than a given distance.
- `ST_Transform` - Enhanced: 2.3.0 support for direct PROJ.4 text was introduced. Return a new geometry with coordinates transformed to a different spatial reference system.
- `ST_Within` - Enhanced: 2.3.0 Enhancement to PIP short-circuit for geometry extended to support MultiPoints with few points. Prior versions only supported point in polygon. Tests if every point of A lies in B, and their interiors have a point in common

Functions changed in PostGIS 2.3

- `ST_PointN` - `ST_PointN(geometry, integer)`: 2.3.0 `ST_PointN(geometry, integer)` `ST_LineString` `ST_CircularString`

13.12.10 PostGIS Functions new or enhanced in 2.2

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.2

- `<<->` - 2.2.0 `<<->(geometry, geometry)`. PostgreSQL 9.1 `<<->(geometry, geometry)` KNN `<<->(geometry, geometry)`. Returns the n-D distance between the A and B geometries or bounding boxes
- `ST_AsEncodedPolyline` - 2.2.0 `ST_AsEncodedPolyline(geometry)`. `ST_AsEncodedPolyline(geometry, integer)`
- `ST_AsTWKB` - 2.2.0 `ST_AsTWKB(geometry)`. `ST_AsTWKB(geometry, integer)` TWKB(Tiny Well-Known Binary) `ST_AsTWKB(geometry)`
- `ST_BoundingDiagonal` - 2.2.0 `ST_BoundingDiagonal(geometry)`. `ST_BoundingDiagonal(geometry, integer)`
- `ST_CPAWithin` - 2.2.0 `ST_CPAWithin(geometry, geometry, float)`. Tests if the closest point of approach of two trajectories is within the specified distance.

- **ST_ClipByBox2D** - 2.2.0. Computes the portion of a geometry falling within a rectangle.
- **ST_ClosestPointOfApproach** - 2.2.0. Returns a measure at the closest point of approach of two trajectories.
- **ST_ClusterIntersecting** - 2.2.0. Aggregate function that clusters input geometries into connected sets.
- **ST_ClusterWithin** - 2.2.0. Aggregate function that clusters geometries by separation distance.
- **ST_DistanceCPA** - 2.2.0. Returns the distance between the closest point of approach of two trajectories.
- **ST_ForceCurve** - 2.2.0. (upcast).
- **ST_IsValidTrajectory** - 2.2.0. Tests if the geometry is a valid trajectory.
- **ST_LineFromEncodedPolyline** - 2.2.0. (polyline).
- **ST_RemoveRepeatedPoints** - 2.2.0. Returns a version of a geometry with duplicate points removed.
- **ST_SetEffectiveArea** - 2.2.0. Sets the effective area for each vertex, using the Visvalingam-Whyatt algorithm.
- **ST_SimplifyVW** - 2.2.0. Returns a simplified representation of a geometry, using the Visvalingam-Whyatt algorithm.
- **ST_Subdivide** - 2.2.0. Computes a rectilinear subdivision of a geometry.
- **ST_SwapOrdinates** - 2.2.0.
- **postgis.enable_outdb_rasters** - 2.2.0. DB.
- **postgis.gdal_datapath** - 2.2.0. GDAL GDAL_DATA.
- **postgis.gdal_enabled_drivers** - 2.2.0. PostGIS GDAL.
- **|=** - 2.2.0. PostgreSQL 9.5 (index-supported) A B (closest point of approach) (trajectory).

Functions enhanced in PostGIS 2.2

- **<->** - 2.2.0 -- PostgreSQL 9.5 KNN("K nearest neighbor"). PostgreSQL 9.4 A B 2.
- **ST Area** - 2.2.0 GeographicLib Proj 4.9.0.
- **ST AsX3D** - 2.2.0 (x/y, z/r) X3D XML ISO-IEC-19776-1.2-X3DEncodings-XML.

- **ST_Azimuth** - **Enhanced**: 2.2.0 support for GeographicLib 2.2.0. Proj 4.9.0 support for 2D and 3D.
- **ST_Distance** - **Enhanced**: 2.2.0 support for GeographicLib 2.2.0. Proj 4.9.0 support for 3D (longest) support.
- **ST_Scale** - **Enhanced**: 2.2.0 support for scaling all dimension (factor parameter) was introduced. Scales a geometry by given factors.
- **ST_Split** - **Enhanced**: 2.2.0 support for splitting a line by a multiline, a multipoint or (multi)polygon boundary was introduced. Returns a collection of geometries created by splitting a geometry by another geometry.
- **ST_Summary** - **Enhanced**: 2.2.0 support for TIN (curve) support.

Functions changed in PostGIS 2.2

- **<->** - **Enhanced**: 2.2.0 support for PostgreSQL 9.5 Hybrid syntax support. PostGIS 2.2 support for PostgreSQL 9.5 Hybrid syntax support. A B 2 support.
- **ST_3DClosestPoint** - **Enhanced**: 2.2.0 support for 2D, (Z 0 support) 2D 3D support, Z 0 support. g2 g1 3 support. 3D support.
- **ST_3DDistance** - **Enhanced**: 2.2.0 support, 2D 3D support Z 0 support. (SRS 3) support.
- **ST_3DLongestLine** - **Enhanced**: 2.2.0 support for 2D, (Z 0 support) 2D 3D support, Z 0 support. 3 support (longest) support.
- **ST_3DMaxDistance** - **Enhanced**: 2.2.0 support, 2D 3D support Z 0 support. (SRS 3) support.
- **ST_3DShortestLine** - **Enhanced**: 2.2.0 support for 2D, (Z 0 support) 2D 3D support, Z 0 support. 3 support (shortest) support.
- **ST_DistanceSphere** - **Enhanced**: 2.2.0 support for ST_Distance_Sphere support. PostGIS 1.5 support.
- **ST_DistanceSpheroid** - **Enhanced**: 2.2.0 support for ST_Distance_Spheroid support. PostGIS 1.5 support.
- **ST_Equals** - **Changed**: 2.2.0 Returns true even for invalid geometries if they are binary equal Tests if two geometries include the same set of points
- **ST_LengthSpheroid** - **Enhanced**: 2.2.0 support for ST_Length_Spheroid support, ST_3DLength_S support.
- **ST_MemSize** - **Changed**: 2.2.0 name changed to ST_MemSize to follow naming convention. ST_Geometry support.
- **ST_PointInsideCircle** - **Changed**: 2.2.0 In prior versions this was called ST_Point_Inside_Circle Tests if a point geometry is inside a circle defined by a center and radius

13.12.11 PostGIS Functions new or enhanced in 2.1

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.1

- **ST_Box2dFromGeoHash** - 2.1.0. Returns the BOX2D of the GeoHash.
- **ST_DelaunayTriangles** - 2.1.0. Returns the Delaunay triangulation of the vertices of a geometry.
- **ST_GeomFromGeoHash** - 2.1.0. Returns the geometry from the GeoHash.
- **ST_PointFromGeoHash** - 2.1.0. Returns the point from the GeoHash.
- **postgis.backend** - 2.1.0. GEOS or SFCGAL. geos or sfcgal, or geos.

Functions enhanced in PostGIS 2.1

- **ST_AsGML** - 2.1.0. Returns GML 3 ID. GML 2 to GML 3.
- **ST_Boundary** - 2.1.0. Returns the boundary of a geometry.
- **ST_DWithin** - Enhanced: 2.1.0 improved speed for geography. See Making Geography faster for details. Tests if two geometries are within a given distance.
- **ST_DWithin** - Enhanced: 2.1.0 support for curved geometries was introduced. Tests if two geometries are within a given distance.
- **ST_Distance** - 2.1.0. Returns the distance between two geometries. Making Geography faster. 3 (longest).
- **ST_Distance** - 2.1.0. Returns the distance between two geometries. 3 (longest).
- **ST_DumpPoints** - Enhanced: 2.1.0 Faster speed. Reimplemented as native-C.
- **ST_MakeValid** - Enhanced: 2.1.0, added support for GEOMETRYCOLLECTION and MULTIPOINT. Attempts to make an invalid geometry valid without losing vertices.
- **ST_Segmentize** - 2.1.0. Returns a modified geometry/geography having no segment longer than a given distance.
- **ST_Summary** - 2.1.0. Returns the summary of a geometry/geography.

Functions changed in PostGIS 2.1

- **ST_EstimatedExtent** - Changed: 2.1.0. Up to 2.0.x this was called ST_Estimated_Extent. Returns the estimated extent of a spatial table.
- **ST_Force2D** - 2.1.0. ST_Force_2D. "2" flag.
- **ST_Force3D** - 2.1.0. ST_Force_3D. XYZ flag. ST_Force3DZ flag.

- **ST_Force3DM** - `ST_Force3DM`: 2.1.0 `ST_Force3DM`, 2.0.x `ST_Force_3DM`. Returns XYM geometry.
- **ST_Force3DZ** - `ST_Force3DZ`: 2.1.0 `ST_Force3DZ`, 2.0.x `ST_Force_3DZ`. Returns XYZ geometry.
- **ST_Force4D** - `ST_Force4D`: 2.1.0 `ST_Force4D`, 2.0.x `ST_Force_4D`. Returns XYZM geometry.
- **ST_ForceCollection** - `ST_ForceCollection`: 2.1.0 `ST_ForceCollection`, 2.0.x `ST_Force_Collection`. Returns geometry collection.
- **ST_LineInterpolatePoint** - `ST_LineInterpolatePoint`: 2.1.0 `ST_LineInterpolatePoint`, 2.0.x `ST_Line_Interpolate_Point`. Returns a point interpolated along a line at a fractional location.
- **ST_LineLocatePoint** - `ST_LineLocatePoint`: 2.1.0 `ST_LineLocatePoint`, 2.0.x `ST_Line_Locate_Point`. Returns the fractional location of the closest point on a line to a point.
- **ST_LineSubstring** - `ST_LineSubstring`: 2.1.0 `ST_LineSubstring`, 2.0.x `ST_Line_Substring`. Returns the part of a line between two fractional locations.
- **ST_Segmentize** - Changed: 2.1.0 As a result of the introduction of geography support, the usage `ST_Segmentize('LINESTRING(1 2, 3 4)', 0.5)` causes an ambiguous function error. The input needs to be properly typed as a geometry or geography. Use `ST_GeomFromText`, `ST_GeogFromText` or a cast to the required type (e.g. `ST_Segmentize('LINESTRING(1 2, 3 4)::geometry, 0.5)`) Returns a modified geometry/geography having no segment longer than a given distance.

13.12.12 PostGIS Functions new or enhanced in 2.0

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 2.0

- **&&&** - 2.0.0 `&&&`. A `n` `&&&` B `n` `&&&` TRUE.
- **<#>** - 2.0.0 `<#>`. PostgreSQL 9.1 `<#>` KNN.
- **<->** - 2.0.0 `<->`. `<->` KNN.
- **ST_3DClosestPoint** - 2.0.0 `ST_3DClosestPoint`. `g2` `ST_3DClosestPoint` `g1` 3 `ST_3DClosestPoint`.
- **ST_3DDFullyWithin** - 2.0.0 `ST_3DDFullyWithin`. Tests if two 3D geometries are entirely within a given 3D distance.
- **ST_3DDWithin** - 2.0.0 `ST_3DDWithin`. Tests if two 3D geometries are within a given 3D distance.
- **ST_3DDistance** - 2.0.0 `ST_3DDistance`. `ST_3DDistance`, `ST_3DDistance` (SRS) 3 `ST_3DDistance`.
- **ST_3DIntersects** - 2.0.0 `ST_3DIntersects`. Tests if two geometries spatially intersect in 3D - only for points, linestrings, polygons, polyhedral surface (area).
- **ST_3DLongestLine** - 2.0.0 `ST_3DLongestLine`. `ST_3DLongestLine` 3 `ST_3DLongestLine` (longest) `ST_3DLongestLine`.

- **ST_3DMaxDistance** - 2.0.0. Returns the maximum distance between any two vertices of a 3D geometry. `ST_3DMaxDistance(geom1, geom2)` returns a float.
- **ST_3DShortestLine** - 2.0.0. Returns the shortest line segment between two 3D geometries. `ST_3DShortestLine(geom1, geom2)` returns a 3D line geometry.
- **ST_AsLatLonText** - 2.0. Returns a text representation of a geometry in latitude/longitude coordinates. `ST_AsLatLonText(geom)` returns a text string.
- **ST_AsX3D** - 2.0.0. Returns an X3D XML representation of a geometry. `ST_AsX3D(geom)` returns an X3D XML string.
- **ST_CollectionHomogenize** - 2.0.0. Returns the simplest representation of a geometry collection.
- **ST_ConcaveHull** - 2.0.0. Computes a possibly concave geometry that contains all input geometry vertices.
- **ST_FlipCoordinates** - 2.0.0. Returns a version of a geometry with X and Y axis flipped.
- **ST_GeomFromGeoJSON** - 2.0.0. Returns a geometry from a GeoJSON object. `ST_GeomFromGeoJSON(json)` returns a geometry.
- **ST_InterpolatePoint** - 2.0.0. Returns a point interpolated along a line. `ST_InterpolatePoint(geom, distance)` returns a point geometry.
- **ST_IsValidDetail** - 2.0.0. Returns a valid_detail row stating if a geometry is valid or if not a reason and a location.
- **ST_IsValidReason** - Availability: 2.0 version taking flags. Returns text stating if a geometry is valid, or a reason for invalidity.
- **ST_MakeLine** - 2.0.0. Returns a line geometry from a set of points. `ST_MakeLine(points)` returns a line geometry.
- **ST_MakeValid** - 2.0.0. Attempts to make an invalid geometry valid without losing vertices.
- **ST_Node** - 2.0.0. Nodes a collection of lines.
- **ST_NumPatches** - 2.0.0. Returns the number of patches in a geometry. `ST_NumPatches(geom)` returns an integer.
- **ST_OffsetCurve** - 2.0. Returns an offset line at a given distance and side from an input line.
- **ST_PatchN** - 2.0.0. Returns the Nth patch of a geometry. `ST_PatchN(geom, n)` returns a geometry.
- **ST_Perimeter** - 2.0.0. Returns the length of the boundary of a polygonal geometry or geography.
- **ST_Project** - 2.0.0. Returns a point projected from a start point by a distance and bearing (azimuth).
- **ST_RelateMatch** - 2.0.0. Tests if a DE-9IM Intersection Matrix matches an Intersection Matrix pattern.
- **ST_SharedPaths** - 2.0.0. Returns the shared paths between two geometries. `ST_SharedPaths(geom1, geom2)` returns a geometry.
- **ST_Snap** - 2.0.0. Returns a geometry snapped to another geometry. `ST_Snap(geom1, geom2)` returns a geometry.
- **ST_Split** - Availability: 2.0.0 requires GEOS. Returns a collection of geometries created by splitting a geometry by another geometry.

- **ST_UnaryUnion** - 2.0.0 新增。Computes the union of the components of a single geometry.

Functions enhanced in PostGIS 2.0

- **&&** - 新增: 2.0.0 新增 (polyhedral surface) 函数。A 2D 几何体 B 2D 几何体 TRUE 返回 TRUE。
- **AddGeometryColumn** - 新增: 2.0.0 新增。use typmod 参数。新增 typmod 参数。新增 typmod 参数。
- **Box2D** - 新增: 2.0.0 新增, 返回 TIN 的 2D 包围盒。Returns a BOX2D representing the 2D extent of a geometry.
- **Box3D** - 新增: 2.0.0 新增, 返回 TIN 的 3D 包围盒。Returns a BOX3D representing the 3D extent of a geometry.
- **GeometryType** - 新增: 2.0.0 新增, 返回 TIN 的 ST_Geometry 类型。
- **Populate_Geometry_Columns** - 新增: 2.0.0 新增。新增 use typmod 参数。Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints.
- **ST_3DExtent** - 新增: 2.0.0 新增, 返回 TIN 的 3D 包围盒。Aggregate function that returns the 3D bounding box of geometries.
- **ST_Affine** - 新增: 2.0.0 新增, 返回 TIN 的 3D 仿射变换。Apply a 3D affine transformation to a geometry.
- **ST_Area** - 新增: 2.0.0 新增 2 个 (polyhedral surface) 函数。新增 2 个函数。
- **ST_AsBinary** - 新增: 2.0.0 新增, 返回 TIN 的 OGC/ISO Well-Known Binary (WKB) 表示。Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- **ST_AsBinary** - 新增: 2.0.0 新增。Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- **ST_AsBinary** - 新增: 2.0.0 新增。Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- **ST_AsEWKB** - 新增: 2.0.0 新增, 返回 TIN 的 Extended Well-Known Binary (EWKB) 表示。Return the Extended Well-Known Binary (EWKB) representation of the geometry with SRID meta data.
- **ST_AsEWKT** - 新增: 2.0.0 新增, 返回 TIN 的 WKT(Well-Known Text) 表示。Return WKT(Well-Known Text) with SRID meta data.
- **ST_AsGML** - 新增: 2.0.0 新增。Return GML 3 '4' 表示。GML 3 '32' 表示。Return GML 2 或 GML 3 表示。
- **ST_AsKML** - 新增: 2.0.0 新增。Return GML 2 或 GML 3 表示。
- **ST_Azimuth** - 新增: 2.0.0 新增。Return 2 个函数。
- **ST_Dimension** - 新增: 2.0.0 新增 (polyhedral surface) 函数。Return 函数。Return ST_Geometry 类型。

- **ST_Dump** - 函数: 2.0.0 返回 TIN 的几何分量。Returns a set of geometry_dump rows for the components of a geometry.
- **ST_DumpPoints** - 函数: 2.0.0 返回 TIN 的几何分量。Returns a set of geometry_dump rows for the components of a geometry.
- **ST_Expand** - 函数: 2.0.0 返回 TIN 的几何分量。Returns a bounding box expanded from another bounding box or a geometry.
- **ST_Extent** - 函数: 2.0.0 返回 TIN 的几何分量。Aggregate function that returns the bounding box of geometries.
- **ST_Force2D** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 2D 版本。
- **ST_Force3D** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 3D 版本。XYZ 坐标。
- **ST_Force3DZ** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 3D 版本。XYZ 坐标。
- **ST_ForceCollection** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的集合。
- **ST_ForceRHR** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的右手规则 (orientation) 版本。
- **ST_GMLToSQL** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 GML 到 SQL 转换。
- **ST_GMLToSQL** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 SRID 版本。GML 到 SQL 转换。
- **ST_GeomFromEWKB** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 EWKB(Extended Well-Known Binary) 版本。
- **ST_GeomFromEWKT** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 EWKT(Extended Well-Known Text) 版本。
- **ST_GeomFromGML** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 GML 版本。
- **ST_GeomFromGML** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 SRID 版本。GML 到 SQL 转换。
- **ST_GeometryN** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 ST_Geometry 版本。
- **ST_GeometryType** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 ST_Geometry 版本。
- **ST_IsClosed** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 LINestring 是否闭合。TRUE 表示闭合。
- **ST_MakeEnvelope** - 函数: 2.0 返回 SRID 的包络面 (envelope) 版本。
- **ST_MakeValid** - Enhanced: 2.0.1, speed improvements Attempts to make an invalid geometry valid without losing vertices.
- **ST_NPoints** - 函数: 2.0.0 返回 TIN 的几何分量 (polyhedral surface) 的 N 个点。

- **ST_NumGeometries** - Enhanced: 2.0.0 - added support for specifying boundary node rule. Tests if two geometries have a topological relationship matching an Intersection Matrix pattern, or computes their Intersection Matrix
- **ST_Rotate** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. Rotates a geometry about an origin point.
- **ST_RotateX** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. Rotates a geometry about the X axis.
- **ST_RotateY** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. Rotates a geometry about the Y axis.
- **ST_RotateZ** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. Rotates a geometry about the Z axis.
- **ST_Scale** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. Scales a geometry by given factors.
- **ST_ShiftLongitude** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. Shifts the longitude coordinates of a geometry between -180..180 and 0..360.
- **ST_Summary** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added.
- **ST_Transform** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. Return a new geometry with coordinates transformed to a different spatial reference system.

Functions changed in PostGIS 2.0

- **AddGeometryColumn** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. `ALTER TABLE some_table ADD COLUMN geom geometry(Point,4326);`
- **AddGeometryColumn** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. `ALTER TABLE some_table ADD COLUMN geom geometry(Point,4326);`
- **AddGeometryColumn** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. `ALTER TABLE some_table ADD COLUMN geom geometry(Point,4326);`
- **DropGeometryColumn** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. `ALTER TABLE some_table DROP COLUMN geom;`
- **DropGeometryTable** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. `DROP TABLE geometry_columns;`
- **Populate Geometry Columns** - Enhanced: 2.0.0 - added support for specifying the origin of rotation were added. Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints.

- **ST_3DExtent** - Changed: 2.0.0 In prior versions this used to be called ST_Extent3D Aggregate function that returns the 3D bounding box of geometries.
- **ST_3DLength** - `geometry`: 2.0.0 `geometry` ST_Length3D `geometry`. `geometry`.
- **ST_3DMakeBox** - Changed: 2.0.0 In prior versions this used to be called ST_MakeBox3D Creates a BOX3D defined by two 3D point geometries.
- **ST_3DPerimeter** - `geometry`: 2.0.0 `geometry` ST_Perimeter3D `geometry`. `geometry`.
- **ST_AsBinary** - `geometry`: 2.0.0 `geometry` ST_AsBinary(`geometry`, `n`) `bytea`. ST_AsBinary('POINT(1 2)') `geometry`, n st_asbinary(unknown) is not unique error `geometry`. `geometry` ST_AsBinary('POINT(1 2)::geometry'); `geometry`. `geometry`, legacy.sql `geometry`. Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- **ST_AsGML** - `geometry`: 2.0.0 `geometry` (named arg) `geometry`. `geometry` GML 2 `geometry` GML 3 `geometry`.
- **ST_AsGeoJSON** - `geometry`: 2.0.0 `geometry` (default arg) `geometry` (named arg) `geometry`. Return a geometry or feature in GeoJSON format.
- **ST_AsSVG** - `geometry`: 2.0.0 `geometry` (default arg) `geometry` (named arg) `geometry`. Returns SVG path data for a geometry.
- **ST_EndPoint** - `geometry`: 2.0.0 `geometry`. PostGIS `geometry`. 2.0.0 `geometry` NULL `geometry`. `geometry`, `geometry` 2.0 `geometry` NULL `geometry`. ST_LineString `geometry` ST_CircularString `geometry`.
- **ST_GeomFromText** - `geometry`: PostGIS 2.0.0 `geometry` ST_GeomFromText('GEOMETRYCOLLECTION `geometry`'). PostGIS 2.0.0 `geometry`, SQL/MM `geometry`. `geometry` ST_GeomFromText('GEOMETRYCOLLECTION EMPTY') `geometry`. WKT `geometry` ST_Geometry `geometry`.
- **ST_GeometryN** - `geometry`: 2.0.0 `geometry` NULL `geometry`. 2.0.0 `geometry` ST_GeometryN(...,1) `geometry`. ST_Geometry `geometry`.
- **ST_IsEmpty** - `geometry`: PostGIS 2.0.0 `geometry` ST_GeomFromText('GEOMETRYCOLLECTION(EMPTY `geometry`)). PostGIS 2.0.0 `geometry`, SQL/MM `geometry`. Tests if a geometry is empty.
- **ST_Length** - `geometry`: 2.0.0 `geometry`. 2.0.0 `geometry`/`geometry`/`geometry`. 2.0.0 `geometry`. `geometry` ST_Perimeter `geometry`. `geometry`.
- **ST_LocateAlong** - `geometry`: 2.0.0 `geometry` ST_Locate Along_Measure `geometry`. `geometry`, `geometry`. Returns the point(s) on a geometry that match a measure value.
- **ST_LocateBetween** - `geometry`: 2.0.0 `geometry` ST_Locate Along_Measure `geometry`. `geometry`, `geometry`. Returns the portions of a geometry that match a measure range.
- **ST_NumGeometries** - `geometry`: 2.0.0 `geometry` NULL `geometry`. 2.0.0 `geometry`, `geometry`, `geometry` 1 `geometry`. `geometry`.

- **ST_NumInteriorRings** - 2.0.0: Returns the number of interior rings of a polygon. Returns NULL for non-polygonal geometries.
- **ST_PointN** - 2.0.0: Returns the Nth point of a geometry. Returns NULL for non-point geometries. ST_LineString and ST_CircularString.
- **ST_StartPoint** - 2.0.0: Returns the first point of a LineString.

13.12.13 PostGIS Functions new or enhanced in 1.5

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 1.5

- **&&** - 1.5.0: Returns TRUE if A is 2D and B is 2D.
- **PostGIS_LibXML_Version** - 1.5: Returns the version number of the libxml2 library.
- **ST_AddMeasure** - 1.5.0: Interpolates measures along a linear geometry.
- **ST_AsBinary** - 1.5.0: Return the OGC/ISO Well-Known Binary (WKB) representation of the geometry/geography without SRID meta data.
- **ST_AsGML** - 1.5.0: Returns GML 2 or GML 3.
- **ST_AsGeoJSON** - 1.5.0: Return a geometry or feature in GeoJSON format.
- **ST_AsText** - 1.5.0: Returns WKT(Well-Known Text) with SRID.
- **ST_Buffer** - Availability: 1.5 - ST_Buffer was enhanced to support different endcaps and join types. These are useful for example to convert road linestrings into polygon roads with flat or square edges instead of rounded edges. Thin wrapper for geography was added. Computes a geometry covering all points within a given distance from a geometry.
- **ST_ClosestPoint** - 1.5.0: Returns the 2D point on g1 that is closest to g2. This is the first point of the shortest line from one geometry to the other.
- **ST_CollectionExtract** - 1.5.0: Given a geometry collection, returns a multi-geometry containing only elements of a specified type.
- **ST_Covers** - 1.5.0: Tests if every point of B lies in A
- **ST_DFullyWithin** - 1.5.0: Tests if a geometry is entirely inside a distance of another
- **ST_DWithin** - Availability: 1.5.0 support for geography was introduced Tests if two geometries are within a given distance
- **ST_Distance** - 1.5.0: Returns the distance between two geometries. Returns NULL for non-point geometries. Returns 3 values (longest).
- **ST_DistanceSphere** - 1.5: Returns the distance between two geometries on a sphere. PostGIS 1.5.

- **ST_DistanceSpheroid** - 1.5. 1.5. PostGIS 1.5.
- **ST_DumpPoints** - 1.5.0.
- **ST_Envelope** - 1.5.0 float4 (double precision; float8).
- **ST_Expand** - Availability: 1.5.0 behavior changed to output double precision instead of float4 coordinates. Returns a bounding box expanded from another bounding box or a geometry.
- **ST_GMLToSQL** - 1.5 LibXML2 1.6 GML ST_Geometry ST_GeomFromGML.
- **ST_GeomFromGML** - 1.5 LibXML2 1.6 GML PostGIS.
- **ST_GeomFromKML** - Availability: 1.5, requires libxml2 2.6+ KML PostGIS.
- **ST_HausdorffDistance** - 1.5.0 3 (shortest).
- **ST_Intersection** - Availability: 1.5 support for geography data type was introduced. Computes a geometry representing the shared portion of geometries A and B.
- **ST_Intersects** - Availability: 1.5 support for geography was introduced. Tests if two geometries intersect (they have at least one point in common).
- **ST_Length** - 1.5.0.
- **ST_LongestLine** - 1.5.0 3 (longest).
- **ST_MakeEnvelope** - 1.5 SRID SRS.
- **ST_MaxDistance** - 1.5.0 2.
- **ST_ShortestLine** - 1.5.0 2.
- **~=** - 1.5.0 A B TRUE.

13.12.14 PostGIS Functions new or enhanced in 1.4

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 1.4

- **Populate_Geometry_Columns** - 1.4.0. Ensures geometry columns are defined with type modifiers or have appropriate spatial constraints.
- **ST_Collect** - 1.4.0 ST_MakeLine ST_MakeLine. Creates a GeometryCollection or Multi* geometry from a set of geometries.
- **ST_ContainsProperly** - 1.4.0. Tests if every point of B lies in the interior of A.
- **ST_GeoHash** - 1.4.0 GeoHash.
- **ST_IsValidReason** - Availability: 1.4 Returns text stating if a geometry is valid, or a reason for invalidity.

- **ST_LineCrossingDirection** - Availability: 1.4 Returns a number indicating the crossing behavior of two LineStrings
- **ST_LocateBetweenElevations** - 1.4.0. Returns the portions of a geometry that lie in an elevation (Z) range.
- **ST_MakeLine** - 1.4.0. `ST_MakeLine` returns a LineString from a set of points. `ST_MakeLine` also takes a text input representing a set of points in a text format.
- **ST_MinimumBoundingCircle** - 1.4.0. Returns the smallest circle polygon that contains a geometry.
- **ST_Union** - Availability: 1.4.0 - `ST_Union` was enhanced. `ST_Union(geomarray)` was introduced and also faster aggregate collection in PostgreSQL. Computes a geometry representing the point-set union of the input geometries.

13.12.15 PostGIS Functions new or enhanced in 1.3

The functions given below are PostGIS functions that were added or enhanced.

Functions new in PostGIS 1.3

- **ST_AsGML** - 1.3.2. Returns a geometry in GML 2 or GML 3 format.
- **ST_AsGeoJSON** - 1.3.4. Return a geometry or feature in GeoJSON format.
- **ST_CurveToLine** - Availability: 1.3.0 Converts a geometry containing curves to a linear geometry.
- **ST_LineToCurve** - Availability: 1.3.0 Converts a linear geometry to a curved geometry.
- **ST_SimplifyPreserveTopology** - 1.3.3. Returns a simplified and valid representation of a geometry, using the Douglas-Peucker algorithm.

Chapter 14

Reporting Problems

14.1 Reporting Software Bugs

Reporting bugs effectively is a fundamental way to help PostGIS development. The most effective bug report is that enabling PostGIS developers to reproduce it, so it would ideally contain a script triggering it and every information regarding the environment in which it was detected. Good enough info can be extracted running `SELECT postgis_full_version()` [for PostGIS] and `SELECT version()` [for postgresql].

If you aren't using the latest release, it's worth taking a look at its [release changelog](#) first, to find out if your bug has already been fixed.

Using the [PostGIS bug tracker](#) will ensure your reports are not discarded, and will keep you informed on its handling process. Before reporting a new bug please query the database to see if it is a known one, and if it is please add any new information you have about it.

You might want to read Simon Tatham's paper about [How to Report Bugs Effectively](#) before filing a new report.

14.2 Reporting Documentation Issues

The documentation should accurately reflect the features and behavior of the software. If it doesn't, it could be because of a software bug or because the documentation is in error or deficient.

Documentation issues can also be reported to the [PostGIS bug tracker](#).

If your revision is trivial, just describe it in a new bug tracker issue, being specific about its location in the documentation.

If your changes are more extensive, a patch is definitely preferred. This is a four step process on Unix (assuming you already have [git](#) installed):

1. Clone the PostGIS' git repository. On Unix, type:

```
git clone https://git.osgeo.org/gitea/postgis/postgis.git
```

This will be stored in the directory `postgis`

2. Make your changes to the documentation with your favorite text editor. On Unix, type (for example):

```
vim doc/postgis.xml
```

Note that the documentation is written in DocBook XML rather than HTML, so if you are not familiar with it please follow the example of the rest of the documentation.

3. Make a patch file containing the differences from the master copy of the documentation. On Unix, type:
git diff doc/postgis.xml > doc.patch
 4. Attach the patch to a new issue in bug tracker.
-

Appendix A

Appendix

A.1 PostGIS 3.5.0

2024/xx/xx

This version requires PostgreSQL 12-17, GEOS 3.8 or higher, and Proj 6.1+. To take advantage of all features, GEOS 3.12+ is needed. To take advantage of all SFCGAL features, SFCGAL 1.5.0+ is needed.

Many thanks to our translation teams, in particular:

Dapeng Wang, Zuo Chenwei from HighGo (Chinese Team)

Teramoto Ikuhiro (Japanese Team)

Vincent Bre (French Team)

A.1.1 Breaking Changes

#5546, TopoGeometry <> TopoGeometry is now ambiguous, to get the old behaviour, assuming your TopoGeometry objects are named tg1 and tg2, use: (id(tg1) <> id(tg2) OR topology_id(tg1) <> topology_id(tg2) OR layer_id(tg1) <> layer_id(tg2) OR type(tg1) <> type(tg2)) (Sandro Santilli)

#5536, comments are not anymore included in PostGIS extensions (Sandro Santilli)

xmllint is now required to build comments (Sandro Santilli)

DocBook5 XSL is now required to build html (Sandro Santilli)

#5602, Drop support for GEOS 3.6 and 3.7 (Regina Obe)

#5571, Improve ST_GeneratePoints performance, but old seeded pseudo random points will need to be regenerated.

#5596, GH-749, Allow promoting column as an id in ST_AsGeoJson(record,..). Views and materialized views that use the ST_AsGeoJSON(record ..) will need rebuilding to upgrade to new signature (Jan Tojnar)

#5496, ST_Clip all variants replaced, will require rebuilding of materialized views that use them (Regina Obe)

#5659, ST_DFullyWithin behaviour has changed to be ST_Contains(ST_Buffer(A, R), B) (Paul Ramsey)

Remove the WFS_locks extra package. (Paul Ramsey)

A.1.2 Deprecated signatures

[GH-761](#), ST_StraightSkeleton = > CG_StraightSkeleton (Loïc Bartoletti)

[GH-189](#), All SFCGAL functions now use the prefix CG_, with the old ones using ST_ being deprecated. (Loïc Bartoletti)

A.1.3 New features

Improvements in the 'postgis' script:

- new command list-enabled
- new command list-all
- command upgrade upgrades all databases that need to be
- command status reports status of all databases

(Sandro Santilli)

[#5742](#), expose version of PROJ at compile time (Sandro Santilli)

[#5721](#), postgis_topology: Allow sharing sequences between different topologies (Lars Opsahl)

[#5667](#), postgis_topology: TopoGeo_LoadGeometry (Sandro Santilli)

[#5055](#), add explicit <> geometry operator to prevent non-unique error with <> and != (Paul Ramsey)

Add ST_HasZ/ST_HasM (Loïc Bartoletti)

[GT-123](#), postgis_sfcgal: CG_YMonotonePartition, CG_ApproxConvexPartition, CG_GreeneApproxConvexPart and CG_OptimalConvexPartition (Loïc Bartoletti)

[GT-156](#), postgis_sfcgal: CG_Visibility (Loïc Bartoletti)

[GT-157](#), postgis_sfcgal: Add ST_ExtrudeStraightSkeleton (Loïc Bartoletti)

[#5496](#), postgis_raster: ST_Clip support for touched (Regina Obe)

[GH-760](#), postgis_sfcgal: CG_Intersection, CG_3DIntersects, CG_Intersects, CG_Difference, CG_Union (and aggregate), CG_Triangulate, CG_Area, CG_3DDistance, CG_Distance (Loïc Bartoletti)

[#5687](#), Don't rely on search_path to determine postgis schema Fix for PG17 security change (Regina Obe)

[#5705](#), [GH-767](#), ST_RemoveIrrelevantPointsForView (Sam Peters)

[#5706](#), [GH-768](#), ST_RemoveSmallParts (Sam Peters)

A.1.4 Enhancements

[#3587](#), postgis_topology: faster load of big lines in topologies (Sandro Santilli)

[#5670](#), postgis_topology: faster ST_CreateTopoGeo (Sandro Santilli)

[#5531](#), documentation format upgraded to DocBook 5 (Sandro Santilli)

[#5543](#), allow building without documentation (Sandro Santilli)

[#5596](#), [GH-749](#), Allow promoting column as an id in ST_AsGeoJson(record,..). (Jan Tojnar)

[GH-744](#), Don't create docbook.css for the HTML manual, use style.css instead (Chris Mayo)

Faster implementation of point-in-poly cached index (Paul Ramsey)

Improve performance of ST_GeneratePoints (Paul Ramsey)

[#5361](#), ST_CurveN, ST_NumCurves and consistency in accessors on curved geometry (Paul Ramsey)

[GH-761](#), postgis_sfcgal: Add an optional parameter to CG_StraightSkeleton (was ST_StraightSkeleton) to use m as a distance in result (Hannes Janetzek, Loïc Bartoletti)