PostGIS 1.4.0 Manual

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Contents

Abstract

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

This is the manual for version 1.4.0

Chapter 1

Introduction

PostGIS is developed by Refractions Research Inc, as a spatial database technology research project. Refractions is a GIS and database consulting company in Victoria, British Columbia, Canada, specializing in data integration and custom software development. We plan on supporting and developing PostGIS to support a range of important GIS functionality, including full OpenGIS support, advanced topological constructs (coverages, surfaces, networks), desktop user interface tools for viewing and editing GIS data, and web-based access tools.

1.1 Credits

Mark Cave-Ayland Coordinates bug fixing and maintenance effort, alignment of PostGIS with PostgreSQL releases, windows build, integration of new GEOS functionality, and new function enhancements.

Paul Ramsey Release Manager, coordinates general direction of the project, often gets his hands dirty doing real coding.

Mark Leslie Ongoing maintenance and development of core functions.

Kevin Neufeld Documentation, Hudson automated build, advanced user support on PostGIS newsgroup.

Sandro Santilli Bug fixes and maintenance and integration of new GEOS functionality

Chris Hodgson General development

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

Jeff Lounsbury Original development of the Shape file loader/dumper.

Other contributors In alphabetical order: Alex Bodnaru, Alex Mayrhofer, Barbara Phillipot, Ben Jubb, Bernhard Reiter, Bruce Rindahl, Bruno Wolff III, Carl Anderson, Charlie Savage, Dane Springmeyer, David Skea, David Techer, Eduin Carillo, IIDA Tetsushi, Geographic Data BC, Gerald Fenoy, Gino Lucrezi, Klaus Foerster, Kris Jurka, Mark Sondheim, Markus Schaber, Michael Fuhr, Nikita Shulga, Norman Vine, Olivier Courtin, Ralph Mason, Regina Obe, Steffen Macke, Stephen Frost.

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

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

1.2 More Information

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

Chapter 2

Installation

2.1 Requirements

PostGIS has the following requirements for building and usage:

- A complete installation of PostgreSQL (including server headers). PostgreSQL is available from http://www.postgresql.org. Version 8.1 or higher is required.
- GNU C compiler (`gcc`). Some other ANSI C compilers can be used to compile PostGIS, but we find far fewer problems when compiling with `gcc`.
- GNU Make (`gmake` or `make`). For many systems, GNU `make` is the default version of make. Check the version by invoking `make-v`. Other versions of `make` may not process the PostGIS `Makefile` properly.
- Proj4 reprojection library. The Proj4 library is used to provide coordinate reprojection support within PostGIS. Proj4 is available for download from http://trac.osgeo.org/proj/.
- GEOS geometry library. The GEOS library is used to provide geometry tests (ST_Touches(), ST_Contains(), ST_Intersects()) and operations (ST_Buffer(), ST_Union(), ST_Difference()) within PostGIS. GEOS is available for download from http://trac.osgeo.org/geos/.
- (Recommended) Apache Ant (`ant`). Required for building any of the drivers under the `java` directory. Ant is available for download from http://ant.apache.org.

2.2 PostGIS

The PostGIS module is an extension to the PostgreSQL backend server. As such, PostGIS 1.4.0 *requires* full PostgreSQL server headers access in order to compile. The PostgreSQL source code is available at http://www.postgresql.org.

PostGIS 1.4.0 can be built against PostgreSQL versions 8.1.0 or higher. Earlier versions of PostgreSQL are *not* supported.

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

2.2.1 Compiling and Installing from Source

1. Before you can compile the PostGIS server modules, you must compile and install the PostgreSQL package.

   Note
   For GEOS functionality you might need to explicitly link PostgreSQL against the standard C++ library:

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

   This is a workaround for bogus C++ exceptions interaction with older development tools. If you experience weird problems (backend unexpectedly closed or similar things) try this trick. This will require recompiling your PostgreSQL from scratch, of course.
   The steps that follow are for Linux users. They will not work on Windows or Mac
   For the below - if you are not logged in as root, you may need to use sudo or su commands to run the make make install commands

2. Retrieve the PostGIS source archive from http://postgis.refractions.net/download/postgis-1.4.0.tar.gz. Uncompress and untar the archive. configure.

   All files are installed using information provided by `pg_config`

   - Libraries are installed `[pkglibdir]/lib/contrib`.
   - Important support files such as `lwpostgis.sql` are installed in `[prefix]/share/contrib`.
   - Loader and dumper binaries are installed in `[bindir]/`.

   ```
   wget http://postgis.refractions.net/download/postgis-1.4.0.tar.gz
   gzip -d -c postgis-1.4.0.tar.gz | tar xvf -
   cd postgis-1.4.0/
   ./configure
   ```

3. Make and Install

   - PostgreSQL provides a utility called `pg_config` to enable extensions like PostGIS to locate the PostgreSQL installation directory. If ./configure didn't find `pg_config`, try using the `--with-pgconfig=/path/to/pg_config` switch to specify a particular PostgreSQL installation.
   - Proj4 is now required in order to build and use PostGIS. If ./configure didn't find the Proj4 library, try using the `---with-projdir=/path/to/projdir` switch to specify an alternative Proj4 installation directory. If you have not compiled or installed Proj4, follow the instructions below if you wish to compile Proj4 from source.
   - GEOS is now required in order to build and use PostGIS. If ./configure didn't find it, try using the `--with-geosconfig=/path/to/geos-config` switch to specify the full path to the `geos-config` program. If you have not compiled or installed Geos, follow the instructions that follow below to compile Geos from source.

   ```
   make clean && make
   make install
   ldconfig
   ```

4. If you are missing proj based on above or running a version below 4.5, then install by following these steps.

   ```
   wget http://download.osgeo.org/proj/proj-4.6.0.tar.gz
   tar xvzf proj-4.6.0.tar.gz
   cd proj-4.6.0
   ./configure && make clean && make
   make install
   ldconfig
   cd ..
   ```

5. If you are missing geos based on above or running a version below 3.0, then install by following these steps.

```
wget http://download.osgeo.org/geos/geos-3.0.0.tar.bz2
tar xvjf geos-3.0.0.tar.bz2
cd geos-3.0.0
./configure && make clean && make
make install
ldconfig
cd ..
```

6. PostGIS requires the PL/pgSQL procedural language extension. Before loading the `lwpostgis.sql` file, you must first enable PL/pgSQL. You should use the `createlang` command. The PostgreSQL Programmer's Guide has the details if you want to this manually for some reason.

   ```
   # createlang plpgsql [yourdatabase]
   ```

7. Now load the PostGIS object and function definitions into your database by loading the `lwpostgis.sql` definitions file.

   ```
   # psql -d [yourdatabase] -f lwpostgis.sql
   ```

   The PostGIS server extensions are now loaded and ready to use.

8. 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.

   ```
   # psql -d [yourdatabase] -f spatial_ref_sys.sql
   ```

2.2.2 Creating PostGIS spatially-enabled databases from an in-built template

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

From the shell:

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

From SQL:

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

2.2.3 Upgrading

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

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

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

2.2.3.1 Soft upgrade

Soft upgrade consists of sourcing the lwpostgis_upgrade.sql script in your spatial database:

```
$ psql -f lwpostgis_upgrade.sql -d your_spatial_database
```

If a soft upgrade is not possible the script will abort and you will be warned about HARD UPGRADE being required, so do not hesitate to try a soft upgrade first.

Note
If you can't find the `lwpostgis_upgrade.sql` file you are probably using a version prior to 1.1 and must generate that file by yourself. This is done with the following command:

```
$ utils/postgis_proc_upgrade.pl lwpostgis.sql > lwpostgis_upgrade.sql
```

2.2.3.2 Hard upgrade

By HARD UPGRADE we intend full dump/reload of postgis-enabled databases. You need an 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.

PostGIS provides an utility script to restore a dump produced with the pg_dump -Fc command. It is experimental so redirecting its output to a file will help in case of problems. The procedure is as follow:

Create a "custom-format" dump of the database you want to upgrade (let's call it "olddb")

```
$ pg_dump -Fc olddb > olddb.dump
```

Restore the dump contextually upgrading postgis into a new database. The new database doesn't have to exist. postgis_restore accepts createdb parameters after the dump file name, and that can for instance be used if you are using a non-default character encoding for your database. Let's call it "newdb", with UNICODE as the character encoding:

```
$ sh utils/postgis_restore.pl lwpostgis.sql newdb olddb.dump -E=UNICODE > restore.log
```

Check that all restored dump objects really had to be restored from dump and do not conflict with the ones defined in lwpostgis.sql

```
$ grep ^KEEPING restore.log | less
```

If upgrading from PostgreSQL < 8.0 to >= 8.0 you might want to drop the attrelid, varattnum and stats columns in the geometry_columns table, which are no-more needed. Keeping them won't hurt. DROPPING THEM WHEN REALLY NEEDED WILL DO HURT !

```
$ psql newdb -c "ALTER TABLE geometry_columns DROP attrelid"
$ psql newdb -c "ALTER TABLE geometry_columns DROP varattnum"
$ psql newdb -c "ALTER TABLE geometry_columns DROP stats"
```

spatial_ref_sys table is restore from the dump, to ensure your custom additions are kept, but the distributed one might contain modification so you should backup your entries, drop the table and source the new one. If you did make additions we assume you know how to backup them before upgrading the table. Replace of it with the new one is done like this:

```
$ psql newdb
newdb=> drop spatial_ref_sys;
DROP
newdb=> \i spatial_ref_sys.sql
```

2.2.4 Common Problems

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

1. Check that you you have installed PostgreSQL 8.1 or newer, and that you are compiling against the same version of the PostgreSQL source as the version of PostgreSQL that is running. Mix-ups can occur when your (Linux) distribution has already installed PostgreSQL, or you have otherwise installed PostgreSQL before and forgotten about it. PostGIS will only work with PostgreSQL 8.1 or newer, and strange, unexpected error messages will result if you use an older version. To check the version of PostgreSQL which is running, connect to the database using psql and run this query:

   ```
   SELECT version();
   ```

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

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

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

2.3 JDBC

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

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

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

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

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

2.4 Loader/Dumper

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

```
# cd postgis-1.4.0/loader
# make
# make install
```

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

Chapter 3

Frequently Asked Questions

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

   You can store point, line, polygon, multipoint, multiline, multipolygon, and geometrycollections. These are specified in the Open GIS Well Known Text Format (with XYZ,XYM,XYZM extensions).

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

   First, you need to create a table with a column of type "geometry" to hold your GIS data. Connect to your database with `psql` and try the following SQL:

```
CREATE TABLE gtest ( ID int4, NAME varchar(20) );
SELECT AddGeometryColumn('', 'gtest','geom',-1,'LINESTRING',2);
```

   If the geometry column addition fails, you probably have not loaded the PostGIS functions and objects into this database. See the installation instructions.Then, you can insert a geometry into the table using a SQL insert statement. The GIS object itself is formatted using the OpenGIS Consortium "well-known text" format:

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

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

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

   The return value should look something like this:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Chapter 4

Using PostGIS

4.1 GIS Objects

The GIS objects supported by PostGIS are a superset of the "Simple Features" defined by the OpenGIS Consortium (OGC). As of version 0.9, PostGIS supports all the objects and functions specified in the OGC "Simple Features for SQL" specification.

PostGIS extends the standard with support for 3DZ,3DM and 4D coordinates.

4.1.1 OpenGIS WKB and WKT

The OpenGIS specification defines two standard ways of expressing spatial objects: the Well-Known Text (WKT) form and the Well-Known Binary (WKB) form. Both WKT and WKB include information about the type of the object and the coordinates which form the object.

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

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

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

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

```
bytea WKB = asBinary(geometry);
text WKT = asText(geometry);
geometry = GeomFromWKB(bytea WKB, SRID);
geometry = GeometryFromText(text WKT, SRID);
```

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

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

4.1.2 PostGIS EWKB, EWKT and Canonical Forms

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

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

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

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

- POINT(0 0 0) -- XYZ
- SRID=32632;POINT(0 0) -- XY with SRID
- POINTM(0 0 0) -- XYM
- POINT(0 0 0 0) -- XYZM
- SRID=4326;MULTIPOINTM(0 0 0,1 2 1) -- XYM with SRID
- MULTILINESTRING((0 0 0,1 1 0,1 2 1),(2 3 1,3 2 1,5 4 1))
- POLYGON((0 0 0,4 0 0,4 4 0,0 4 0,0 0 0),(1 1 0,2 1 0,2 2 0,1 2 0,1 1 0))
- MULTIPOLYGON(((0 0 0,4 0 0,4 4 0,0 4 0,0 0 0),(1 1 0,2 1 0,2 2 0,1 2 0,1 1 0)),((-1 -1 0,-1 -2 0,-2 -2 0,-2 -1 0,-1 -1 0)))
- GEOMETRYCOLLECTIONM(POINTM(2 3 9), LINESTRINGM(2 3 4, 3 4 5))

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

```
bytea EWKB = asEWKB(geometry);
text EWKT = asEWKT(geometry);
geometry = GeomFromEWKB(bytea EWKB);
geometry = GeomFromEWKT(text EWKT);
```

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

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

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

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

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

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

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

4.1.3 SQL-MM Part 3

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

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

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

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

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

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

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

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

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

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

  This is currently where PostGIS falls down. Due to the way compound strings are represented internally, we cannot yet embed them within curve polygons.

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

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

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

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

Note
Currently, PostGIS cannot support the use of Compound Curves in a Curve Polygon.

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

4.2 Using OpenGIS Standards

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

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

4.2.1 The SPATIAL_REF_SYS Table and Spatial Reference Systems

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

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

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

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

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

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

The `SPATIAL_REF_SYS` table definition is as follows:

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

The `SPATIAL_REF_SYS` columns are as follows:

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

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

AUTH_SRID The ID of the Spatial Reference System as defined by the Authority cited in the `AUTH_NAME`. In the case of EPSG, this is where the EPSG projection code would go.

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

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

For a listing of EPSG projection codes and their corresponding WKT representations, see http://www.opengis.org/techno/-interop/EPSG2WKT.TXT. For a discussion of WKT in general, see the OpenGIS "Coordinate Transformation Services Implementation Specification" at http://www.opengis.org/techno/specs.htm. For information on the European Petroleum Survey Group (EPSG) and their database of spatial reference systems, see http://epsg.org.

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

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

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

4.2.2 The GEOMETRY_COLUMNS Table

The GEOMETRY_COLUMNS table definition is as follows:

```
CREATE TABLE geometry_columns (
  f_table_catalog    VARRCHAR(256) NOT NULL,
  f_table_schema     VARCHAR(256) NOT NULL,
  f_table_nam        VARCHAR(256) NOT NULL,
  f_geometry_column  VARCHAR(256) NOT NULL,
  coord_dimension    INTEGER NOT NULL,
  srid               INTEGER NOT NULL,
  type               VARCHAR(30) NOT NULL
)
```

The columns are as follows:

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

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

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

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

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

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

4.2.3 Creating a Spatial Table

Creating a table with spatial data is done in two stages:

- Create a normal non-spatial table.
  For example: **CREATE TABLE ROADS_GEOM (ID int4, NAME varchar(25))**
- Add a spatial column to the table using the OpenGIS "AddGeometryColumn" function.
  The syntax is:

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

Or, using current schema:

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

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

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

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

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

Here is another example, using the generic "geometry" type and the undefined SRID value of -1:

```
CREATE TABLE roads (
  road_id INTEGER,
  road_name VARCHAR
);
SELECT AddGeometryColumn( 'roads', 'roads_geom', -1, 'GEOMETRY', 3 );
```

4.2.4 Ensuring OpenGIS compliancy of geometries

Most of the functions implemented by the GEOS library rely on the assumption that your geometries are valid as specified by the OpenGIS Simple Feature Specification. To check validity of geometries you can use the IsValid() function:

```
 gisdb=# select isvalid('LINESTRING(0 0, 1 1)'),
        isvalid('LINESTRING(0 0,0 0)');

 isvalid | isvalid
---------+---------
       t |       f
```

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

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

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

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

4.3 Loading GIS Data

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

4.3.1 Using SQL

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

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

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

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

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

4.3.2 Using the Loader

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

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

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

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

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

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

-s <SRID> Creates and populates the geometry tables with the specified SRID.

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

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

-I Create a GiST index on the geometry column.

-w Output WKT format, for use with older (0.x) versions of PostGIS. Note that this will introduce coordinate drifts and will drop M values from shapefiles.

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

Note that -a, -c, -d and -p are mutually exclusive.

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

```
# shp2pgsql shaperoads myschema.roadstable > roads.sql
# psql -d roadsdb -f roads.sql
```

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

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

4.4 Retrieving GIS Data

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

4.4.1 Using SQL

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

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

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

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

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

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

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

Next, you can use these operators in queries. Note that when specifying geometries and boxes on the SQL command line, you must explicitly turn the string representations into geometries by using the "GeomFromText()" function. So, for example:

```
SELECT road_id, road_name
  FROM roads
  WHERE roads_geom ~= GeomFromText('LINESTRING(191232 243118,191108 243242)',-1);
```

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

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

```
SELECT road_id, road_name
FROM roads
WHERE roads_geom && GeomFromText('POLYGON((...))',-1);
```

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

The most common spatial query will probably be a "frame-based" query, used by client software, like data browsers and web mappers, to grab a "map frame" worth of data for display. Using a "BOX3D" object for the frame, such a query looks like this:

```
SELECT AsText(roads_geom) AS geom
FROM roads
WHERE
  roads_geom && SetSRID('BOX3D(191232 243117,191232 243119)'::box3d,-1);
```

Note the use of the SRID, to specify the projection of the BOX3D. The value -1 is used to indicate no specified SRID.

4.4.2 Using the Dumper

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

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

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

The commandline options are:

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

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

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

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

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

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

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

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

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

4.5 Building Indexes

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

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

4.5.1 GiST Indexes

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

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

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

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

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

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

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

4.5.2 Using Indexes

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

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

- Firstly, make sure statistics are gathered about the number and distributions of values in a table, to provide the query planner with better information to make decisions around index usage. For PostgreSQL 7.4 installations and below this is done by running **update_geometry_stats([table_name, column_name])** (compute distribution) and **VACUUM ANALYZE [table_name] [column_name]** (compute number of values). Starting with PostgreSQL 8.0 running **VACUUM ANALYZE** will do both operations. You should regularly vacuum your databases anyways -- many PostgreSQL DBAs have **VACUUM** run as an off-peak cron job on a regular basis.

- If vacuuming does not work, you can force the planner to use the index information by using the **SET ENABLE_SEQSCAN=OFF** command. You should only use this command sparingly, and only on spatially indexed queries: generally speaking, the planner knows better than you do about when to use normal B-Tree indexes. Once you have run your query, you should consider setting `ENABLE_SEQSCAN` back on, so that other queries will utilize the planner as normal.

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

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

4.6 Complex Queries

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

4.6.1 Taking Advantage of Indexes

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

```
SELECT the_geom
FROM geom_table
WHERE ST_Distance(the_geom, GeomFromText('POINT(100000 200000)', -1)) < 100
```

This query is selecting all the geometries in geom_table which are within 100 units of the point (100000, 200000). It will be slow because it is calculating the distance between each point in the table and our specified point, ie. one `ST_Distance()` calculation for each row in the table. We can avoid this by using the && operator to reduce the number of distance calculations required:

```
SELECT the_geom
FROM geom_table
WHERE the_geom && 'BOX3D(90900 190900, 100100 200100)'::box3d
  AND
ST_Distance(the_geom, GeomFromText('POINT(100000 200000)', -1)) < 100
```

This query selects the same geometries, but it does it in a more efficient way. Assuming there is a GiST index on the_geom, the query planner will recognize that it can use the index to reduce the number of rows before calculating the result of the `distance()` function. Notice that the `BOX3D` geometry which is used in the && operation is a 200 unit square box centered on the original point - this is our "query box". The && operator uses the index to quickly reduce the result set down to only those geometries which have bounding boxes that overlap the "query box". Assuming that our query box is much smaller than the extents of the entire geometry table, this will drastically reduce the number of distance calculations that need to be done.

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

4.6.2 Examples of Spatial SQL

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

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

The table definition for the `bc_municipality` table is:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

   This is an example of a "spatial join", because we are bringing together data from two tables (doing a join) but using a spatial interaction condition ("contained") as the join condition rather than the usual relational approach of joining on a common key:

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

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

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

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

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

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

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

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

kilometers
------------------
```

```
4.89151904172838
(1 row)
```

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

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

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

4.7 Using Mapserver

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

- The Mapserver homepage is at http://mapserver.gis.umn.edu.
- The OpenGIS Web Map Specification is at http://www.opengis.org/techno/specs/01-047r2.pdf.

4.7.1 Basic Usage

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

To use PostGIS with Mapserver, you will need:

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

Mapserver accesses PostGIS/PostgreSQL data like any other PostgreSQL client -- using `libpq`. This means that Mapserver can be installed on any machine with network access to the PostGIS server, as long as the system has the `libpq` PostgreSQL client libraries.

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

```
LAYER
  CONNECTIONTYPE postgis
  NAME "widehighways"
  # Connect to a remote spatial database
  CONNECTION "user=dbuser dbname=gisdatabase host=bigserver"
  # Get the lines from the 'geom' column of the 'roads' table
  DATA "geom from roads"
  STATUS ON
  TYPE LINE
  # Of the lines in the extents, only render the wide highways
  FILTER "type = 'highway' and numlanes >= 4"
  CLASS
    # Make the superhighways brighter and 2 pixels wide
    EXPRESSION ([numlanes] >= 6)
    STYLE
```

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

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

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

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

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

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

DATA The form of this parameter is "<column> from <tablename>" where the column is the spatial column to be rendered to the map.

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

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

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

4. If you will be querying your layers using Mapserver you will also need an "oid index".

   Mapserver requires unique identifiers for each spatial record when doing queries, and the PostGIS module of Mapserver uses the PostgreSQL `oid` value to provide these unique identifiers. A side-effect of this is that in order to do fast random access of records during queries, an index on the `oid` is needed.

   To build an "oid index", use the following SQL:

```
CREATE INDEX [indexname] ON [tablename] ( oid );
```

4.7.2 Frequently Asked Questions

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

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

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

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

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

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

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

   In general, expect PostGIS layers to be 10% slower than equivalent Shape files layers, due to the extra overhead involved in database connections, data transformations and data transit between the database and Mapserver.If you are finding substantial draw performance problems, it is likely that you have not build a spatial index on your table.

```
postgis# CREATE INDEX geotable_gix ON geotable USING GIST ( geocolumn );
postgis# SELECT update_geometry_stats(); -- For PGSQL < 8.0
postgis# VACUUM ANALYZE; -- For PGSQL >= 8.0
```

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

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

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

   If your table does not have an explicit unique column, you can "fake" a unique column by using the PostgreSQL row "oid" for your unique column. "oid" is the default unique column if you do not declare one, so enhancing your query speed is a matter of building an index on your spatial table oid value.

   ```
   postgis# CREATE INDEX geotable_oid_idx ON geotable (oid);
   ```

4.7.3 Advanced Usage

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

```
DATA "the_geom FROM (
  SELECT
    table1.the_geom AS the_geom,
    table1.oid AS oid,
    table2.data AS data
  FROM table1
  LEFT JOIN table2
  ON table1.id = table2.id
) AS new_table USING UNIQUE oid USING SRID=-1"
```

USING UNIQUE <uniqueid> Mapserver requires a unique id for each row in order to identify the row when doing map queries. Normally, it would use the oid as the unique identifier, but views and subselects don't automatically have an oid column. If you want to use Mapserver's query functionality, you need to add a unique column to your view or subselect, and declare it with `USING UNIQUE`. For example, you could explicitly select one of the table's oid values for this purpose, or any other column which is guaranteed to be unique for the result set.

The `USING` statement can also be useful even for simple `DATA` statements, if you are doing map queries. It was previously recommended to add an index on the oid column of tables used in query-able layers, in order to speed up the performance of map queries. However, with the `USING` clause, it is possible to tell mapserver to use your table's primary key as the identifier for map queries, and then it is no longer necessary to have an additional index.

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

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

Warning
The parser for Mapserver PostGIS layers is fairly primitive, and is case sensitive in a few areas. Be careful to ensure that all SQL keywords and all your `USING` clauses are in upper case, and that your `USING UNIQUE` clause precedes your `USING SRID` clause.

4.7.4 Examples

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

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

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

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

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

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

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

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

```
LAYER
  CONNECTION "user=theuser password=thepass dbname=thedb host=theserver"
  DATA "the_geom FROM (SELECT roads.oid AS oid, roads.the_geom AS the_geom,
        road_names.name as name FROM roads LEFT JOIN road_names ON
        roads.road_name_id = road_names.road_name_id)
        AS named_roads USING UNIQUE oid USING SRID=-1"
  MAXSCALE 20000
  STATUS ON
  TYPE ANNOTATION
  LABELITEM name
  CLASS
    LABEL
      ANGLE auto
      SIZE 8
      COLOR 0 192 0
      TYPE truetype
      FONT arial
    END
  END
END
```

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

4.8 Java Clients (JDBC)

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

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

public class JavaGIS {

public static void main(String[] args) {

  java.sql.Connection conn;

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

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

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

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

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

4.9 C Clients (libpq)

...

4.9.1 Text Cursors

...

4.9.2 Binary Cursors

...

Chapter 5

Performance tips

5.1 Small tables of large geometries

5.1.1 Problem description

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

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

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

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

5.1.2 Workarounds

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

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

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

```
SELECT AddGeometryColumn('myschema','mytable','bbox','4326','GEOMETRY','2');
UPDATE mytable SET bbox = ST_Envelope(ST_Force_2d(the_geom));
```

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

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

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

5.2 CLUSTERing on geometry indices

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

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

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

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

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

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

5.3 Avoiding dimension conversion

Sometimes, you happen to have 3D or 4D data in your table, but always access it using OpenGIS compliant ST_AsText() or ST_AsBinary() functions that only output 2D geometries. They do this by internally calling the ST_Force_2d() function, which introduces a significant overhead for large geometries. To avoid this overhead, it may be feasible to pre-drop those additional dimensions once and forever:

```
UPDATE mytable SET the_geom = ST_Force_2d(the_geom);
VACUUM FULL ANALYZE mytable;
```

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

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

Chapter 6

PostGIS Reference

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

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

6.1 OpenGIS Functions

6.1.1 Geometry Relationship Functions

ST_Covers(geometry A, geometry B) Returns 1 (TRUE) if no point in Geometry B is outside Geometry A

Refer to http://lin-ear-th-inking.blogspot.com/2007/06/subtleties-of-ogc-covers-spatial.html for an explanation of the need of this function.

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_Covers.

ST_CoveredBy(geometry A, geometry B) Returns 1 (TRUE) if no point in Geometry A is outside Geometry B

Refer to http://lin-ear-th-inking.blogspot.com/2007/06/subtleties-of-ogc-covers-spatial.html for an explanation of the need of this function.

ST_Relate(geometry, geometry, intersectionPatternMatrix) Returns 1 (TRUE) if this Geometry is spatially related to anotherGeometry, by testing for intersections between the Interior, Boundary and Exterior of the two geometries as specified by the values in the intersectionPatternMatrix.

Performed by the GEOS module

Do not call with a GeometryCollection as an argument

NOTE: this is the "allowable" version that returns a boolean, not an integer.

OGC SPEC s2.1.1.2 // s2.1.13.3

ST_Relate(geometry, geometry) returns the DE-9IM (dimensionally extended nine-intersection matrix)

Performed by the GEOS module

Do not call with a GeometryCollection as an argument

not in OGC spec, but implied. see s2.1.13.2

6.1.2 Geometry Processing Functions

ST_Boundary(geometry) Returns the closure of the combinatorial boundary of this Geometry. The combinatorial boundary is defined as described in section 3.12.3.2 of the OGC SPEC. Because the result of this function is a closure, and hence topologically closed, the resulting boundary can be represented using representational geometry primitives as discussed in the OGC SPEC, section 3.12.2.

Performed by the GEOS module

OGC SPEC s2.1.1.1

ST_Buffer(geometry, double, [integer]) Returns a geometry that represents all points whose distance from this Geometry is less than or equal to distance. Calculations are in the Spatial Reference System of this Geometry. The optional third parameter sets the number of segment used to approximate a quarter circle (defaults to 8).

Performed by the GEOS module.

OGC SPEC s2.1.1.3

ST_ConvexHull(geometry) The convex hull of a geometry represents the minimum closed geometry that encloses all geometries within the set.

It is usually used with MULTI and Geometry Collections. Although it is not an aggregate - you can use it in conjunction with ST_Collect to get the convex hull of a set of points. ST_ConvexHull(ST_Collect(somepointfield)). It is often used to determine an affected area based on a set of point observations.

```
SELECT d.disease_type, ST_ConvexHull(ST_Collect(d.the_geom)) As the_geom
  FROM disease_obs As d
  GROUP BY d.disease_type
```

Performed by the GEOS module

OGC SPEC s2.1.1.3

ST_Intersection(geometry, geometry) Returns a geometry that represents the point set intersection of the Geometries.

In other words - that portion of geometry A and geometry B that is shared between the two geometries.

Performed by the GEOS module

Do not call with a GeometryCollection as an argument

OGC SPEC s2.1.1.3

ST_Shift_Longitude(geometry) Reads every point/vertex in every component of every feature in a geometry, and if the longitude coordinate is <0, adds 360 to it. The result would be a 0-360 version of the data to be plotted in a 180 centric map

ST_SymDifference(geometry A, geometry B) Returns a geometry that represents the portions of A and B that do not intersect. It is called a symmetric difference because ST_SymDifference(A,B) = ST_SymDifference(B,A).

Performed by the GEOS module

Do not call with a GeometryCollection as an argument

OGC SPEC s2.1.1.3

ST_Difference(geometry A, geometry B) Returns a geometry that represents that part of geometry A that does not intersect with geometry B.

Performed by the GEOS module

Do not call with a GeometryCollection as an argument

OGC SPEC s2.1.1.3

ST_MemUnion(geometry set) Same as the above, only memory-friendly (uses less memory and more processor time).

6.1.3 Geometry Accessors

ST_IsEmpty(geometry) Returns 1 (TRUE) if this Geometry is the empty geometry . If true, then this Geometry represents the empty point set - i.e. GEOMETRYCOLLECTION(EMPTY).

OGC SPEC s2.1.1.1

ST_IsSimple(geometry) Returns 1 (TRUE) if this Geometry has no anomalous geometric points, such as self intersection or self tangency.

Performed by the GEOS module

OGC SPEC s2.1.1.1

ST_NumGeometries(geometry) If geometry is a GEOMETRYCOLLECTION (or MULTI*) return the number of geometries, otherwise return NULL.

ST_GeometryN(geometry,nth integer) Return the Nth geometry if the geometry is a GEOMETRYCOLLECTION, MULTIPOINT, MULTILINESTRING or MULTIPOLYGON. Otherwise, return NULL.

> **Note**
> Index is 1-based as for OGC specs since version 0.8.0. Previous versions implemented this as 0-based instead.

ST_NumPoints(geometry) Find and return the number of points in the first linestring in the geometry. Return NULL if there is no linestring in the geometry.

ST_PointN(geometry,nth integer) Return the Nth point in the first linestring in the geometry. Return NULL if there is no linestring in the geometry.

> **Note**
> Index is 1-based as for OGC specs since version 0.8.0. Previous versions implemented this as 0-based instead.

ST_ExteriorRing(polygon geometry) Return the exterior ring of the polygon geometry. Return NULL if the geometry is not a polygon. Will not work with MULTIPOLYGON

```
--If you have a table of polygons
SELECT gid, ST_ExteriorRing(the_geom) AS ering
FROM sometable;

--If you have a table of MULTIPOLYGONs
--and want to return a MULTILINESTRING composed of the exterior rings of each polygon
SELECT gid, ST_Collect(ST_ExteriorRing(the_geom)) AS erings
  FROM (SELECT gid, (ST_Dump(the_geom)).geom As the_geom
      FROM sometable) As foo
GROUP BY gid;
```

ST_NumInteriorRings(polygon geometry) Return the number of interior rings of the first polygon in the geometry. This will work with both POLYGON and MULTIPOLYGON types but only looks at the first polygon. Return NULL if there is no polygon in the geometry.

```
--If you have a regular polygon
SELECT gid, field1, field2, ST_NumInteriorRings(the_geom) AS numholes
FROM sometable;

--If you have multipolygons
--And you want to know the total number of interior rings in the MULTIPOLYGON
SELECT gid, field1, field2, SUM(ST_NumInteriorRings(the_geom)) AS numholes
FROM (SELECT gid, field1, field2, (ST_Dump(the_geom)).geom As the_geom
  FROM sometable) As foo
GROUP BY gid, field1,field2;
```

ST_NumInteriorRing(geometry) Synonym to NumInteriorRings(geometry). The OpenGIS specs are ambiguous about the exact function naming, so we provide both spellings.

ST_InteriorRingN(geometry,nth integer) Return the Nth interior ring of the polygon geometry. Return NULL if the geometry is not a polygon or the given N is out of range.

> **Note**
> Index is 1-based as for OGC specs since version 0.8.0. Previous versions implemented this as 0-based instead.

GeometryType(geometry) Returns the type of the geometry as a string. Eg: 'LINESTRING', 'POLYGON', 'MULTIPOINT', etc.

OGC SPEC s2.1.1.1 - Returns the name of the instantiable subtype of Geometry of which this Geometry instance is a member. The name of the instantiable subtype of Geometry is returned as a string.

> **Note**
> This function also indicates if the geometry is measured, by returning a string of the form 'POINTM'.

ST_X(geometry) Return the X coordinate of the point. Input must be a point.

ST_Y(geometry) Return the Y coordinate of the point. Input must be a point.

ST_Z(geometry) Return the Z coordinate of the point, or NULL if not available. Input must be a point.

ST_M(geometry) Return the M coordinate of the point, or NULL if not available. Input must be a point.

> **Note**
> This is not (yet) part of the OGC spec, but is listed here to complete the point coordinate extractor function list.

6.1.4 Geometry Constructors

ST_LineFromText(text), ST_LineFromText(text,srid integer) Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Throws an error if the WKT is not a Line

ST_LinestringFromText(text), ST_LinestringFromText(text,srid integer) Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to -1.

from the conformance suite

Throws an error if the WKT is not a Line

ST_PolyFromText(text,[<srid>]) Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Throws an error if the WKT is not a Polygon

ST_PolygonFromText(text,[<srid>]) Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to -1.

from the conformance suite

Throws an error if the WKT is not a Polygon

ST_MPointFromText(text,[<srid>]) Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Throws an error if the WKT is not a MULTIPOINT

ST_MLineFromText(text,[<srid>]) Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Throws an error if the WKT is not a MULTILINESTRING

ST_MPolyFromText(text,[<srid>]) Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Throws an error if the WKT is not a MULTIPOLYGON

ST_GeomCollFromText(text,[<srid>]) Makes a Geometry from WKT with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

Throws an error if the WKT is not a GEOMETRYCOLLECTION

ST_GeomFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.6.2 - option SRID is from the conformance suite

ST_GeometryFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.7.2 - option SRID is from the conformance suite

ST_PointFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.7.2 - option SRID is from the conformance suite

throws an error if WKB is not a POINT

ST_LineFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.7.2 - option SRID is from the conformance suite

throws an error if WKB is not a LINESTRING

ST_LinestringFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

from the conformance suite

throws an error if WKB is not a LINESTRING

ST_PolyFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.7.2 - option SRID is from the conformance suite

throws an error if WKB is not a POLYGON

ST_PolygonFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

from the conformance suite

throws an error if WKB is not a POLYGON

ST_MPointFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.7.2 - option SRID is from the conformance suite

throws an error if WKB is not a MULTIPOINT

ST_MLineFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.7.2 - option SRID is from the conformance suite

throws an error if WKB is not a MULTILINESTRING

ST_MPolyFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.7.2 - option SRID is from the conformance suite

throws an error if WKB is not a MULTIPOLYGON

ST_GeomCollFromWKB(bytea,[<srid>]) Makes a Geometry from WKB with the given SRID. If SRID is not give, it defaults to -1.

OGC SPEC 3.2.7.2 - option SRID is from the conformance suite

throws an error if WKB is not a GEOMETRYCOLLECTION

6.2 PostGIS Extensions

6.2.1 Management Functions

update_geometry_stats([<table_name>, <column_name>]) Update statistics about spatial tables for use by the query planner. You will also need to run "VACUUM ANALYZE [table_name] [column_name]" for the statistics gathering process to be complete. NOTE: starting with PostgreSQL 8.0 statistics gathering is automatically performed running "VACUUM ANALYZE".

postgis_script_build_date() Returns build date of the PostGIS scripts.

Availability: 1.0.0RC1

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

postgis_scripts_released() Returns the version number of the lwpostgis.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

6.2.2 Operators

A &< B The "&<" operator returns true if A's bounding box overlaps or is to the left of B's bounding box.

A &> B The "&>" operator returns true if A's bounding box overlaps or is to the right of B's bounding box.

A « B The "«" operator returns true if A's bounding box is strictly to the left of B's bounding box.

A » B The "»" operator returns true if A's bounding box is strictly to the right of B's bounding box.

A &<| B The "&<|" operator returns true if A's bounding box overlaps or is below B's bounding box.

A |&> B The "|&>" operator returns true if A's bounding box overlaps or is above B's bounding box.

A «| B The "«|" operator returns true if A's bounding box is strictly below B's bounding box.

A |» B The "|»" operator returns true if A's bounding box is strictly above B's bounding box.

A ~= B The "~=" operator is the "same as" operator. It tests actual geometric equality of two features. So if A and B are the same feature, vertex-by-vertex, the operator returns true.

A @ B The "@" operator returns true if A's bounding box is completely contained by B's bounding box.

A ~ B The "~" operator returns true if A's bounding box completely contains B's bounding box.

A && B The "&&" operator is the "overlaps" operator. If A's bounding box overlaps B's bounding box the operator returns true.

6.2.3 Measurement Functions

ST_Distance_Sphere(point, point) Returns linear distance in meters between two lat/lon points. Uses a spherical earth and radius of 6370986 meters. Faster than ST_Distance_Spheroid(), but less accurate. Only implemented for points.

ST_Distance_Spheroid(point, point, spheroid) Returns linear distance between two lat/lon points given a particular spheroid. See the explanation of spheroids given for length_spheroid(). Currently only implemented for points.

ST_length2d(geometry) Returns the 2-dimensional length of the geometry if it is a linestring or multi-linestring.

ST_length3d(geometry) Returns the 3-dimensional length of the geometry if it is a linestring or multi-linestring.

ST_length_spheroid(geometry,spheroid) Calculates the length of a geometry on an ellipsoid. This is useful if the coordinates of the geometry are in latitude/longitude and a length is desired without reprojection. The ellipsoid is a separate database type and can be constructed as follows:

```
SPHEROID[<NAME>,<SEMI-MAJOR
              AXIS>,<INVERSE FLATTENING>]
```

Eg:

```
SPHEROID["GRS_1980",6378137,298.257222101]
```

An example calculation might look like this:

```
SELECT length_spheroid( geometry_column,
              'SPHEROID["GRS_1980",6378137,298.257222101]' )
              FROM geometry_table;
```

ST_length3d_spheroid(geometry,spheroid) Calculates the length of a geometry on an ellipsoid, taking the elevation into account. This is just like length_spheroid except vertical coordinates (expressed in the same units as the spheroid axes) are used to calculate the extra distance vertical displacement adds.

ST_max_distance(linestring,linestring) Returns the largest distance between two line strings.

ST_perimeter2d(geometry) Returns the 2-dimensional perimeter of the geometry, if it is a polygon or multi-polygon.

ST_perimeter3d(geometry) Returns the 3-dimensional perimeter of the geometry, if it is a polygon or multi-polygon.

ST_azimuth(geometry, geometry) Returns the azimuth of the segment defined by the given Point geometries, or NULL if the two points are coincident. Return value is in radians.

Availability: 1.1.0

6.2.4 Geometry Constructors

ST_MakePointM(<x>, <y>, <m>) Creates a 3dm point geometry.

ST_MakeBox2D(<LL>, <UR>) Creates a BOX2D defined by the given point geometries.

ST_MakeBox3D(<LLB>, <URT>) Creates a BOX3D defined by the given point geometries.

ST_LineFromMultiPoint(multipoint) Creates a LineString from a MultiPoint geometry.

ST_Polygonize(geometry set) Aggregate. Creates a GeometryCollection containing possible polygons formed from the constituent linework of a set of geometries.

Availability: 1.0.0RC1 - requires GEOS >= 2.1.0.

ST_DumpRings(geometry) This is a set-returning function (SRF). It returns a set of geometry_dump rows, formed by a geometry (geom) and an array of integers (path). The 'path' field holds the polygon ring index, contains a single element: 0 for the shell, hole number for holes. The 'geom' field contains the corresponding ring as a polygon.

Availability: PostGIS 1.1.3. Requires PostgreSQL 7.3 or higher.

6.2.5 Geometry Editors

ST_AddBBOX(geometry) Add bounding box to the geometry. This would make bounding box based queries faster, but will increase the size of the geometry.

ST_DropBBOX(geometry) Drop the bounding box cache from the geometry. This reduces geometry size, but makes bounding-box based queries slower.

ST_Force_collection(geometry) Converts the geometry into a GEOMETRYCOLLECTION. This is useful for simplifying the WKB representation.

ST_Force_2d(geometry) Forces the geometries into a "2-dimensional mode" so that all output representations will only have the X and Y coordinates. This is useful for force OGC-compliant output (since OGC only specifies 2-D geometries).

ST_Force_3dz(geometry), ST_Force_3d(geometry) Forces the geometries into XYZ mode.

ST_Force_3dm(geometry) Forces the geometries into XYM mode.

ST_Force_4d(geometry) Forces the geometries into XYZM mode.

ST_Affine(geometry, float8, float8, float8, float8, float8, float8, float8, float8, float8, float8, float8, float8) Applies an 3d affine transformation to the geometry. The call

```
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.

Availability: 1.1.2.

ST_Affine(geometry, float8, float8, float8, float8, float8, float8) Applies an 2d affine transformation to the geometry. The call

```
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.

Availability: 1.1.2.

ST_Scale(geometry, float8, float8, float8) scales the geometry to a new size by multiplying the ordinates with the parameters. Ie: scale(geom, Xfactor, Yfactor, Zfactor).

Availability: 1.1.0

ST_RotateZ(geometry, float8), ST_RotateX(geometry, float8), ST_RotateY(geometry, float8) Rotate the geometry around the Z, X or Y axis by the given angle given in radians. Follows the right-hand rule.

Availability: 1.1.2.

ST_TransScale(geometry, float8, float8, float8, float8) First, translates the geometry using the first two floats, then scales it using the second two floats, working in 2D only. Using `transscale(geom, X, Y, XFactor, YFactor)` internally calls `affine(geom, XFactor, 0, 0, 0, YFactor, 0, 0, 0, 1, X*XFactor, Y*YFactor, 0)`.

Availability: 1.1.0.

ST_ForceRHR(geometry) Force polygons of the collection to obey Right-Hand-Rule.

ST_Simplify(geometry, tolerance) Returns a "simplified" version of the given geometry using the Douglas-Peuker algorithm. Will actually do something only with (multi)lines and (multi)polygons but you can safely call it with any kind of geometry. Since simplification occurs on a object-by-object basis you can also feed a GeometryCollection to this function. Note that returned geometry might loose its simplicity (see $ST_IsSimple(geometry)$)

ST_SimplifyPreserveTopology(geometry, tolerance) Returns a "simplified" version of the given geometry using the Douglas-Peuker algorithm. Will avoid creating derived geometries (polygons in particular) that are invalid.

ST_SnapToGrid(geometry, originX, originY, sizeX, sizeY), ST_SnapToGrid(geometry, sizeX, sizeY), ST_SnapToGrid(geometry Snap all points of the input geometry to the grid defined by its origin and cell size. Remove consecutive points falling on the same cell, eventually returning NULL if output points are not enough to define a geometry of the given type. Collapsed geometries in a collection are stripped from it.

> **Note**
> The returned geometry might loose its simplicity (see $ST_IsSimple(geometry)$).

> **Note**
> Before release 1.1.0 this function always returned a 2d geometry. Starting at 1.1.0 the returned geometry will have same dimensionality as the input one with higher dimension values untouched. Use the version taking a second geometry argument to define all grid dimensions.

Availability: 1.0.0RC1

ST_SnapToGrid(geometry, geometry, sizeX, sizeY, sizeZ, sizeM) Snap all points of the input geometry to the grid defined by its origin (the second argument, must be a point) and cell sizes. Specify 0 as size for any dimension you don't want to snap to a grid.

Availability: 1.1.0

ST_Segmentize(geometry, maxlength) Return a modified geometry having no segment longer then the given distance. Interpolated points will have Z and M values (if needed) set to 0. Distance computation is performed in 2d only.

ST_LineMerge(geometry) Returns a (set of) LineString(s) formed by sewing together constituent linework of input.

Availability: 1.1.0 - requires GEOS >= 2.1.0

6.2.6 Linear Referencing

ST_line_interpolate_point(linestring geometry, locationfraction float8) Returns a point interpolated along a line. First argument must be a LINESTRING. Second argument is a float8 between 0 and 1 representing fraction of total 2d length the point has to be located.

See line_locate_point() for computing the line location nearest to a Point.

> **Note**
> Since release 1.1.1 this function also interpolates M and Z values (when present), while prior releases set them to 0.0.

Availability: 0.8.2

ST_Line_Substring(linestring geometry, startfraction float8, endfraction float8) Return a linestring being a substring of the input one starting and ending at the given fractions of total 2d length. Second and third arguments are float8 values between 0 and 1. This only works with LINESTRINGs. To use with contiguous MULTILINESTRINGs use in conjunction with ST_LineMerge.

If 'start' and 'end' have the same value this is equivalent to line_interpolate_point().

See line_locate_point() for computing the line location nearest to a Point.

> **Note**
> Since release 1.1.1 this function also interpolates M and Z values (when present), while prior releases set them to unspecified values.

Availability: 1.1.0

```
--Return the approximate 1/3 mid-range part of a linestring
SELECT ST_Line_SubString(ST_LineFromText('LINESTRING(748130.463 2919491.079,
  747979.395 2919630.415,
  747895.989829177 2919705.518)'), 0.333, 0.666);

--The below example simulates a while loop in
--SQL using PostgreSQL generate_series() to cut all
--linestrings in a table to 100 unit segments
-- of which no segment is longer than 100 units
-- units are measured in the SRID units of measurement
-- It also assumes all geometries are LINESTRING or contiguous MULTILINESTRING
--and no geometry is longer than 100 units*10000
--for better performance you can reduce the 10000
--to match max number of segments you expect

SELECT field1, field2, ST_Line_Substring(the_geom, 100.00*n/length,
  CASE
```

```
    WHEN 100.00*(n+1) < length THEN 100.00*(n+1)/length
    ELSE 1
  END) As the_geom
FROM
  (SELECT sometable.field1, sometable.field2,
  ST_LineMerge(sometable.the_geom) AS the_geom,
  ST_Length(sometable.the_geom) As length
  FROM sometable
  ) AS t
CROSS JOIN generate_series(0,10000) AS n
WHERE n*100.00/length < 1;
```

ST_line_locate_point(LineString geometry, Point geometry) Returns a float between 0 and 1 representing the location of the closest point on LineString to the given Point, as a fraction of total 2d line length.

You can use the returned location to extract a Point (line_interpolate_point) or a substring (line_substring).

Availability: 1.1.0

ST_locate_along_measure(geometry, float8) Return a derived geometry collection value with elements that match the specified measure. Polygonal elements are not supported.

Semantic is specified by: ISO/IEC CD 13249-3:200x(E) - Text for Continuation CD Editing Meeting

Availability: 1.1.0

ST_locate_between_measures(geometry, float8, float8) Return a derived geometry collection value with elements that match the specified range of measures inclusively. Polygonal elements are not supported.

Semantic is specified by: ISO/IEC CD 13249-3:200x(E) - Text for Continuation CD Editing Meeting

Availability: 1.1.0

6.2.7 Misc

ST_box2d(geometry) Returns a BOX2D representing the maximum extents of the geometry.

ST_box3d(geometry) Returns a BOX3D representing the maximum extents of the geometry.

ST_extent(geometry set) The extent() function is an "aggregate" function in the terminology of PostgreSQL. That means that it operators on lists of data, in the same way the sum() and mean() functions do. For example, "SELECT ST_Extent(GEOM) FROM GEOMTABLE" will return a BOX3D giving the maximum extent of all features in the table. Similarly, "SELECT ST_Extent(GEOM) FROM GEOMTABLE GROUP BY CATEGORY" will return one extent result for each category.

ST_zmflag(geometry) Returns ZM (dimension semantic) flag of the geometries as a small int. Values are: 0=2d, 1=3dm, 2=3dz, 3=4d.

ST_HasBBOX(geometry) Returns TRUE if the bbox of this geometry is cached, FALSE otherwise. Use addBBOX() and dropBBOX() to control caching.

ST_nrings(geometry) If the geometry is a polygon or multi-polygon returns the number of rings.

ST_estimated_extent([schema], table, geocolumn) Return the 'estimated' extent of the given spatial table. The estimated is taken from the geometry column's statistics. The current schema will be used if not specified.

For PostgreSQL>=8.0.0 statistics are gathered by VACUUM ANALYZE and resulting extent will be about 95% of the real one.

For PostgreSQL<8.0.0 statistics are gathered by update_geometry_stats() and resulting extent will be exact.

ST_find_srid(varchar,varchar,varchar) The syntax is find_srid(<db/schema>, <table>, <column>) and the function returns the integer SRID of the specified column by searching through the GEOMETRY_COLUMNS table. If the geometry column has not been properly added with the AddGeometryColumns() function, this function will not work either.

ST_mem_size(geometry) Returns the amount of space (in bytes) the geometry takes.

ST_point_inside_circle(geometry, float, float, float) The syntax for this functions is point_inside_circle(<geometry>,<circle_center_x
Returns the true if the geometry is a point and is inside the circle. Returns false otherwise.

ST_XMin(box3d) ST_YMin(box3d) ST_ZMin(box3d) Returns the requested minima of a bounding box.

ST_XMax(box3d) ST_YMax(box3d) ST_ZMax(box3d) Returns the requested maxima of a bounding box.

ST_Accum(geometry set) Aggregate. Constructs an array of geometries.

6.2.8 Long Transactions support

This module and associated pl/pgsql functions have been implemented to provide long locking support required by Web Feature Service specification.

Note
Users must use serializable transaction level otherwise locking mechanism would break.

EnableLongTransactions() Enable long transaction support. This function creates the required metadata tables, needs to be called once before using the other functions in this section. Calling it twice is harmless.

Availability: 1.1.3

DisableLongTransactions() Disable long transaction support. This function removes the long transaction support metadata tables, and drops all triggers attached to lock-checked tables.

Availability: 1.1.3

CheckAuth([<schema>], <table>, <rowid_col>) Check updates and deletes of rows in given table for being authorized. Identify rows using <rowid_col> column.

Availability: 1.1.3

LockRow([<schema>], <table>, <rowid>, <authid>, [<expires>]) Set lock/authorization for specific row in table <authid> is a text value, <expires> is a timestamp defaulting to now()+1hour. Returns 1 if lock has been assigned, 0 otherwise (already locked by other auth)

Availability: 1.1.3

UnlockRows(<authid>) Remove all locks held by specified authorization id. Returns the number of locks released.

Availability: 1.1.3

AddAuth(<authid>) Add an authorization token to be used in current transaction.

Availability: 1.1.3

6.3 SQL-MM Functions

This is a listing of the SQL-MM defined functions that PostGIS currently supports. The implementations of these functions follow the ArcSDE implementation, and thus deviate somewhat from the spec. These deviations will be noted.

As of version 1.2.0, these functions have been implemented by wrapping existing PostGIS functions. As a result, full support for curved geometries may not be in place for many functions.

Note
SQL-MM defines the default SRID of all geometry constructors as 0. PostGIS uses a default SRID of -1.

ST_Boundary Return the boundary of the ST_Geometry value.

SQL-MM 3: 5.1.14

ST_Buffer Return a buffer around the ST_Geometry value.

SQL-MM 3: 5.1.17

ST_ConvexHull The convex hull of a geometry represents the minimum geometry that encloses all geometries within the set.

It is usually used with MULTI and Geometry Collections. Although it is not an aggregate - you can use it in conjunction with ST_Collect to get the convex hull of a set of points. ST_ConvexHull(ST_Collect(somepointfield)). It is often used to determine an affected area based on a set of point observations.

SQL-MM 3: 5.1.16

ST_CoordDim Return the coordinate dimension of the ST_Geometry value.

SQL-MM 3: 5.1.3

ST_Difference Return an ST_Geometry value that represents the point set difference of two ST_Geometry values.

SQL-MM 3: 5.1.20

ST_Disjoint Test if an ST_Geometry value is spatially disjoint from another ST_Geometry value.

SQL-MM 3: 5.1.26

ST_ExteriorRing Return the exterior ring of an ST_Surface

SQL-MM 3: 8.2.3, 8.3.3

ST_GeometryN Return the indicated ST_Geometry value from an ST_GeomCollection.

SQL-MM 3: 9.1.5

ST_GeomFromWKB Return a specified ST_Geometry value.

SQL-MM 3: 5.1.41

ST_InteriorRingN Return the specified interior ring of an ST_Surface value.

SQL-MM 3: 8.2.6, 8.3.5

ST_Intersection Return an ST_Geometry value that represents the point set intersection of two ST_Geometry values.

In other words - that portion of geometry A and geometry B that is shared between the two geometries.

SQL-MM 3: 5.1.18

ST_Intersects Test if an ST_Geometry value spatially intersects another ST_Geometry value.

SQL-MM 3: 5.1.27

ST_IsEmpty Test if an ST_Geometry value corresponds to the empty set.

Note
SQL-MM defines the result of ST_IsEmpty(NULL) to be 0, while PostGIS returns NULL.

SQL-MM 3: 5.1.7

ST_IsSimple Test if an ST_Geometry value has no anomalous geometric points, such as self intersection or self tangency.

Note
SQL-MM defines the result of ST_IsSimple(NULL) to be 0, while PostGIS returns NULL.

SQL-MM 3: 5.1.8

ST_LineFromText Return a specified ST_LineString value.
SQL-MM 3: 7.2.8

ST_LineFromWKB Return a specified ST_LineString value.
SQL-MM 3: 7.2.9

ST_MLineFromText Return a specified ST_MultiLineString value.
SQL-MM 3: 9.4.4

ST_MLineFromWKB Return a specified ST_MultiLineString value.
SQL-MM 3: 9.4.5

ST_MPointFromText Return a specified ST_MultiPoint value.
SQL-MM 3: 9.2.4

ST_MPointFromWKB Return a specified ST_MultiPoint value.
SQL-MM 3: 9.2.5

ST_MPolyFromText Return a specified ST_MultiPolygon value.
SQL-MM 3: 9.6.4

ST_MPolyFromWKB Return a specified ST_MultiPolygon value.
SQL-MM 3: 9.6.5

ST_NumGeometries Return the number of geometries in an ST_GeomCollection.
SQL-MM 3: 9.1.4

ST_NumInteriorRing Return the number of interior rings in an ST_Surface.
SQL-MM 3: 8.2.5

ST_Point Returns an ST_Point with the given coordinate values.
SQL-MM 3: 6.1.2

ST_PointFromText Return a specified ST_Point value.
SQL-MM 3: 6.1.8

ST_PointFromWKB Return a specified ST_Point value.
SQL-MM 3: 6.1.9

ST_PointN Return the specified ST_Point value in an ST_LineString or ST_CircularString
SQL-MM 3: 7.2.5, 7.3.5

ST_PolyFromText Return a specified ST_Polygon value.
SQL-MM 3: 8.3.6

ST_PolyFromWKB Return a specified ST_Polygon value.
SQL-MM 3: 8.3.7

ST_Polygon Return a polygon build from the specified linestring and SRID.
SQL-MM 3: 8.3.2

ST_Relate Test if an ST_Geometry value is spatially related to another ST_Geometry value.
SQL-MM 3: 5.1.25

ST_SymDifference Return an ST_Geometry value that represents the point set symmetric difference of two ST_Geometry values.
SQL-MM 3: 5.1.21

ST_WKBToSQL Return an ST_Geometry value for a given well-known binary representation.
SQL-MM 3: 5.1.36

ST_X Returns the x coordinate value of an ST_Point value.
SQL-MM 3: 6.1.3

ST_Y Returns the y coordinate value of an ST_Point value.
SQL-MM 3: 6.1.4

6.4 ArcSDE Functions

Additional functions have been added to improve support for an ArcSDE style interface.

SE_EnvelopesIntersect Returns t (TRUE) if the envelopes of two geometries intersect; otherwise, it returns f (FALSE).

SE_Is3d Test if a geometry value has z coordinate values.

SE_IsMeasured Test if a geometry value has m coordinate values.

SE_LocateAlong Return a derived geometry collection value with elements that match the specified measur.

SE_LocateBetween Return a derived geometry collection value with elements that match the specified range of measures inclusively.

SE_M Returns the m coordinate value of an ST_Point value.

SE_Z Returns the z coordinate value of an ST_Point value

Chapter 7

PostGIS Reference

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

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

7.1 Management Functions

7.1.1 AddGeometryColumn

Name

AddGeometryColumn – Adds a geometry column to an existing table of attributes.

Synopsis

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

Description

Adds a geometry column to an existing table of attributes. The `schema_name` is the name of the table schema (unused for pre-schema PostgreSQL installations). The `srid` must be an integer value reference to an entry in the SPATIAL_REF_SYS table. The `type` must be an uppercase string corresponding to the geometry type, eg, 'POLYGON' or 'MULTILINESTRING'.

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

Examples

```
-- Create a new simple PostgreSQL table
postgis=# 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
postgis=# SELECT AddGeometryColumn ('my_schema','my_spatial_table','the_geom',4326,'POINT'
    ',2);

-- Describe the table again reveals the addition of a new "the_geom" 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)
 the_geom | geometry |
Check constraints:
    "enforce_dims_the_geom" CHECK (ndims(the_geom) = 2)
    "enforce_geotype_the_geom" CHECK (geometrytype(the_geom) = 'POINT'::text OR the_geom IS
         NULL)
    "enforce_srid_the_geom" CHECK (srid(the_geom) = 4326)
```

See Also

DropGeometryColumn, DropGeometryTable

7.1.2 DropGeometryColumn

Name

DropGeometryColumn – Removes a geometry column from a spatial table.

Synopsis

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

Description

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

✓ This method implements the OpenGIS Simple Features Implementation Specification for SQL.

See Also

AddGeometryColumn, DropGeometryTable

7.1.3 DropGeometryTable

Name

DropGeometryTable – Drops a table and all its references in geometry_columns.

Synopsis

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

Description

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

See Also

AddGeometryColumn, DropGeometryColumn

7.1.4 PostGIS_Full_Version

Name

PostGIS_Full_Version – Reports full postgis version and build configuration infos.

Synopsis

text **PostGIS_Full_Version**();

Description

Reports full postgis version and build configuration infos.

Examples

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

See Also

PostGIS_GEOS_Version, PostGIS_JTS_Version, PostGIS_Lib_Version, PostGIS_PROJ_Version, PostGIS_Version

7.1.5 PostGIS_GEOS_Version

Name

PostGIS_GEOS_Version – Returns the version number of the GEOS library.

Synopsis

text **PostGIS_GEOS_Version**();

Description

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

Examples

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

See Also

PostGIS_Full_Version, PostGIS_JTS_Version, PostGIS_Lib_Version, PostGIS_PROJ_Version, PostGIS_Version

7.1.6 PostGIS_JTS_Version

Name

PostGIS_JTS_Version – Returns the version number of the JTS library.

Synopsis

text **PostGIS_JTS_Version**();

Description

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

Examples

```
SELECT PostGIS_JTS_Version();
 postgis_jts_version
---------------------
 1.8
(1 row)
```

See Also

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_Lib_Version, PostGIS_PROJ_Version, PostGIS_Version

7.1.7 PostGIS_Lib_Build_Date

Name

PostGIS_Lib_Build_Date – Returns build date of the PostGIS library.

Synopsis

text **Postgis_Lib_Build_Date**();

Description

Returns build date of the PostGIS library.

Examples

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

7.1.8 PostGIS_Lib_Version

Name

PostGIS_Lib_Version – Returns the version number of the PostGIS library.

Synopsis

text **PostGIS_Lib_Version**();

Description

Returns the version number of the PostGIS library.

Examples

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

See Also

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_JTS_Version, PostGIS_PROJ_Version, PostGIS_Version

7.1.9 PostGIS_PROJ_Version

Name

PostGIS_PROJ_Version – Returns the version number of the PROJ4 library.

Synopsis

text **PostGIS_PROJ_Version**();

Description

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

Examples

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

See Also

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_JTS_Version, PostGIS_Lib_Version, PostGIS_Version

7.1.10 PostGIS_Uses_Stats

Name

PostGIS_Uses_Stats – Returns `TRUE` if STATS usage has been enabled.

Synopsis

text **PostGIS_Uses_Stats**();

Description

Returns `TRUE` if STATS usage has been enabled, `FALSE` otherwise.

Examples

```
SELECT PostGIS_Uses_Stats();
 postgis_uses_stats
--------------------
 t
(1 row)
```

See Also

PostGIS_Version

7.1.11 PostGIS_Version

Name

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

Synopsis

text **PostGIS_Version**();

Description

Returns PostGIS version number and compile-time options.

Examples

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

See Also

PostGIS_Full_Version, PostGIS_GEOS_Version, PostGIS_JTS_Version, PostGIS_Lib_Version, PostGIS_PROJ_Version

7.1.12 UpdateGeometrySRID

Name

UpdateGeometrySRID – Updates the SRID of all features in a geometry column, geometry_columns metadata and srid table constraint

Synopsis

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

Description

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

See Also

ST_SetSRID

7.2 Geometry Constructors

7.2.1 ST_BdPolyFromText

Name

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

Synopsis

geometry **ST_BdPolyFromText**(text WKT);

Description

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

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

✓ This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SFSQL 1.1 - 3.2.6.2

Availability: 1.1.0 - requires GEOS >= 2.1.0.

Examples

```
Forthcoming
```

See Also

ST_BuildArea, ST_BdMPolyFromText

7.2.2 ST_BdMPolyFromText

Name

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

Synopsis

geometry **ST_BdMPolyFromText**(text WKT);

Description

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

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

This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SFSQL 1.1 - 3.2.6.2

Availability: 1.1.0 - requires GEOS >= 2.1.0.

Examples

```
Forthcoming
```

See Also

ST_BuildArea, ST_BdPolyFromText

7.2.3 ST_BuildArea

Name

ST_BuildArea – Creates an areal geometry formed by the constituent linework of given geometry

Synopsis

boolean **ST_BuildArea**(geometry A);

Description

Creates an areal geometry formed by the constituent linework of given geometry. The return type can be a Polygon or MultiPolygon, depending on input. If the input lineworks do not form polygons NULL is returned. The inputs can be LINESTRINGS, MULTILINESTRINGS, POLYGONS, MULTIPOLYGONS, and GeometryCollections.

This function will assume all inner geometries represent holes

Availability: 1.1.0 - requires GEOS >= 2.1.0.

Examples

```
--This will create a donut
SELECT ST_BuildArea(ST_Collect(smallc,bigc))
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 2)'), 10) As smallc,
  ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As bigc) As foo

--This will create a gaping hole
--inside the circle with prongs sticking out
SELECT ST_BuildArea(ST_Collect(line,circle))
```

```
FROM (SELECT ST_Buffer(ST_MakeLine(ST_MakePoint(21, 22),ST_MakePoint(-19, -18)),1)  As line ↵
    ,
  ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As circle) As foo;

--this creates the same gaping hole
--but using linestrings instead of polygons
SELECT ST_AsBinary(ST_BuildArea(ST_Collect(ST_ExteriorRing(line),ST_ExteriorRing(circle))))
FROM (SELECT ST_Buffer(ST_MakeLine(ST_MakePoint(21, 22),ST_MakePoint(-19, -18)),1)  As line ↵
    ,
  ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As circle) As foo
```

See Also

ST_BdPolyFromText, ST_BdMPolyFromTextwrappers to this function with standard OGC interface

7.2.4 ST_Collect

Name

ST_Collect – Return a specified ST_Geometry value from a collection of other geometries.

Synopsis

geometry **ST_Collect**(geometry set g1field);
geometry **ST_Collect**(geometry g1, geometry g2);

Description

Output type can be a MULTI* or a GEOMETRYCOLLECTION. Comes in 2 variants. Variant 1 collects 2 geometries. Variant 2 is an aggregate function that takes a set of geometries and collects them into a single ST_Geometry.

Aggregate version: This function returns a GEOMETRYCOLLECTION or a MULTI object from a set of geometries. The ST_Collect() function is an "aggregate" function in the terminology of PostgreSQL. That means that it operates on rows of data, in the same way the SUM() and AVG() functions do. For example, "SELECT ST_Collect(GEOM) FROM GEOMTABLE GROUP BY ATTRCOLUMN" will return a separate GEOMETRYCOLLECTION for each distinct value of ATTRCOLUMN.

Non-Aggregate version: This function returns a geometry being a collection of two input geometries. Output type can be a MULTI* or a GEOMETRYCOLLECTION.

> **Note**
> ST_Collect and ST_Union are often interchangeable. ST_Collect is in general orders of magnitude faster than ST_Union because it does not try to dissolve boundaries or validate that a constructed MultiPolgon doesn't have overlapping regions. It merely rolls up single geometries into MULTI and MULTI or mixed geometry types into Geometry Collections. Unfortunately geometry collections are not well-supported by GIS tools. To prevent ST_Collect from returning a Geometry Collection when collecting MULTI geometries, one can use the below trick that utilizes ST_Dump to expand the MULTIs out to singles and then regroup them.

Examples

Aggregate example

```
Thread ref: http://postgis.refractions.net/pipermail/postgis-users/2008-June/020331.html
SELECT stusps,
     ST_Multi(ST_Collect(f.the_geom)) as singlegeom
   FROM (SELECT stusps, (ST_Dump(the_geom)).geom As the_geom
        FROM
        somestatetable ) As f
GROUP BY stusps
```

Non-Aggregate example

```
Thread ref: http://postgis.refractions.net/pipermail/postgis-users/2008-June/020331.html
SELECT ST_AsText(ST_Collect(ST_GeomFromText('POINT(1 2)'),
  ST_GeomFromText('POINT(-2 3)') ));

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

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

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

See Also

ST_Dump, ST_Union

7.2.5 ST_Dump

Name

ST_Dump – Returns a set of geometry_dump rows, formed by a geometry (geom).

Synopsis

geometry_dump[]**ST_Dump**(geometry g1);

Description

This is a set-returning function (SRF). It returns a set of geometry_dump rows, formed by a geometry (geom) and an array of integers (path). When the input geometry is a simple type (POINT,LINESTRING,POLYGON) a single record will be returned with an empty path array and the input geometry as geom. When the input geometry is a collection or multi it will return a record for each of the collection components, and the path will express the position of the component inside the collection.

ST_Dump is useful for expanding geometries. It is the reverse of a GROUP BY in that it creates new rows. For example it can be use to expand MULTIPOLYGONS into POLYGONS.

Availability: PostGIS 1.0.0RC1. Requires PostgreSQL 7.3 or higher.

Examples

```
SELECT sometable.field1, sometable.field1,
      (ST_Dump(sometable.the_geom)).geom As the_geom
FROM sometable
```

See Also

ST_Collect

7.2.6 ST_GeomFromEWKB

Name

ST_GeomFromEWKB – Return a specified ST_Geometry value from Extended Well-Known Binary representation (EWKB).

Synopsis

geometry **ST_GeomFromEWKB**(bytea EWKB);

Description

Constructs a PostGIS ST_Geometry object from the OGC Extended Well-Known binary (EWKT) representation.

> **Note**
> The EWKB format is not an OGC standard, but a PostGIS specific format that includes the spatial reference system (SRID) identifier

Examples

line string binary rep 0f LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144 42.25932) in NAD 83 long lat (4269).

> **Note**
> NOTE: Even though byte arrays are delimited with \ and may have ', we need to escape both out with \ and ''. So it does not look exactly like its AsEWKB representation.

```
SELECT ST_GeomFromEWKB(E'\\001\\002\\000\\000 \\255\\020\\000\\000\\003\\000\\000\\000\\344 ←
    J=
\\013B\\312Q\\300n\\303(\\010\\036!E@''\\277E''K
\\312Q\\300\\366{b\\235*!E@\\225|\\354.P\\312Q
\\300p\\231\\323e1!E@');
```

See Also

ST_AsBinary, ST_AsEWKB

7.2.7 ST_GeomFromEWKT

Name

ST_GeomFromEWKT – Return a specified ST_Geometry value from Extended Well-Known Text representation (EWKT).

Synopsis

geometry **ST_GeomFromEWKT**(text EWKT);

Description

Constructs a PostGIS ST_Geometry object from the OGC Extended Well-Known text (EWKT) representation.

Note
The EWKT format is not an OGC standard, but an PostGIS specific format that includes the spatial reference system (SRID) identifier

Examples

```
SELECT ST_GeomFromEWKT('SRID=4269;LINESTRING(-71.160281 42.258729,-71.160837 ↩
    42.259113,-71.161144 42.25932)');
SELECT ST_GeomFromEWKT('SRID=4269;MULTILINESTRING((-71.160281 42.258729,-71.160837 ↩
    42.259113,-71.161144 42.25932))');

SELECT ST_GeomFromEWKT('SRID=4269;POINT(-71.064544 42.28787)');

SELECT ST_GeomFromEWKT('SRID=4269;POLYGON((-71.1776585052917 ↩
    42.3902909739571,-71.1776820268866 42.3903701743239,
-71.1776063012595 42.3903825660754,-71.1775826583081 42.3903033653531,-71.1776585052917 ↩
    42.3902909739571))');

SELECT ST_GeomFromEWKT('SRID=4269;MULTIPOLYGON(((-71.1031880899493 42.3152774590236,
-71.1031627617667 42.3152960829043,-71.102923838298 42.3149156848307,
-71.1023097974109 42.3151969047397,-71.1019285062273 42.3147384934248,
-71.102505233663 42.3144722937587,-71.10277487471 42.3141658254797,
-71.103113945163 42.3142739188902,-71.10324876416 42.31402489987,
-71.1033002961013 42.3140393340215,-71.1033488797549 42.3139495090772,
-71.103396240451 42.3138632439557,-71.1041521907712 42.3141153348029,
-71.1041411411543 42.3141545014533,-71.1041287795912 42.3142114839058,
-71.1041188134329 42.3142693656241,-71.1041112482575 42.3143272556118,
-71.1041072845732 42.3143851580048,-71.1041057218871 42.3144430686681,
-71.1041065602059 42.3145009876017,-71.1041097995362 42.3145589148055,
-71.1041166403905 42.3146168544148,-71.1041258822717 42.3146748022936,
-71.1041375307579 42.3147318674446,-71.1041492906949 42.3147711126569,
-71.1041598612795 42.314808571739,-71.1042515013869 42.3151287620809,
-71.1041173835118 42.3150739481917,-71.1040809891419 42.3151344119048,
-71.1040438678912 42.3151191367447,-71.1040194562988 42.3151832057859,
-71.1038734225584 42.3151140942995,-71.1038446938243 42.3151006300338,
-71.1038315271889 42.315094347535,-71.1037393329282 42.315054824985,
-71.1035447555574 42.3152608696313,-71.1033436658644 42.3151648370544,
-71.1032580383161 42.3152269126061,-71.103223066939 42.3152517403219,
-71.1031880899493 42.3152774590236)),
((-71.1043632495873 42.315113108546,-71.1043583974082 42.3151211109857,
-71.1043443253471 42.3150676015829,-71.1043850704575 42.3150793250568,-71.1043632495873 ↩
    42.315113108546)))');
```

See Also

ST_AsEWKT, ST_GeomFromText, ST_GeomFromEWKT

7.2.8 ST_GeometryFromText

Name

ST_GeometryFromText – Return a specified ST_Geometry value from Well-Known Text representation (WKT). This is an alias name for ST_GeomFromText

Synopsis

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

Description

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

This method implements the SQL/MM specification: SQL-MM 3: 5.1.40

See Also

ST_GeomFromText

7.2.9 ST_GeomFromText

Name

ST_GeomFromText – Return a specified ST_Geometry value from Well-Known Text representation (WKT).

Synopsis

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

Description

Constructs a PostGIS ST_Geometry object from the OGC Well-Known text representation.

Note
There are 2 variants of ST_GeomFromText function, the first takes no SRID and returns a geometry with no defined spatial reference system. The second takes a spatial reference id as the second argument and returns an ST_Geometry that includes this srid as part of its meta-data. The srid must be defined in the spatial_ref_sys table.

This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SPEC 3.2.6.2 - option SRID is from the conformance suite.

This method implements the SQL/MM specification: SQL-MM 3: 5.1.40

Examples

```
SELECT ST_GeomFromText('LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144  ←
    42.25932)');
SELECT ST_GeomFromText('LINESTRING(-71.160281 42.258729,-71.160837 42.259113,-71.161144  ←
    42.25932)',4269);

SELECT ST_GeomFromText('MULTILINESTRING((-71.160281 42.258729,-71.160837  ←
    42.259113,-71.161144 42.25932))');
```

```
SELECT ST_GeomFromText('POINT(-71.064544 42.28787)');

SELECT ST_GeomFromText('POLYGON((-71.1776585052917 42.3902909739571,-71.1776820268866 ←
    42.3903701743239,
-71.1776063012595 42.3903825660754,-71.1775826583081 42.3903033653531,-71.1776585052917 ←
    42.3902909739571))');

SELECT ST_GeomFromText('MULTIPOLYGON(((-71.1031880899493 42.3152774590236,
-71.1031627617667 42.3152960829043,-71.102923838298 42.3149156848307,
-71.1023097974109 42.3151969047397,-71.1019285062273 42.3147384934248,
-71.102505233663 42.3144722937587,-71.10277487471 42.3141658254797,
-71.103113945163 42.3142739188902,-71.10324876416 42.31402489987,
-71.1033002961013 42.3140393340215,-71.1033488797549 42.3139495090772,
-71.103396240451 42.3138632439557,-71.1041521907712 42.3141153348029,
-71.1041411411543 42.3141545014533,-71.1041287795912 42.3142114839058,
-71.1041188134329 42.3142693656241,-71.1041112482575 42.3143272556118,
-71.1041072845732 42.3143851580048,-71.1041057218871 42.3144430686681,
-71.1041065602059 42.3145009876017,-71.1041097995362 42.3145589148055,
-71.1041166403905 42.3146168544148,-71.1041258822717 42.3146748022936,
-71.1041375307579 42.3147318674446,-71.1041492906949 42.3147711126569,
-71.1041598612795 42.314808571739,-71.1042515013869 42.3151287620809,
-71.1041173835118 42.3150739481917,-71.1040809891419 42.3151344119048,
-71.1040438678912 42.3151191367447,-71.1040194562988 42.3151832057859,
-71.1038734225584 42.3151140942995,-71.1038446938243 42.3151006300338,
-71.1038315271889 42.315094347535,-71.1037393329282 42.315054824985,
-71.1035447555574 42.3152608696313,-71.1033436658644 42.3151648370544,
-71.1032580383161 42.3152269126061,-71.103223066939 42.3152517403219,
-71.1031880899493 42.3152774590236)),
((-71.1043632495873 42.315113108546,-71.1043583974082 42.3151211109857,
-71.1043443253471 42.3150676015829,-71.1043850704575 42.3150793250568,-71.1043632495873 ←
    42.315113108546)))',4326);
```

See Also

ST_GeomFromEWKT, $ST_{G}eomFromWKB(bytea, [< srid >])$, ST_SRID

7.2.10 ST_MakeLine

Name

ST_MakeLine – Creates a Linestring from point geometries.

Synopsis

geometry **ST_MakeLine**(geometry set pointfield);

geometry **ST_MakeLine**(geometry point1, geometry point2);

Description

ST_MakeLine comes in 2 forms: a spatial aggregate that takes rows of point geometries and returns a line string, and a regular function that takes two point geometries. You might want to use a subselect to order points before feeding them to the aggregate version of this function.

Examples: Spatial Aggregate version

This example takes a sequence of GPS points and creates one record for each gps travel where the geometry field is a line string composed of the gps points in the order of the travel.

```
SELECT gps.gps_track, ST_MakeLine(gps.the_geom) As newgeom
  FROM (SELECT gps_track,gps_time, the_geom
      FROM gps_points ORDER BY gps_track, gps_time) As gps
  GROUP BY gps.gps_track
```

Examples: Non-Spatial Aggregate version

First example is a simple one off line string composed of 2 points. The second formulates line strings from 2 points a user draws

```
SELECT ST_AsText(ST_MakeLine(ST_MakePoint(1,2), ST_MakePoint(3,4)));
SELECT userpoints.id, ST_MakeLine(startpoint, endpoint) As drawn_line
  FROM userpoints ;
```

See Also

ST_GeomFromText, ST_MakePoint

7.2.11 ST_MakePoint

Name

ST_MakePoint – Creates a 2d,3dz or 4d point geometry.

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);

Description

Creates a 2d,3dz or 4d point geometry (geometry with measure). ST_MakePoint while not being OGC compliant is generally faster and more precise than ST_GeomFromText and ST_PointFromText. It is also easier to use if you have raw coordinates rather than WKT.

> **Note**
> Note x is longitude and y is latitude

Examples

```
--Return point with unknown SRID
SELECT ST_MakePoint(-71.1043443253471, 42.3150676015829);

--Return point marked as WGS 84 long lat
SELECT ST_SetSRID(ST_MakePoint(-71.1043443253471, 42.3150676015829),4326);
```

```
--Return a 3d point (e.g. has altitude)
SELECT ST_MakePoint(1, 2,1.5);

--Get z of point
SELECT ST_Z(ST_MakePoint(1, 2,1.5));
result
-------
1.5
```

See Also

ST_GeomFromText, ST_PointFromText, ST_SetSRID

7.2.12 ST_MakePolygon

Name

ST_MakePolygon – Creates a Polygon formed by the given shell. Input geometries must be closed LINESTRINGS.

Synopsis

geometry **ST_MakePolygon**(geometry linestring);

geometry **ST_MakePolygon**(geometry outerlinestring, geometry[] interiorlinestrings);

Description

Creates a Polygon formed by the given shell. Input geometries must be closed LINESTRINGS. Comes in 2 variants.

Variant 1: takes one closed linestring.

Variant 2: Creates a Polygon formed by the given shell and array of holes. You can construct a geometry array using ST_Accum or the PostgreSQL ARRAY[] and ARRAY() constructs. Input geometries must be closed LINESTRINGS.

Note
This function will not accept a MULTILINESTRING. Use $ST_{L}ineMerge(geometry)$ or ST_Dump to generate line strings.

Examples: Single closed LINESTRING

```
SELECT ST_MakePolygon(ST_GeomFromText('LINESTRING(75.15 29.53,77 29,77.6 29.5, 75.15 29.53) ↩
    '));
--If linestring is not closed
--you can add the start point to close it
SELECT ST_MakePolygon(ST_AddPoint(foo.open_line, ST_StartPoint(foo.open_line)))
FROM (
SELECT ST_GeomFromText('LINESTRING(75.15 29.53,77 29,77.6 29.5)') As open_line) As foo
```

Examples: Outter shell with inner shells

Build a donut with an ant hole

```
SELECT ST_MakePolygon(
    ST_ExteriorRing(ST_Buffer(foo.line,10)),
  ARRAY[ST_Translate(foo.line,1,1),
    ST_ExteriorRing(ST_Buffer(ST_MakePoint(20,20),1)) ]
  )
FROM
  (SELECT ST_ExteriorRing(ST_Buffer(ST_MakePoint(10,10),10,10))
    As line )
    As foo;
```

Build province boundaries with holes representing lakes in the province from a set of province polygons/multipolygons and water line strings this is an example of using PostGIS ST_Accum

Note
The use of CASE because feeding a null array into ST_MakePolygon results in NULL

Note
the use of left join to guarantee we get all provinces back even if they have no lakes

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

  --Same example above but utilizing a correlated subquery
  --and PostgreSQL built-in ARRAY() function that converts a row set to an array

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

See Also

$ST_{A}ccum(geometryset)$, ST_AddPoint, ST_GeometryType, ST_IsClosed, $ST_{L}ineMerge(geometry)$

7.2.13 ST_PointFromText

Name

ST_PointFromText – Makes a point Geometry from WKT with the given SRID. If SRID is not given, it defaults to unknown.

Synopsis

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

Description

Constructs a PostGIS ST_Geometry point object from the OGC Well-Known text representation. If SRID is not give, it defaults to unknown (currently -1). If geometry is not a WKT point representation, returns null. If completely invalid WKT, then throws an error.

> **Note**
> There are 2 variants of ST_PointFromText function, the first takes no SRID and returns a geometry with no defined spatial reference system. The second takes a spatial reference id as the second argument and returns an ST_Geometry that includes this srid as part of its meta-data. The srid must be defined in the spatial_ref_sys table.

> **Note**
> If you are absolutely sure all your WKT geometries are points, don't use this function. It is slower than ST_GeomFromText since it adds an additional validation step. If you are building points from long lat coordinates and care more about performance than OGC compliance, use ST_MakePoint.

This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SPEC 3.2.6.2 - option SRID is from the conformance suite.

This method implements the SQL/MM specification: SQL-MM 3: 5.1.40

Examples

```
SELECT ST_PointFromText('POINT(-71.064544 42.28787)');
SELECT ST_PointFromText('POINT(-71.064544 42.28787)', 4326);
```

See Also

ST_GeomFromText, ST_MakePoint, ST_SRID

7.2.14 ST_Union

Name

ST_Union – Returns a geometry that represents the point set union of the Geometries.

Synopsis

geometry **ST_Union**(geometry set g1field);
geometry **ST_Union**(geometry g1);

Description

Output type can be a MULTI* , single geometry, or Geometry Collection. Comes in 2 variants. Variant 1 unions 2 geometries resulting in a new geomety with no intersecting regions. Variant 2 is an aggregate function that takes a set of geometries and unions them into a single ST_Geometry resulting in no intersecting regions.

Aggregate version: This function returns a MULTI geometry or NON-MULTI geometry from a set of geometries. The ST_Union() function is an "aggregate" function in the terminology of PostgreSQL. That means that it operates on rows of data, in the same way the SUM() and AVG() functions do.

Non-Aggregate version: This function returns a geometry being a union of two input geometries. Output type can be a MULTI* ,NON-MULTI or GEOMETRYCOLLECTION.

> **Note**
> ST_Collect and ST_Union are often interchangeable. ST_Union is in general orders of magnitude slower than ST_Collect because it tries to dissolve boundaries and reorder geometries to ensure that a constructed Multi* doesn't have intersecting regions.

Performed by the GEOS module.

NOTE: this function was formerly called GeomUnion(), which was renamed from "Union" because UNION is an SQL reserved word.

This method implements the OpenGIS Simple Features Implementation Specification for SQL: OGC SPEC s2.1.1.3

This method implements the SQL/MM specification: SQL-MM 3: 5.1.19

> **Note**
> Aggregate version is not explicitly defined in OGC SPEC.

Examples

Aggregate example

```
SELECT stusps,
     ST_Multi(ST_Union(f.the_geom)) as singlegeom
   FROM sometable As f
GROUP BY stusps
```

Non-Aggregate example

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

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


SELECT ST_AsText(ST_Union(ST_GeomFromText('POINT(1 2)'),
```

```
    ST_GeomFromText('POINT(1 2)') ) );
st_astext
----------
POINT(1 2)
```

See Also

ST_Collect

7.2.15 ST_WKTToSQL

Name

ST_WKTToSQL – Return a specified ST_Geometry value from Well-Known Text representation (WKT). This is an alias name for ST_GeomFromText

Synopsis

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

Description

This method implements the SQL/MM specification: SQL-MM 3: 5.1.34

See Also

ST_GeomFromText

7.3 Geometry Accessors

7.3.1 ST_Dimension

Name

ST_Dimension – The inherent dimension of this Geometry object, which must be less than or equal to the coordinate dimension.

Synopsis

integer **ST_Dimension**(geometry g);

Description

The inherent dimension of this Geometry object, which must be less than or equal to the coordinate dimension. OGC SPEC s2.1.1.1 - returns 0 for `POINT`, 1 for `LINESTRING`, 2 for `POLYGON`, and the largest dimension of the components of a `GEOMETRYCOLLECTION`.

This method implements the SQL/MM specification: SQL-MM 3: 5.1.2

Examples

```
SELECT ST_Dimension('GEOMETRYCOLLECTION(LINESTRING(1 1,0 0),POINT(0 0))');
ST_Dimension
-----------
1
```

See Also

ST_NDims

7.3.2 ST_EndPoint

Name

ST_EndPoint – Returns the last point of a `LINESTRING` geometry as a `POINT`.

Synopsis

boolean **ST_EndPoint**(geometry g);

Description

Returns the last point of a `LINESTRING` geometry as a `POINT` or `NULL` if the input parameter is not a `LINESTRING`.

✓ This method implements the SQL/MM specification: SQL-MM 3: 7.1.4

Examples

```
postgis=# SELECT ST_AsText(ST_EndPoint('LINESTRING(1 1, 2 2, 3 3)'::geometry));
 st_astext
------------
 POINT(3 3)
(1 row)

postgis=# SELECT ST_EndPoint('POINT(1 1)'::geometry) IS NULL AS is_null;
  is_null
----------
 t
(1 row)
```

See Also

ST*pointN*(*geometry*, *nthinteger*), ST_StartPoint

7.3.3 ST_Envelope

Name

ST_Envelope – Returns a geometry representing the bounding box of the supplied geometry.

Synopsis

boolean **ST_Envelope**(geometry g1);

Description

Returns the minimum bounding box for the supplied geometry, as a geometry. The polygon is defined by the corner points of the bounding box ((`MINX`, `MINY`), (`MINX`, `MAXY`), (`MAXX`, `MAXY`), (`MAXX`, `MINY`), (`MINX`, `MINY`)). (PostGIS will add a `ZMIN`/`ZMAX` coordinate as well).

Degenerate cases (vertical lines, points) will return a geometry of lower dimension than `POLYGON`, ie. `POINT` or `LINESTRING`.

Caution
In PostGIS, the bounding box of a geometry is represented internally using `float4`s instead of `float8`s that are used to store geometries. The bounding box coordinates are floored, guarenteeing that the geometry is contained entirely within its bounds. This has the advantage that a geometry's bounding box is half the size as the minimum bounding rectangle, which means significantly faster indexes and general performance. But it also means that the bounding box is NOT the same as the minimum bounding rectangle that bounds the geometry.

This method implements the OpenGIS Simple Features Implementation Specification for SQL: v1.1: s2.1.1.1

This method implements the SQL/MM specification: SQL-MM 3: 5.1.15

Examples

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


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


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

7.3.4 ST_GeometryType

Name

ST_GeometryType – Return the geometry type of the ST_Geometry value.

Synopsis

text **ST_GeometryType**(geometry g1);

Description

Returns the type of the geometry as a string. EG: 'ST_Linestring', 'ST_Polygon','ST_MultiPolygon' etc. This function differs from GeometryType(geometry) in the case of the string and ST in front that is returned, as well as the fact that it will not indicate whether the geometry is measured.

This method implements the SQL/MM specification: SQL-MM 3: 5.1.4

Examples

```
SELECT ST_GeometryType(ST_GeomFromText('LINESTRING(77.29 29.07,77.42 29.26,77.27 ↵
    29.31,77.29 29.07)'));
      --result
      ST_LineString
```

See Also

GeometryType(geometry)

7.3.5 ST_IsClosed

Name

ST_IsClosed – Returns `TRUE` if the `LINESTRING`'s start and end points are coincident.

Synopsis

boolean **ST_IsClosed**(geometry g);

Description

Returns `TRUE` if the `LINESTRING`'s start and end points are coincident.

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

This method implements the SQL/MM specification: SQL-MM 3: 7.1.5, 9.3.3

Note
SQL-MM defines the result of `ST_IsClosed(NULL)` to be 0, while PostGIS returns `NULL`.

Examples

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

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

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

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

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

See Also

ST_IsRing

7.3.6 ST_IsValid

Name

ST_IsValid – Returns `true` if the `ST_Geometry` is well formed.

Synopsis

boolean **ST_IsValid**(geometry g);

Description

Test if an ST_Geometry value is well formed. For geometries that are invalid, the PostgreSQL NOTICE will provide details of why it is not valid.

> **Note**
> SQL-MM defines the result of ST_IsValid(NULL) to be 0, while PostGIS returns NULL.

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

This method implements the SQL/MM specification: SQL-MM 3: 5.1.9

Examples

```
SELECT ST_IsValid(ST_GeomFromText('LINESTRING(0 0, 1 1)')) As good_line,
  ST_IsValid(ST_GeomFromText('POLYGON((0 0, 1 1, 1 2, 1 1, 0 0))')) As bad_poly
--results
NOTICE:  Self-intersection at or near point 0 0
 good_line | bad_poly
-----------+----------
 t         | f
```

See Also

ST_Summary

7.3.7 ST_NDims

Name

ST_NDims – Returns coordinate dimension of the geometry as a small int. Values are: 2,3 or 4.

Synopsis

integer **ST_NDims**(geometry g1);

Description

Returns the coordinate dimension of the geometry. PostGIS supports 2 - (x,y) , 3 - (x,y,z) or 2D with measure - x,y,m, and 4 - 3D with measure space x,y,z,m

Examples

```
SELECT ST_NDims(ST_GeomFromText('POINT(1 1)')) As d2point,
  ST_NDims(ST_GeomFromEWKT('POINT(1 1 2)')) As d3point,
  ST_NDims(ST_GeomFromEWKT('POINTM(1 1 0.5)')) As d2pointm;

   d2point | d3point | d2pointm
---------+---------+----------
       2 |       3 |        3
```

See Also

ST_Dimension, ST_GeomFromEWKT

7.3.8 ST_NPoints

Name

ST_NPoints – Return the number of points (vertexes) in a geometry.

Synopsis

integer **ST_NPoints**(geometry g1);

Description

Return the number of points in a geometry. Works for all geometries.

Examples

```
SELECT ST_NPoints(ST_GeomFromText('LINESTRING(77.29 29.07,77.42 29.26,77.27 29.31,77.29 ↩
    29.07)'));
      --result
      4
```

See Also

ST_NumPoints

7.3.9 ST_NumPoints

Name

ST_NumPoints – Return the number of points in an ST_LineString or ST_CircularString value.

Synopsis

integer **ST_NumPoints**(geometry g1);

Description

Return the number of points in an ST_LineString or ST_CircularString value. Prior to 1.4 only works with Linestrings as the specs state. From 1.4 forward this is an alias for ST_NPoints which returns number of vertexes for not just line strings. Consider using ST_NPoints instead which is multi-purpose and works with many geometry types.

✓ This method implements the OpenGIS Simple Features Implementation Specification for SQL.

✓ This method implements the SQL/MM specification: SQL-MM 3: 7.2.4

Examples

```
SELECT ST_NumPoints(ST_GeomFromText('LINESTRING(77.29 29.07,77.42 29.26,77.27 29.31,77.29 ↩
    29.07)'));
    --result
    4
```

See Also

ST_NPoints

7.3.10 ST_IsRing

Name

ST_IsRing – Returns `TRUE` if this `LINESTRING` is both closed and simple.

Synopsis

boolean **ST_IsRing**(geometry g);

Description

Returns `TRUE` if this `LINESTRING` is both ST_IsClosed (`ST_StartPoint` $((g))$ ~= `ST_Endpoint` $((g))$) and $ST_{I}sSimple(geometr$
(does not self intersect).

This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SFSQL 1.1 - 2.1.5.1

This method implements the SQL/MM specification: SQL-MM 3: 7.1.6

Note
SQL-MM defines the result of `ST_IsRing(NULL)` to be 0, while PostGIS returns `NULL`.

Examples

```
SELECT ST_IsRing(the_geom), ST_IsClosed(the_geom), ST_IsSimple(the_geom)
FROM (SELECT 'LINESTRING(0 0, 0 1, 1 1, 1 0, 0 0)'::geometry AS the_geom) AS foo;
 st_isring | st_isclosed | st_issimple
-----------+-------------+-------------
 t         | t           | t
(1 row)

SELECT ST_IsRing(the_geom), ST_IsClosed(the_geom), ST_IsSimple(the_geom)
FROM (SELECT 'LINESTRING(0 0, 0 1, 1 0, 1 1, 0 0)'::geometry AS the_geom) AS foo;
 st_isring | st_isclosed | st_issimple
-----------+-------------+-------------
 f         | t           | f
(1 row)
```

See Also

ST_IsClosed, $ST_{I}sSimple(geometry)$, ST_StartPoint, ST_EndPoint

7.3.11 ST_SRID

Name

ST_SRID – Returns the spatial reference identifier for the ST_Geometry as defined in spatial_ref_sys table.

Synopsis

integer **ST_SRID**(geometry g1);

Description

Returns the spatial reference identifier for the ST_Geometry as defined in Section 4.2.1 table.

> **Note**
> spatial_ref_sys table is a table that catalogs all spatial reference systems known to PostGIS and is used for transformations from one spatial reference system to another. So verifying you have the right spatial reference system identifier is important if you plan to ever transform your geometries.

This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SPEC s2.1.1.1

This method implements the SQL/MM specification: SQL-MM 3: 5.1.5

Examples

```
SELECT ST_SRID(ST_GeomFromText('POINT(-71.1043 42.315)',4326));
    --result
    4326
```

See Also

Section 4.2.1,ST_GeomFromText, ST_SetSRID, ST_Transform

7.3.12 ST_StartPoint

Name

ST_StartPoint – Returns the first point of a `LINESTRING` geometry as a `POINT`.

Synopsis

boolean **ST_StartPoint**(geometry g);

Description

Returns the first point of a `LINESTRING` geometry as a `POINT` or `NULL` if the input parameter is not a `LINESTRING`.

This method implements the SQL/MM specification: SQL-MM 3: 7.1.3

Examples

```
postgis=# SELECT ST_AsText(ST_StartPoint('LINESTRING(0 1, 0 2)'::geometry));
 st_astext
------------
 POINT(0 1)
(1 row)

postgis=# SELECT ST_StartPoint('POINT(0 1)'::geometry) IS NULL AS is_null;
  is_null
----------
 t
(1 row)
```

See Also

ST_EndPoint, ST$_{pointN(geometry, nthinteger)}$

7.3.13 ST_Summary

Name

ST_Summary – Returns a text summary of the contents of the `ST_Geometry`.

Synopsis

text **ST_Summary**(geometry g);

Description

Returns a text summary of the contents of the geometry.

Examples

```
SELECT ST_Summary(ST_GeomFromText('LINESTRING(0 0, 1 1)')) As good_line,
  ST_Summary(ST_GeomFromText('POLYGON((0 0, 1 1, 1 2, 1 1, 0 0))')) As bad_poly
--results
      good_line       |        bad_poly
----------------------+-------------------------
                      |
Line[B] with 2 points : Polygon[B] with 1 rings
                      :    ring 0 has 5 points
                      :
```

See Also

ST_IsValid

7.4 Geometry Editors

7.4.1 ST_AddPoint

Name

ST_AddPoint – Adds a point to a LineString before point <position> (0-based index).

Synopsis

geometry **ST_AddPoint**(geometry linestring, geometry point);

geometry **ST_AddPoint**(geometry linestring, geometry point, integer position);

Description

Adds a point to a LineString before point <position> (0-based index). Third parameter can be omitted or set to -1 for appending.

Availability: 1.1.0

Examples

```
--guarantee all linestrings in a table are closed
--by adding the start point of each linestring to the end of the line string
--only for those that are not closed
UPDATE sometable
SET the_geom = ST_AddPoint(the_geom, ST_StartPoint(the_geom))
FROM sometable
WHERE ST_IsClosed(the_geom) = false;
```

See Also

ST_RemovePoint, ST_SetPoint

7.4.2 ST_Multi

Name

ST_Multi – Returns the geometry as a MULTI* geometry. If the geometry is already a MULTI*, it is returned unchanged.

Synopsis

geoometry **ST_Multi**(geometry g1);

Description

Returns the geometry as a MULTI* geometry. If the geometry is already a MULTI*, it is returned unchanged.

Examples

```
SELECT ST_AsText(ST_Multi(ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,
      743265 2967450,743265.625 2967416,743238 2967416))')));
      st_astext
      --------------------------------------------------------------------------------------------------

      MULTIPOLYGON(((743238 2967416,743238 2967450,743265 2967450,743265.625 2967416,
      743238 2967416)))
      (1 row)
```

See Also

ST_AsText

7.4.3 ST_RemovePoint

Name

ST_RemovePoint – Removes point from a linestring. Offset is 0-based.

Synopsis

geometry **ST_RemovePoint**(geometry linestring, integer offset);

Description

Removes point from a linestring. Useful for turning a closed ring into an open line string

Availability: 1.1.0

Examples

```
--guarantee no LINESTRINGS are closed
--by removing the end point.  The below assumes the_geom is of type LINESTRING
UPDATE sometable
  SET the_geom = ST_RemovePoint(the_geom, ST_NPoints(the_geom) - 1)
  FROM sometable
  WHERE ST_IsClosed(the_geom) = true;
```

See Also

ST_AddPoint, ST_NPoints, ST_NumPoints

7.4.4 ST_Reverse

Name

ST_Reverse – Returns the geometry with vertex order reversed.

Synopsis

geometry **ST_Reverse**(geometry g1);

Description

Can be used on any geometry and reverses the order of the vertexes.

Examples

```
SELECT ST_AsText(the_geom) as line, ST_AsText(ST_Reverse(the_geom)) As reverseline
FROM
(SELECT ST_MakeLine(ST_MakePoint(1,2),
    ST_MakePoint(1,10)) As the_geom) as foo;
--result
        line          |     reverseline
---------------------+----------------------
LINESTRING(1 2,1 10) | LINESTRING(1 10,1 2)
```

7.4.5 ST_SetPoint

Name

ST_SetPoint – Replace point N of linestring with given point. Index is 0-based.

Synopsis

geometry **ST_SetPoint**(geometry linestring, integer zerobasedposition, geometry point);

Description

Replace point N of linestring with given point. Index is 0-based. This is especially useful in triggers when trying to maintain relationship of joints when one vertex moves.

Availability: 1.1.0

Examples

```
--Change second point in line string from -1 3 to -1 1
SELECT ST_AsText(ST_SetPoint('LINESTRING(-1 2,-1 3)', 1, 'POINT(-1 1)'));
       st_astext
-----------------------
 LINESTRING(-1 2,-1 1)
```

See Also

ST_AddPoint,ST_RemovePoint

7.4.6 ST_SetSRID

Name

ST_SetSRID – Sets the SRID on a geometry to a particular integer value.

Synopsis

boolean **ST_SetSRID**(geometry geom, integer srid);

Description

Sets the SRID on a geometry to a particular integer value. Useful in constructing bounding boxes for queries.

Note
This function does not transform the geometry is any way - it simply sets the projection the geometry that it's currently in. Use ST_Transform if you want to transform the geometry into a new projection.

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

See Also

Section 4.2.1, ST_SRID, ST_Transform, UpdateGeometrySRID

7.4.7 ST_Transform

Name

ST_Transform – Returns a new geometry with its coordinates transformed to the SRID referenced by the integer parameter.

Synopsis

geometry **ST_Transform**(geometry g1, integer srid);

Description

Returns a new geometry with its coordinates transformed to spatial reference system referenced by the SRID integer parameter. The destination SRID must exist in the `SPATIAL_REF_SYS` table.

ST_Transform is often confused with ST_SetSRID(). ST_Transform actually changes the coordinates of a geometry from one spatial reference system to another, while ST_SetSRID() simply changes the SRID identifier of the geometry

---

Note
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.

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

This method implements the SQL/MM specification: SQL-MM 3: 5.1.6

Examples

Change Mass state plane US feet geometry to WGS 84 long lat

```
    SELECT ST_AsText(ST_Transform(ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,
  743265 2967450,743265.625 2967416,743238 2967416))',2249),4326)) As wgs_geom;

 wgs_geom
---------------------------
 POLYGON((-71.1776848522251 42.3902896512902,-71.1776843766326 42.3903829478009,
-71.1775844305465 42.3903826677917,-71.1775825927231 42.3902893647987,-71.177684
8522251 42.3902896512902));
(1 row)
```

Example of creating a partial functional index. For tables where you are not sure all the geometries will be filled in, its best to use a partial index that leaves out null geometries which will both conserve space and make your index smaller and more efficient.

```
CREATE INDEX idx_the_geom_26986_parcels
  ON parcels
  USING gist
  (ST_Transform(the_geom, 26986))
  WHERE the_geom IS NOT NULL;
```

See Also

ST_AsText, ST_SetSRID, UpdateGeometrySRID

7.4.8 ST_Translate

Name

ST_Translate – Translates the geometry to a new location using the numeric parameters as offsets. Ie: ST_Translate(geom, X, Y) or ST_Translate(geom, X, Y,Z).

Synopsis

geometry **ST_Translate**(geometry g1, float deltax, float deltay);
geometry **ST_Translate**(geometry g1, float deltax, float deltay, float deltaz);

Description

Returns a new geometry whose coordinates are translated delta x,delta y,delta z units. Units are based on the units defined in spatial reference (SRID) for this geometry.

Availability: 1.2.2

Examples

Move a point 1 degree longitude

```
  SELECT ST_AsText(ST_Translate(ST_GeomFromText('POINT(-71.01 42.37)',4326),1,0)) As  ↩
      wgs_transgeomtxt;

  wgs_transgeomtxt
  ---------------------
  POINT(-70.01 42.37)
```

Move a linestring 1 degree longitude and 1/2 degree latitude

```
SELECT ST_AsText(ST_Translate(ST_GeomFromText('LINESTRING(-71.01 42.37,-71.11 42.38)',4326) ↩
    ,1,0.5)) As wgs_transgeomtxt;
      wgs_transgeomtxt
  ---------------------------------------
  LINESTRING(-70.01 42.87,-70.11 42.88)
```

See Also

ST_AsText, ST_GeomFromText

7.5 Geometry Outputs

7.5.1 ST_AsBinary

Name

ST_AsBinary – Return the Well-Known Binary (WKB) representation of the geometry without SRID meta data.

Synopsis

bytea **ST_AsBinary**(geometry g1);
bytea **ST_AsBinary**(geometry g1, text NDR_or_XDR);

Description

Returns the Well-Known Binary representation of the geometry. There are 2 variants of the function. The first variant takes no endian encoding paramater and defaults to little endian. The second variant takes a second argument denoting the encoding - using little-endian ('NDR') or big-endian ('XDR') encoding.

This is useful in binary cursors to pull data out of the database without converting it to a string representation.

Note
The WKB spec does not include the SRID. To get the OGC WKB with SRID format use ST_AsEWKB

Note
ST_AsBinary is the reverse of $ST_{GeomFromWKB}(bytea,[<srid>])$. Use $ST_{GeomFromWKB}(bytea,[<srid>])$ to convert to a postgis geometry from ST_AsBinary representation.

This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SPEC s2.1.1.1

This method implements the SQL/MM specification: SQL-MM 3: 5.1.37

Examples

```
SELECT ST_AsBinary(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

           st_asbinary
--------------------------------
\001\003\000\000\000\001\000\000\000\005
\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000
\000\000\000\360?\000\000\000\000\000\000
\360?\000\000\000\000\000\000\360?\000\000
\000\000\000\000\360?\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000
(1 row)
```

```
SELECT ST_AsBinary(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326), 'XDR');
           st_asbinary
--------------------------------
\000\000\000\000\003\000\000\000\001\000\000\000\005\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000
\000?\360\000\000\000\000\000\000?\360\000\000\000\000\000\000?\360\000\000
\000\000\000\000?\360\000\000\000\000\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000
(1 row)
```

See Also

ST_AsEWKB, ST_AsEWKT, ST_AsText, ST_GeomFromEWKB

7.5.2 ST_AsEWKB

Name

ST_AsEWKB – Return the Well-Known Binary (WKB) representation of the geometry with SRID meta data.

Synopsis

bytea **ST_AsEWKB**(geometry g1);
bytea **ST_AsEWKB**(geometry g1, text NDR_or_XDR);

Description

Returns the Well-Known Binary representation of the geometry with SRID metadata. There are 2 variants of the function. The first variant takes no endian encoding paramater and defaults to little endian. The second variant takes a second argument denoting the encoding - using little-endian ('NDR') or big-endian ('XDR') encoding.

This is useful in binary cursors to pull data out of the database without converting it to a string representation.

> **Note**
> The WKB spec does not include the SRID. To get the OGC WKB format use ST_AsBinary

Note
ST_AsEWKB is the reverse of ST_GeomFromEWKB. Use ST_GeomFromEWKB to convert to a postgis geometry from ST_AsEWKB representation.

Examples

```
SELECT ST_AsEWKB(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

           st_asewkb
--------------------------------
\001\003\000\000 \346\020\000\000\001\000
\000\000\005\000\000\000\000
\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000
\000\000\360?\000\000\000\000\000\000\360?
\000\000\000\000\000\000\360?\000\000\000\000\000
\000\360?\000\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000\000\000
(1 row)
```

```
      SELECT ST_AsEWKB(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326), 'XDR');
           st_asewkb
--------------------------------
\000 \000\000\003\000\000\020\346\000\000\000\001\000\000\000\005\000\000\000\000\
000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000?
\360\000\000\000\000\000\000?\360\000\000\000\000\000\000?\360\000\000\000\000
\000\000?\360\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000\000
\000\000\000\000\000\000\000\000\000\000\000\000\000
```

See Also

ST_AsBinary, ST_AsEWKT, ST_AsText, ST_GeomFromEWKT, ST_SRID

7.5.3 ST_AsEWKT

Name

ST_AsEWKT – Return the Well-Known Text (WKT) representation of the geometry with SRID meta data.

Synopsis

text **ST_AsEWKT**(geometry g1);

Description

Returns the Well-Known Text representation of the geometry prefixed with the SRID.

Note
The WKT spec does not include the SRID. To get the OGC WKT format use ST_AsText

WKT format does not maintain precision so to prevent floating truncation, use ST_AsBinary or ST_AsEWKB format for transport.

> **Note**
> ST_AsEWKT is the reverse of ST_GeomFromEWKT. Use ST_GeomFromEWKT to convert to a postgis geometry from ST_AsEWKT representation.

Examples

```
SELECT ST_AsEWKT('0103000020E61000000100000005000000000000
      000000000000000000000000000000000000000000000000000000
      F03F000000000000F03F000000000000F03F000000000000F03
      F000000000000000000000000000000000000000000000000'::geometry);

           st_asewkt
--------------------------------
SRID=4326;POLYGON((0 0,0 1,1 1,1 0,0 0))
(1 row)
```

See Also

ST_AsBinaryST_AsEWKBST_AsText, ST_GeomFromEWKT

7.5.4 ST_AsGeoJSON

Name

ST_AsGeoJSON – Return the geometry as a GeoJSON element.

Synopsis

text **ST_AsGeoJSON**(geometry g1);
text **ST_AsGeoJSON**(geometry g1, integer max_decimal_digits);
text **ST_AsGeoJSON**(geometry g1, integer max_decimal_digits, integer options);
text **ST_AsGeoJSON**(integer version, geometry g1);
text **ST_AsGeoJSON**(integer version, geometry g1, integer max_decimal_digits);
text **ST_AsGeoJSON**(integer version, geometry g1, integer max_decimal_digits, integer options);

Description

Return the geometry as a Geometry Javascript Object Notation (GeoJSON) element. (Cf GeoJSON specifications 1.0). 2D and 3D Geometries are both supported. GeoJSON only support SFS 1.1 geometry type (no curve support for example).

The version parameter, if specified, must be 1.

The third argument may be used to reduce the maximum number of significant digits used in output (defaults to 15).

The last 'options' argument could be used to add Bbox or Crs in GeoJSON output:

- 0: means no option (default value)
- 1: GeoJSON CRS

- 2: GeoJSON Bbox
- 3: Both GeoJSON Bbox and CRS

GeoJson CRS pattern is: `auth_name:auth_srid` from spatial_ref_sys table (EPSG:4326 for instance).

Version 1: ST_AsGeoJSON(geom) / precision=15 version=1 options=0

Version 2: ST_AsGeoJSON(geom, precision) / version=1 options=0

Version 3: ST_AsGeoJSON(geom, precision, options) / version=1

Version 4: ST_AsGeoJSON(version, geom) / precision=15 options=0

Version 5: ST_AsGeoJSON(version, geom, precision) /options=0

Version 6: ST_AsGeoJSON(version, geom, precision,options)

> **Note**
> Availability: 1.3.4

Examples

GeoJSON format is generally more efficient than other formats for use in ajax mapping. One popular javascript client that supports this is Open Layers. Example of its use is OpenLayers GeoJSON Example

```
SELECT ST_AsGeoJSON(the_geom) from fe_edges limit 1;
                       st_asgeojson
--------------------------------------------------------------------------------------------------------


{"type":"MultiLineString","coordinates":[[[-89.734634999999997,31.492072000000000],
[-89.734955999999997,31.492237999999997]]]}
(1 row)
```

7.5.5 ST_AsGML

Name

ST_AsGML – Return the geometry as a GML version 2 or 3 element.

Synopsis

text **ST_AsGML**(geometry g1);
text **ST_AsGML**(geometry g1, integer max_num_decimal_digits);
text **ST_AsGML**(integer version, geometry g1, integer max_num_decimal_digits);

Description

Return the geometry as a Geography Markup Language (GML) element. The version parameter, if specified, may be either 2 or 3. If no version parameter is specified then the default is assumed to be 2. The third argument may be used to reduce the maximum number of significant digits used in output (defaults to 15).

> **Note**
> Availability: 1.3.2

Examples

```
SELECT ST_AsGML(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

    st_asgml
    --------
```

7.5.6 ST_AsHEXEWKB

Name

ST_AsHEXEWKB – Returns a Geometry in HEXEWKB format (as text) using either little-endian (NDR) or big-endian (XDR) encoding.

Synopsis

text **ST_AsHEXEWKB**(geometry g1, text NDRorXDR);
text **ST_AsHEXEWKB**(geometry g1);

Description

Returns a Geometry in HEXEWKB format (as text) using either little-endian (NDR) or big-endian (XDR) encoding. If no encoding is specified, then NDR is used.

> **Note**
> Availability: 1.2.2

Examples

```
SELECT ST_AsHEXEWKB(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));
    which gives same answer as

    SELECT ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326)::text;

    st_ashexewkb
    --------
    0103000020E61000000100000005000
    00000000000000000000000000000000
    00000000000000000000000000000F03F
    000000000000F03F000000000000F03F000000000000F03
    F000000000000000000000000000000000000000000000000
```

7.5.7 ST_AsKML

Name

ST_AsKML – Return the geometry as a KML element. Second argument may be used to reduce the maximum number of significant digits used in output (defaults to 15).

Synopsis

text **ST_AsKML**(geometry g1);
text **ST_AsKML**(geometry g1, integer max_num_decimal_digits);

Description

Return the geometry as a Keyhole Markup Language (KML) element. Second argument may be used to reduce the maximum number of significant digits used in output (defaults to 15).

> **Note**
> Availability: 1.2.2 - later variants that include version param came in 1.3.2

Examples

```
SELECT ST_AsKML(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

    st_askml
    --------
```

7.5.8 ST_AsSVG

Name

ST_AsSVG – Returns a Geometry in SVG path data.

Synopsis

text **ST_AsSVG**(geometry g1);
text **ST_AsSVG**(geometry g1, integer rel);
text **ST_AsSVG**(geometry g1, integer rel, integer maxdecimaldigits);

Description

Return the geometry as Scalar Vector Graphics (SVG) path data. Use 1 as second argument to have the path data implemented in terms of relative moves, the default (or 0) uses absolute moves. Third argument may be used to reduce the maximum number of decimal digits used in output (defaults to 15). Point geometries will be rendered as cx/cy when 'rel' arg is 0, x/y when 'rel' is 1. Multipoint geometries are delimited by commas (","), GeometryCollection geometries are delimited by semicolons (";").

> **Note**
> Availability: 1.2.2

Examples

```
SELECT ST_AsSVG(ST_GeomFromText('POLYGON((0 0,0 1,1 1,1 0,0 0))',4326));

    st_assvg
    --------
    M 0 0 0 -1 1 -1 1 0 Z
```

7.5.9 ST_AsText

Name

ST_AsText – Return the Well-Known Text (WKT) representation of the geometry without SRID metadata.

Synopsis

text **ST_AsText**(geometry g1);

Description

Returns the Well-Known Text representation of the geometry.

> **Note**
> The WKT spec does not include the SRID. To get the SRID as part of the data, use the non-standard PostGIS ST_AsEWKT

WKT format does not maintain precision so to prevent floating truncation, use ST_AsBinary or ST_AsEWKB format for transport.

> **Note**
> ST_AsText is the reverse of ST_GeomFromText. Use ST_GeomFromText to convert to a postgis geometry from ST_AsText representation.

This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SPEC s2.1.1.1

This method implements the SQL/MM specification: SQL-MM 3: 5.1.25

Examples

```
SELECT ST_AsText('01030000000100000005000000000000000000
000000000000000000000000000000000000000000000000
F03F000000000000F03F000000000000F03F000000000000F03
F000000000000000000000000000000000000000000000000');

           st_astext
--------------------------------
 POLYGON((0 0,0 1,1 1,1 0,0 0))
(1 row)
```

See Also

ST_AsBinary, ST_AsEWKB, ST_AsEWKT, ST_GeomFromText

7.6 Operators

7.7 Spatial Relationships and Measurements

7.7.1 ST_Area

Name

ST_Area – Returns the area of the geometry if it is a polygon or multi-polygon.

Synopsis

float **ST_Area**(geometry g1);

Description

Returns the area of the geometry if it is a polygon or multi-polygon. Return the area measurement of an ST_Surface or ST_MultiSurface value. Area is in the units of the spatial reference system.

✓ This method implements the OpenGIS Simple Features Implementation Specification for SQL.

✓ This method implements the SQL/MM specification: SQL-MM 3: 8.1.2, 9.5.3

Examples

Return area in square feet for a plot of Massachusetts land. Note this is in square feet because 2249 is Mass State Plane Feet

```
SELECT ST_Area(ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,
  743265 2967450,743265.625 2967416,743238 2967416))',2249));
st_area
---------
 928.625
(1 row)

--this returns in square meters
SELECT ST_Area(ST_Transform(ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,
  743265 2967450,743265.625 2967416,743238 2967416))',2249), 26986));
st_area
------------------
 86.2724306061864
```

See Also

ST_GeomFromText, ST_SetSRID,ST_Transform

7.7.2 ST_Centroid

Name

ST_Centroid – Returns the geometric center of a geometry.

Synopsis

boolean **ST_Centroid**(geometry g1);

Description

Computes the geometric center of a geometry, or equivalently, the center of mass of the geometry as a `POINT`. For `[MULTI]POINT`s, this is computed as the arithmetic mean of the input coordinates. For `[MULTI]LINESTRING`s, this is computed as the weighted length of each line segment. For `[MULTI]POLYGON`s, "weight" is thought in terms of area. If an empty geometry is supplied, an empty `GEOMETRYCOLLECTION` is returned. If `NULL` is supplied, `NULL` is returned.

The centroid is equal to the centroid of the set of component Geometries of highest dimension (since the lower-dimension geometries contribute zero "weight" to the centroid).

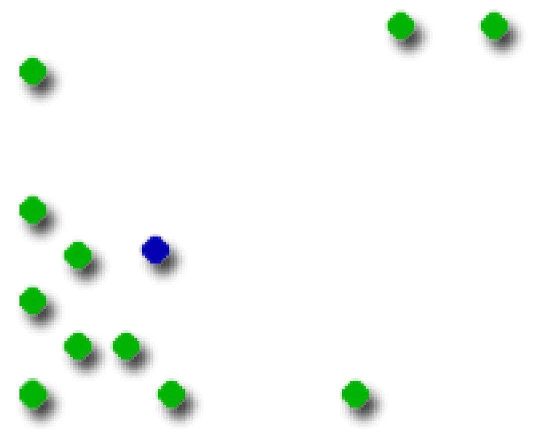
Note
Computation will be more accurate if performed by the GEOS module (enabled at compile time).

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

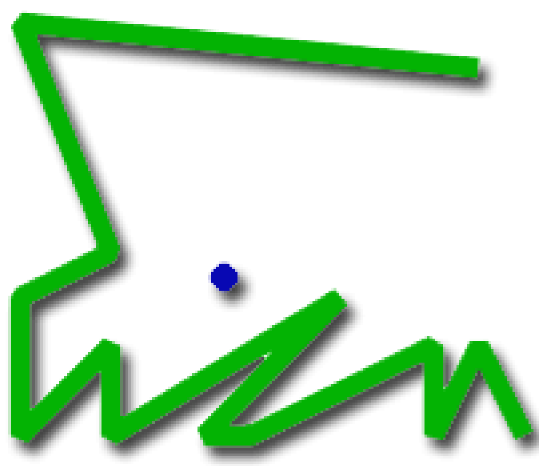
This method implements the SQL/MM specification: SQL-MM 3: 8.1.4, 9.5.5

Examples

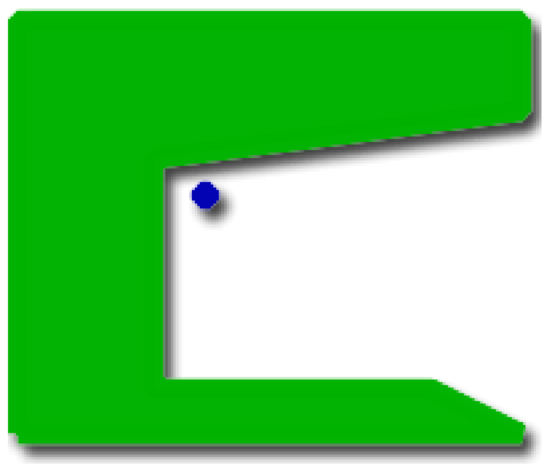
In each of the following illustrations, the blue dot represents the centroid of the source geometry.



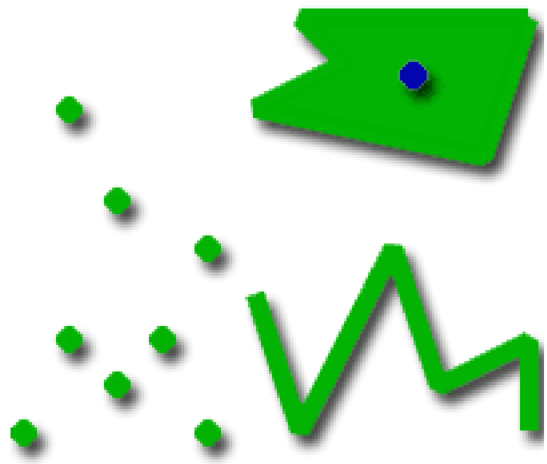
Centroid of a MULTIPOINT



Centroid of a LINESTRING



Centroid of a POLYGON



Centroid of a GEOMETRYCOLLECTION

```
SELECT ST_AsText(ST_Centroid('MULTIPOINT ( -1 0, -1 2, -1 3, -1 4, -1 7, 0 1, 0 3, 1 1, 2 ↩
    0, 6 0, 7 8, 9 8, 10 6 )'));
                st_astext
------------------------------------------
 POINT(2.30769230769231 3.30769230769231)
(1 row)
```

See Also

ST_PointOnSurface

7.7.3 ST_Contains

Name

ST_Contains – Returns true if the geometry B is completely inside geometry A

Synopsis

boolean **ST_Contains**(geometry A, geometry B);

Description

Returns TRUE if geometry B is completely inside geometry A. For this function to make sense, the source geometries must both be of the same coordinate projection, having the same SRID. ST_Contains is the inverse of ST_Within. So ST_Contains(A,B) implies ST_Within(B,A) except in the case of invalid geometries where the result is always false regardless or not defined.

Performed by the GEOS module

> **Important**
> Do not call with a `GEOMETRYCOLLECTION` as an argument

Important
Do not use this function with invalid geometries. You will get unexpected results.

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_Contains.

NOTE: this is the "allowable" version that returns a boolean, not an integer.

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

Examples

```
--a circle within a circle
SELECT ST_Contains(smallc,smallc) As smallinsmall,
ST_Contains(smallc, bigc) As smallcontainsbig,
ST_Contains(bigc,smallc) As bigcontainssmall,
ST_Contains(ST_Union(smallc, bigc), bigc) as unioncontainsbig,
ST_Contains(bigc, ST_Union(smallc, bigc)) as bigcontainsunion,
ST_Equals(bigc, ST_Union(smallc, bigc)) as bigisunion
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 | smallcontainsbig | bigcontainssmall | unioncontainsbig | bigcontainsunion | ←
    bigisunion
--------------+------------------+------------------+------------------+------------------+---------

t            | f                | t                | t                | t                | ←
    t
```

See Also

ST_Equals,ST_Within

7.7.4 ST_Crosses

Name

ST_Crosses – Returns `TRUE` if the supplied geometries have some, but not all, interior points in common.

Synopsis

boolean **ST_Crosses**(geometry g1, geometry g2);

Description

`ST_Crosses` takes two geometry objects and returns `TRUE` if their intersection "spatially cross", that is, the geometries have some, but not all interior points in common. The intersection of the interiors of the geometries must not be the empty set and must have a dimensionality less than the the maximum dimension of the two input geometries. Additionally, the intersection of the two geometries must not equal either of the source geometries. Otherwise, it returns `FALSE`.

In mathematical terms, this is expressed as:

The DE-9IM Intersection Matrix for the two geometries is:

- T*T****** (for Point/Line, Point/Area, and Line/Area situations)
- T*****T** (for Line/Point, Area/Point, and Area/Line situations)
- 0******** (for Line/Line situations)

For any other combination of dimensions this predicate returns false.

The OpenGIS Simple Features Specification defines this predicate only for Point/Line, Point/Area, Line/Line, and Line/Area situations. JTS / GEOS extends the definition to apply to Line/Point, Area/Point and Area/Line situations as well. This makes the relation symmetric.

Important
Do not call with a `GEOMETRYCOLLECTION` as an argument

Note
This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries.

This method implements the OpenGIS Simple Features Implementation Specification for SQL: 1.1: s2.1.13.3

This method implements the SQL/MM specification: SQL-MM 3: 5.1.29

Examples

The following illustrations all return `TRUE`.

MULTIPOINT / LINESTRING	*MULTIPOINT / POLYGON*
LINESTRING / POLYGON	*LINESTRING / LINESTRING*

Consider a situation where a user has two tables: a table of roads and a table of highways.

```
CREATE TABLE roads (
  id serial NOT NULL,
  the_geom geometry,
  CONSTRAINT roads_pkey PRIMARY KEY ( ←
     road_id)
);
```

```
CREATE TABLE highways (
  id serial NOT NULL,
  the_gem geometry,
  CONSTRAINT roads_pkey PRIMARY KEY ( ←
     road_id)
);
```

To determine a list of roads that cross a highway, use a query similiar to:

```
SELECT roads.id
FROM roads, highways
WHERE ST_Crosses(roads.the_geom, highways.the_geom);
```

7.7.5 ST_Disjoint

Name

ST_Disjoint – Returns TRUE if the Geometries do not "spatially intersect" - if they do not share any space together.

Synopsis

boolean **ST_Disjoint**(geometry A , geometry B);

Description

Overlaps, Touches, Within all imply geometries are not spatially disjoint. If any of the aforementioned returns true, then the geometries are not spatially disjoint. Disjoint implies false for spatial intersection.

> **Important**
> Do not call with a `GEOMETRYCOLLECTION` as an argument

Performed by the GEOS module

> **Note**
> This function call does not use indexes

> **Note**
> NOTE: this is the "allowable" version that returns a boolean, not an integer.

This method implements the OGC SPEC s2.1.1.2 //s2.1.13.3 - a.Relate(b, 'FF*FF****')

Examples

```
SELECT ST_Disjoint('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )'::geometry);
 st_disjoint
---------------
 t
(1 row)
SELECT ST_Disjoint('POINT(0 0)'::geometry, 'LINESTRING ( 0 0, 0 2 )'::geometry);
 st_disjoint
---------------
 f
(1 row)
```

See Also

ST_IntersectsST_Intersects

7.7.6 ST_Distance

Name

ST_Distance – Returns the cartesian distance between two geometries in projected units.

Synopsis

boolean **ST_Distance**(geometry g1, geometry g2);

Description

Returns the cartesian distance between two geometries in projected units.

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

This method implements the SQL/MM specification: SQL-MM 3: 5.1.23

Examples

```
postgis=# SELECT ST_Distance('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )'::geometry);
   st_distance
-----------------
 1.4142135623731
(1 row)
```

See Also

ST_DWithin, ST$_{D}istance_{S}phere(point, point)$, ST$_{D}istance_{S}pheroid(point, point, spheroid)$

7.7.7 ST_DWithin

Name

ST_DWithin – Returns true if the geometries are within the specified distance of one another

Synopsis

boolean **ST_DWithin**(geometry g1, geometry g2, double precision distance);

Description

Returns true if the geometries are 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 coorindate projection, having the same SRID.

> **Note**
> This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries.

> **Note**
> Prior to 1.3, ST_Expand was commonly used in conjunction with && and ST_Distance to achieve the same effect and in pre-1.3.4 this function was basically short-hand for that construct. From 1.3.4, ST_DWithin uses a more short-circuit distance function which should make it more efficient than prior versions for larger buffer regions.

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

Examples

```
--Find the nearest hospital to each school
--that is within 3000 units of the school.
-- We do an ST_DWithin search to utilize indexes to limit our search list
-- that the non-indexable ST_Distance needs to process
--If the units of the spatial reference is meters then units would be meters
SELECT DISTINCT ON (s.gid) s.gid, s.school_name, s.the_geom, h.hospital_name
  FROM schools s
    LEFT JOIN hospitals h ON ST_DWithin(s.the_geom, h.the_geom, 3000)
  ORDER BY s.gid, ST_Distance(s.the_geom, h.the_geom);

--The schools with no close hospitals
--Find all schools with no hospital within 3000 units
--away from the school.  Units is in units of spatial ref (e.g. meters, feet, degrees)
SELECT s.gid, s.school_name
  FROM schools s
    LEFT JOIN hospitals h ON ST_DWithin(s.the_geom, h.the_geom, 3000)
  WHERE h.gid IS NULL;
```

See Also

ST_Distance, ST_Expand

7.7.8 ST_Equals

Name

ST_Equals – Returns true if the given geometries represent the same geometry. Directionality is ignored.

Synopsis

boolean **ST_Equals**(geometry A, geometry B);

Description

Returns TRUE if the given Geometries are "spatially equal". Use this for a 'better' answer than '='. Note by spatially equal we mean ST_Within(A,B) = true and ST_Within(B,A) = true and also mean ordering of points can be different but represent the same geometry structure. To verify the order of points is consistent, use ST_OrderingEquals (it must be noted ST_OrderingEquals is a little more stringent than simply verifying order of points are the same).

> **Important**
> This function will return false if either geometry is invalid even if they are binary equal.

This method implements the OpenGIS Simple Features Implementation Specification for SQL OGC SPEC s2.1.1.2

This method implements the SQL/MM specification: SQL-MM 3: 5.1.24

Examples

```
SELECT ST_Equals(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
    ST_GeomFromText('LINESTRING(0 0, 5 5, 10 10)'));
 st_equals
-----------
 t
(1 row)

SELECT ST_Equals(ST_Reverse(ST_GeomFromText('LINESTRING(0 0, 10 10)')),
    ST_GeomFromText('LINESTRING(0 0, 5 5, 10 10)'));
 st_equals
-----------
 t
(1 row)
```

See Also

ST_IsValid, ST_OrderingEquals, ST_Reverse, ST_Within

7.7.9 ST_Intersects

Name

ST_Intersects – Returns TRUE if the Geometries "spatially intersect" - (share any portion of space) and FALSE if they don't (they are Disjoint).

Synopsis

boolean **ST_Intersects**(geometry A , geometry B);

Description

Overlaps, Touches, Within all imply spatial intersection. If any of the aforementioned returns true, then the geometries also spatially intersect. Disjoint implies false for spatial intersection.

> **Important**
> Do not call with a `GEOMETRYCOLLECTION` as an argument

Performed by the GEOS module

> **Note**
> This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries.

> **Note**
> NOTE: this is the "allowable" version that returns a boolean, not an integer.

This method implements the OpenGIS Simple Features Implementation Specification for SQL

OGC SPEC s2.1.1.2 //s2.1.13.3 - ST_Intersects(g1, g2) --> Not (ST_Disjoint(g1, g2))

Examples

```
SELECT ST_Intersects('POINT(0 0)'::geometry, 'LINESTRING ( 2 0, 0 2 )'::geometry);
 st_intersects
---------------
 f
(1 row)
SELECT ST_Intersects('POINT(0 0)'::geometry, 'LINESTRING ( 0 0, 0 2 )'::geometry);
 st_intersects
---------------
 t
(1 row)
```

See Also

ST_Disjoint

7.7.10 ST_Length

Name

ST_Length – Returns the length of the geometry if it is a linestring or multilinestring.

Synopsis

float **ST_Length**(geometry g1);

Description

Returns the 2D length of the geometry if it is a linestring, multilinestring, ST_Curve, ST_MultiCurve. 0 is returned for areal geometries. For areal geometries use ST_Perimeter. Measurements are in the units of the spatial reference system of the geometry.

Currently this is an alias for ST_Length2D, but this may change to support higher dimensions.

This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SPEC 2.1.5.1

This method implements the SQL/MM specification: SQL-MM 3: 7.1.2, 9.3.4

Examples

Return length in feet for line string. Note this is in feet because 2249 is Mass State Plane Feet

```
SELECT SELECT ST_Length(ST_GeomFromText('LINESTRING(743238 2967416,743238 2967450,743265 ↩
    2967450,
743265.625 2967416,743238 2967416)',2249));
st_length
---------
 122.630744000095
(1 row)
```

See Also

ST_Perimeter

7.7.11 ST_OrderingEquals

Name

ST_OrderingEquals – Returns true if the given geometries represent the same geometry and points are in the same directional order.

Synopsis

boolean **ST_OrderingEquals**(geometry A, geometry B);

Description

ST_OrderingEquals compares two geometries and t (TRUE) if the geometries are equal and the coordinates are in the same order; otherwise it returns f (FALSE).

Note
This function is implemented as per the ArcSDE SQL specification rather than SQL-MM. http://edndoc.esri.com/arcsde/9.1/sql_api/sqlapi3.htm#ST_OrderingEquals

This method implements the SQL/MM specification: SQL-MM 3: 5.1.43

Examples

```
SELECT ST_OrderingEquals(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
    ST_GeomFromText('LINESTRING(0 0, 5 5, 10 10)'));
 st_orderingequals
-----------
 f
(1 row)

SELECT ST_OrderingEquals(ST_GeomFromText('LINESTRING(0 0, 10 10)'),
    ST_GeomFromText('LINESTRING(0 0, 0 0, 10 10)'));
 st_orderingequals
-----------
 t
```

```
(1 row)

SELECT ST_OrderingEquals(ST_Reverse(ST_GeomFromText('LINESTRING(0 0, 10 10)')),
    ST_GeomFromText('LINESTRING(0 0, 0 0, 10 10)'));
 st_orderingequals
-----------
 f
(1 row)
```

See Also

ST_Equals, ST_Reverse

7.7.12 ST_Overlaps

Name

ST_Overlaps – Returns TRUE if the Geometries share space, are of the same dimension, but are not completely contained by each other.

Synopsis

boolean **ST_Overlaps**(geometry A, geometry B);

Description

Returns TRUE if the Geometries "spatially overlap". By that we mean they intersect, but one does not completely contain another.

Performed by the GEOS module

> **Note**
> Do not call with a GeometryCollection as an argument

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_Overlaps.

NOTE: this is the "allowable" version that returns a boolean, not an integer.

OGC SPEC s2.1.1.2 // s2.1.13.3

This method implements the SQL/MM specification: SQL-MM 3: 5.1.32

Examples

```
--a point on a line is contained by the line and is of a lower dimension, and therefore does not overlap the line
      nor crosses

SELECT ST_Overlaps(a,b) As a_overlap_b,
  ST_Crosses(a,b) As a_crosses_b,
    ST_Intersects(a, b) As a_intersects_b, ST_Contains(b,a) As b_contains_a
FROM (SELECT ST_GeomFromText('POINT(1 0.5)') As a, ST_GeomFromText('LINESTRING(1 0, 1 1, 3 5)')  As b)
  As foo
```

```
a_overlap_b | a_crosses_b | a_intersects_b | b_contains_a
------------+-------------+----------------+--------------
f           | f           | t              | t

--a line that is partly contained by circle, but not fully is defined as intersecting and ↩
   crossing,
-- but since of different dimension it does not overlap
SELECT ST_Overlaps(a,b) As a_overlap_b, ST_Crosses(a,b) As a_crosses_b,
  ST_Intersects(a, b) As a_intersects_b,
  ST_Contains(a,b) As a_contains_b
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 0.5)'), 3)  As a, ST_GeomFromText(' ↩
   LINESTRING(1 0, 1 1, 3 5)')  As b)
  As foo;

 a_overlap_b | a_crosses_b | a_intersects_b | a_contains_b
-------------+-------------+----------------+--------------
 f           | t           | t              | f

 -- a 2-dimensional bent hot dog (aka puffered line string) that intersects a circle,
 -- but is not fully contained by the circle is defined as overlapping since they are of ↩
    the same dimension,
--  but it does not cross, because the intersection of the 2 is of the same dimension
--  as the maximum dimension of the 2

SELECT ST_Overlaps(a,b) As a_overlap_b, ST_Crosses(a,b) As a_crosses_b, ST_Intersects(a, b) ↩
    As a_intersects_b,
ST_Contains(b,a) As b_contains_a,
ST_Dimension(a) As dim_a, ST_Dimension(b) as dim_b, ST_Dimension(ST_Intersection(a,b)) As ↩
   dima_intersection_b
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 0.5)'), 3)  As a,
  ST_Buffer(ST_GeomFromText('LINESTRING(1 0, 1 1, 3 5)'),0.5)  As b)
  As foo;

 a_overlap_b | a_crosses_b | a_intersects_b | b_contains_a | dim_a | dim_b |  ↩
    dima_intersection_b
-------------+-------------+----------------+--------------+-------+-------+--------------------- ↩

 t           | f           | t              | f            |     2 |     2 |                 2
```

See Also

ST_Contains, ST_Crosses, ST_Dimension, ST_Intersects

7.7.13 ST_Perimeter

Name

ST_Perimeter – Return the length measurement of the boundary of an ST_Surface or ST_MultiSurface value. (Polygon, Multi-polygon)

Synopsis

float **ST_Perimeter**(geometry g1);

Description

Returns the 2D perimeter of the geometry if it is a ST_Surface, ST_MultiSurface (Polygon, Multipolygon). 0 is returned for non-areal geometries. For linestrings use ST_Length. Measurements are in the units of the spatial reference system of the geometry.

Currently this is an alias for ST_Perimeter2D, but this may change to support higher dimensions.

✓ This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SPEC 2.1.5.1

✓ This method implements the SQL/MM specification: SQL-MM 3: 8.1.3, 9.5.4

Examples

Return perimeter in feet for polygon and multipolygon. Note this is in feet because 2249 is Mass State Plane Feet

```
SELECT ST_Perimeter(ST_GeomFromText('POLYGON((743238 2967416,743238 2967450,743265 2967450,
743265.625 2967416,743238 2967416))', 2249));
st_perimeter
---------
 122.630744000095
(1 row)

SELECT ST_Perimeter(ST_GeomFromText('MULTIPOLYGON(((763104.471273676 2949418.44119003,
763104.477769673 2949418.42538203,
763104.189609677 2949418.22343004,763104.471273676 2949418.44119003)),
((763104.471273676 2949418.44119003,763095.804579742 2949436.33850239,
763086.132105649 2949451.46730207,763078.452329651 2949462.11549407,
763075.354136904 2949466.17407812,763064.362142565 2949477.64291974,
763059.953961626 2949481.28983009,762994.637609571 2949532.04103014,
762990.568508415 2949535.06640477,762986.710889563 2949539.61421415,
763117.237897679 2949709.50493431,763235.236617789 2949617.95619822,
763287.718121842 2949562.20592617,763111.553321674 2949423.91664605,
763104.471273676 2949418.44119003)))', 2249));
st_perimeter
---------
 845.227713366825
(1 row)
```

See Also

ST_Length

7.7.14 ST_PointOnSurface

Name

ST_PointOnSurface – Returns a `POINT` guaranteed to lie on the surface.

Synopsis

boolean **ST_PointOnSurface**(geometry g1);

Description

Returns a `POINT` guaranteed to intersect a surface.

This method implements the OpenGIS Simple Features Implementation Specification for SQL: 3.2.14.2, 3.2.18.2

This method implements the SQL/MM specification: SQL-MM 3: 8.1.5, 9.5.6

Examples

```
SELECT ST_AsText(ST_PointOnSurface('POINT(0 5)'::geometry));
 st_astext
------------
 POINT(0 5)
(1 row)

SELECT ST_AsText(ST_PointOnSurface('LINESTRING(0 5, 0 10)'::geometry));
 st_astext
------------
 POINT(0 5)
(1 row)

SELECT ST_AsText(ST_PointOnSurface('POLYGON((0 0, 0 5, 5 5, 5 0, 0 0))'::geometry));
   st_astext
----------------
 POINT(2.5 2.5)
(1 row)
```

See Also

ST_Centroid, $ST_{point_inside_circle}(geometry, float, float, float)$

7.7.15 ST_Touches

Name

ST_Touches – Returns `TRUE` if the geometries have at least one point in common, but their interiors do not intersect.

Synopsis

boolean **ST_Touches**(geometry g1, geometry g2);

Description

Returns `TRUE` if the only points in common between *g1* and *g2* lie in the union of the boundaries of *g1* and *g2*. The `ST_Touches` relation applies to all Area/Area, Line/Line, Line/Area, Point/Area and Point/Line pairs of relationships, but *not* to the Point/Point pair.

In mathematical terms, this predicate is expressed as:

The allowable DE-9IM Intersection Matrices for the two geometries are:

- FT*******
- F**T*****
- F***T****

Important
Do not call with a `GEOMETRYCOLLECTION` as an argument

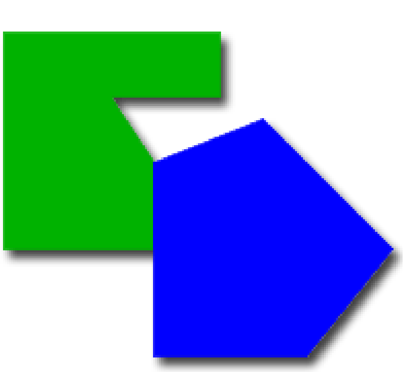
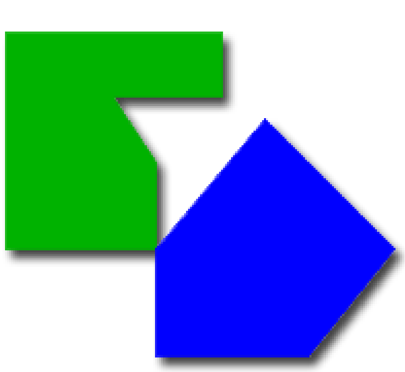
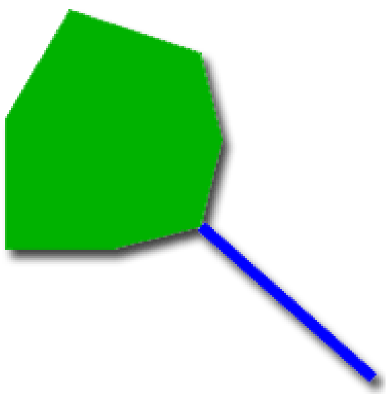
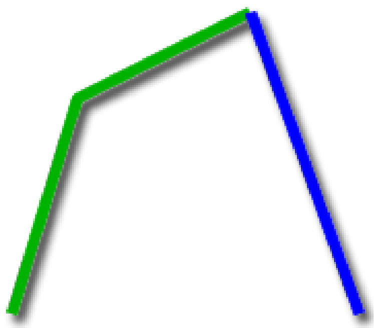
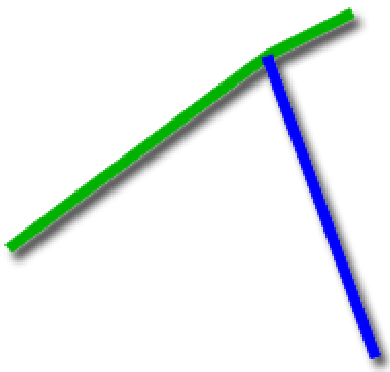
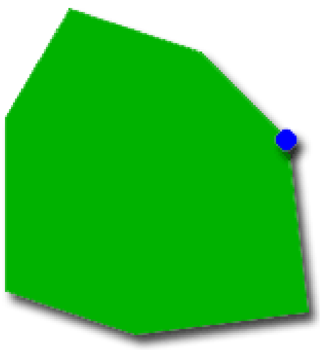
Note
This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid using an index, use `_ST_Touches` instead.

This method implements the OpenGIS Simple Features Implementation Specification for SQL: 2.1.1.2, 2.1.13.3

This method implements the SQL/MM specification: SQL-MM 3: 5.1.28

Examples

The `ST_Touches` predicate returns `TRUE` in all the following illustrations.

 *POLYGON / POLYGON*	 *POLYGON / POLYGON*	 *POLYGON / LINESTRING*
 *LINESTRING / LINESTRING*	 *LINESTRING / LINESTRING*	 *POLYGON / POINT*

```
SELECT ST_Touches('LINESTRING(0 0, 1 1, 0 2)'::geometry, 'POINT(1 1)'::geometry);
 st_touches
------------
 f
(1 row)

SELECT ST_Touches('LINESTRING(0 0, 1 1, 0 2)'::geometry, 'POINT(0 2)'::geometry);
 st_touches
------------
 t
(1 row)
```

7.7.16 ST_Within

Name

ST_Within – Returns true if the geometry A is completely inside geometry B

Synopsis

boolean **ST_Within**(geometry A, geometry B);

Description

Returns TRUE if geometry A is completely inside geometry B. For this function to make sense, the source geometries must both be of the same coordinate projection, having the same SRID. It is a given that if ST_Within(A,B) is true and ST_Within(B,A) is true, then the two geometries are considered spatially equal.

Performed by the GEOS module

> **Important**
> Do not call with a `GEOMETRYCOLLECTION` as an argument

> **Important**
> Do not use this function with invalid geometries. You will get unexpected results.

This function call will automatically include a bounding box comparison that will make use of any indexes that are available on the geometries. To avoid index use, use the function _ST_Within.

NOTE: this is the "allowable" version that returns a boolean, not an integer.

✓ This method implements the OpenGIS Simple Features Implementation Specification for SQL. OGC SPEC s2.1.1.2 // s2.1.13.3 - a.Relate(b, 'T*F**F***')

✓ This method implements the SQL/MM specification: SQL-MM 3: 5.1.30

Examples

```
--a circle within a circle
SELECT ST_Within(smallc,smallc) As smallinsmall,
  ST_Within(smallc, bigc) As smallinbig,
  ST_Within(bigc,smallc) As biginsmall,
  ST_Within(ST_Union(smallc, bigc), bigc) as unioninbig,
  ST_Within(bigc, ST_Union(smallc, bigc)) as biginunion,
  ST_Equals(bigc, ST_Union(smallc, bigc)) as bigisunion
FROM (SELECT ST_Buffer(ST_GeomFromText('POINT(1 2)'), 10) As smallc,
  ST_Buffer(ST_GeomFromText('POINT(1 2)'), 20) As bigc) As foo;
--Result
 smallinsmall | smallinbig | biginsmall | unioninbig | biginunion | bigisunion
--------------+------------+------------+------------+------------+------------
 t            | t          | f          | t          | t          | t
(1 row)
```

See Also

ST_Contains, ST_Equals,ST_IsValid

7.8 Linear Referencing

7.9 Long Transactions Support

7.10 Misc

7.10.1 ST_Expand

Name

ST_Expand – Returns bounding box expanded in all directions from the bounding box of the input geometry

Synopsis

geometry **ST_Expand**(geometry g1, float units_to_expand);
box2d **ST_Expand**(box2d g1, float units_to_expand);
box3d **ST_Expand**(box3d g1, float units_to_expand);

Description

This function returns a bounding box expanded in all directions from the bounding box of the input geometry, by an amount specified in the second argument. Very useful for distance() queries, or bounding box queries to add an index filter to the query.

There are 3 variants of this. The one that takes a geometry will return a POLYGON geometry representation of the bounding box and is the most commonly used variant.

ST_Expand is similar in concept to ST_Buffer except while buffer expands the geometry in all directions, ST_Expand expands the bounding box an x,y,z unit amount.

Units are in the units of the spatial reference system in use denoted by the SRID

Note
Pre 1.3, ST_Expand was used in conjunction with distance to do indexable queries. Something of the form `the_geom && ST_Expand('POINT(10 20)', 10) AND ST_Distance(the_geom, 'POINT(10 20)') < 10` Post 1.2, this was replaced with the easier ST_DWithin construct.

Note
Bounding boxes of all geometries are currently 2-d even if they are 3-dimensional geometries.

Examples

Note
Examples below use US National Atlas Equal Area (SRID=2163) which is a meter projection

```
--10 meter expanded box around bbox of a linestring
SELECT CAST(ST_Expand(ST_GeomFromText('LINESTRING(2312980 110676,2312923 110701,2312892 ↩
    110714)', 2163),10) As box2d);
                 st_expand
------------------------------------
 BOX(2312882 110666,2312990 110724)

--10 meter expanded 3d box of a 3d box
SELECT ST_Expand(CAST('BOX3D(778783 2951741 1,794875 2970042.61545891 10)' As box3d),10)
                          st_expand
-----------------------------------------------------
 BOX3D(778773 2951731 -9,794885 2970052.61545891 20)

 --10 meter geometry astext rep of a expand box around a point geometry
 SELECT ST_AsEWKT(ST_Expand(ST_GeomFromEWKT('SRID=2163;POINT(2312980 110676)'),10));
                                            st_asewkt
------------------------------------------------------------------------------------------------- ↩

 SRID=2163;POLYGON((2312970 110666,2312970 110686,2312990 110686,2312990 110666,2312970 ↩
    110666))
```

See Also

ST_AsEWKT, ST$_{B}uffer(geometry, double, [integer])$, ST_DWithin, ST_GeomFromEWKT,ST_GeomFromText, ST_SRID

Chapter 8

Reporting Problems

8.1 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.

8.2 Reporting Documentation Issues

The documentation should accurately reflect the features and behavior of the software. If it doesn't, it could be because of a software bug or because the documentation is in error or deficient.

Documentation issues can also be reported to the PostGIS bug tracker.

If your revision is trivial, just describe it in a new bug tracker issue, being specific about its location in the documentation.

If your changes are more extensive, a Subversion patch is definitely preferred. This is a four step process on Unix (assuming you already have Subversion installed):

1. Check out a copy of PostGIS' Subversion trunk. On Unix, type:

   svn checkout http://svn.refractions.net/postgis/trunk/

   This will be stored in the directory ./trunk

2. Make your changes to the documentation with your favorite text editor. On Unix, type (for example):

   vi trunk/doc/postgis.xml

   Note that the documentation is written in SGML rather than HTML, so if you are not familiar with it please follow the example of the rest of the documentation.

3. Make a patch file containing the differences from the master copy of the documentation. On Unix, type:

   svn diff trunk/doc/postgis.xml > doc.patch

4. Attach the patch to a new issue in bug tracker.

Appendix A

Appendix

A.1 Release 1.3.3

Release date: 2008/04/12

This release fixes bugs shp2pgsql, adds enhancements to SVG and KML support, adds a ST_SimplifyPreserveTopology function, makes the build more sensitive to GEOS versions, and fixes a handful of severe but rare failure cases.

A.2 Release 1.3.2

Release date: 2007/12/01

This release fixes bugs in ST_EndPoint() and ST_Envelope, improves support for JDBC building and OS/X, and adds better support for GML output with ST_AsGML(), including GML3 output.

A.3 Release 1.3.1

Release date: 2007/08/13

This release fixes some oversights in the previous release around version numbering, documentation, and tagging.

A.4 Release 1.3.0

Release date: 2007/08/09

This release provides performance enhancements to the relational functions, adds new relational functions and begins the migration of our function names to the SQL-MM convention, using the spatial type (SP) prefix.

A.4.1 Added Functionality

JDBC: Added Hibernate Dialect (thanks to Norman Barker)

Added ST_Covers and ST_CoveredBy relational functions. Description and justification of these functions can be found at http://lin-ear-th-inking.blogspot.com/2007/06/subtleties-of-ogc-covers-spatial.html

Added ST_DWithin relational function.

A.4.2 Performance Enhancements

Added cached and indexed point-in-polygon short-circuits for the functions ST_Contains, ST_Intersects, ST_Within and ST_Disjoint

Added inline index support for relational functions (except ST_Disjoint)

A.4.3 Other Changes

Extended curved geometry support into the geometry accessor and some processing functions

Began migration of functions to the SQL-MM naming convention; using a spatial type (ST) prefix.

Added initial support for PostgreSQL 8.3

A.5 Release 1.2.1

Release date: 2007/01/11

This release provides bug fixes in PostgreSQL 8.2 support and some small performance enhancements.

A.5.1 Changes

Fixed point-in-polygon shortcut bug in Within().

Fixed PostgreSQL 8.2 NULL handling for indexes.

Updated RPM spec files.

Added short-circuit for Transform() in no-op case.

JDBC: Fixed JTS handling for multi-dimensional geometries (thanks to Thomas Marti for hint and partial patch). Additionally, now JavaDoc is compiled and packaged. Fixed classpath problems with GCJ. Fixed pgjdbc 8.2 compatibility, losing support for jdk 1.3 and older.

A.6 Release 1.2.0

Release date: 2006/12/08

This release provides type definitions along with serialization/deserialization capabilities for SQL-MM defined curved geometries, as well as performance enhancements.

A.6.1 Changes

Added curved geometry type support for serialization/deserialization

Added point-in-polygon shortcircuit to the Contains and Within functions to improve performance for these cases.

A.7 Release 1.1.6

Release date: 2006/11/02

This is a bugfix release, in particular fixing a critical error with GEOS interface in 64bit systems. Includes an updated of the SRS parameters and an improvement in reprojections (take Z in consideration). Upgrade is *encouraged*.

A.7.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.7.2 Bug fixes

fixed CAPI change that broke 64-bit platforms

loader/dumper: fixed regression tests and usage output

Fixed setSRID() bug in JDBC, thanks to Thomas Marti

A.7.3 Other changes

use Z ordinate in reprojections

spatial_ref_sys.sql updated to EPSG 6.11.1

Simplified Version.config infrastructure to use a single pack of version variables for everything.

Include the Version.config in loader/dumper USAGE messages

Replace hand-made, fragile JDBC version parser with Properties

A.8 Release 1.1.5

Release date: 2006/10/13

This is an bugfix release, including a critical segfault on win32. Upgrade is *encouraged*.

A.8.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.8.2 Bug fixes

Fixed MingW link error that was causing pgsql2shp to segfault on Win32 when compiled for PostgreSQL 8.2

fixed nullpointer Exception in Geometry.equals() method in Java

Added EJB3Spatial.odt to fulfill the GPL requirement of distributing the "preferred form of modification"

Removed obsolete synchronization from JDBC Jts code.

Updated heavily outdated README files for shp2pgsql/pgsql2shp by merging them with the manpages.

Fixed version tag in jdbc code that still said "1.1.3" in the "1.1.4" release.

A.8.3 New Features

Added -S option for non-multi geometries to shp2pgsql

A.9 Release 1.1.4

Release date: 2006/09/27

This is an bugfix release including some improvements in the Java interface. Upgrade is *encouraged*.

A.9.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.9.2 Bug fixes

Fixed support for PostgreSQL 8.2

Fixed bug in collect() function discarding SRID of input

Added SRID match check in MakeBox2d and MakeBox3d

Fixed regress tests to pass with GEOS-3.0.0

Improved pgsql2shp run concurrency.

A.9.3 Java changes

reworked JTS support to reflect new upstream JTS developers' attitude to SRID handling. Simplifies code and drops build depend on GNU trove.

Added EJB2 support generously donated by the "Geodetix s.r.l. Company" http://www.geodetix.it/

Added EJB3 tutorial / examples donated by Norman Barker <nbarker@ittvis.com>

Reorganized java directory layout a little.

A.10 Release 1.1.3

Release date: 2006/06/30

This is an bugfix release including also some new functionalities (most notably long transaction support) and portability enhancements. Upgrade is *encouraged*.

A.10.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.10.2 Bug fixes / correctness

BUGFIX in distance(poly,poly) giving wrong results.

BUGFIX in pgsql2shp successful return code.

BUGFIX in shp2pgsql handling of MultiLine WKT.

BUGFIX in affine() failing to update bounding box.

WKT parser: forbidden construction of multigeometries with EMPTY elements (still supported for GEOMETRYCOLLECTION).

A.10.3 New functionalities

NEW Long Transactions support.

NEW DumpRings() function.

NEW AsHEXEWKB(geom, XDR|NDR) function.

A.10.4 JDBC changes

Improved regression tests: MultiPoint and scientific ordinates

Fixed some minor bugs in jdbc code

Added proper accessor functions for all fields in preparation of making those fields private later

A.10.5 Other changes

NEW regress test support for loader/dumper.

Added --with-proj-libdir and --with-geos-libdir configure switches.

Support for build Tru64 build.

Use Jade for generating documentation.

Don't link pgsql2shp to more libs then required.

Initial support for PostgreSQL 8.2.

A.11 Release 1.1.2

Release date: 2006/03/30

This is an bugfix release including some new functions and portability enhancements. Upgrade is *encouraged*.

A.11.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.11.2 Bug fixes

BUGFIX in SnapToGrid() computation of output bounding box

BUGFIX in EnforceRHR()

jdbc2 SRID handling fixes in JTS code

Fixed support for 64bit archs

A.11.3 New functionalities

Regress tests can now be run *before* postgis installation

New affine() matrix transformation functions

New rotate{,X,Y,Z}() function

Old translating and scaling functions now use affine() internally

Embedded access control in estimated_extent() for builds against pgsql >= 8.0.0

A.11.4 Other changes

More portable ./configure script

Changed ./run_test script to have more sane default behaviour

A.12 Release 1.1.1

Release date: 2006/01/23

This is an important Bugfix release, upgrade is *highly recommended*. Previous version contained a bug in postgis_restore.pl preventing hard upgrade procedure to complete and a bug in GEOS-2.2+ connector preventing GeometryCollection objects to be used in topological operations.

A.12.1 Upgrading

If you are upgrading from release 1.0.3 or later follow the soft upgrade procedure.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.12.2 Bug fixes

Fixed a premature exit in postgis_restore.pl

BUGFIX in geometrycollection handling of GEOS-CAPI connector

Solaris 2.7 and MingW support improvements

BUGFIX in line_locate_point()

Fixed handling of postgresql paths

BUGFIX in line_substring()

Added support for localized cluster in regress tester

A.12.3 New functionalities

New Z and M interpolation in line_substring()

New Z and M interpolation in line_interpolate_point()

added NumInteriorRing() alias due to OpenGIS ambiguity

A.13 Release 1.1.0

Release date: 2005/12/21

This is a Minor release, containing many improvements and new things. Most notably: build procedure greatly simplified; transform() performance drastically improved; more stable GEOS connectivity (CAPI support); lots of new functions; draft topology support.

It is *highly recommended* that you upgrade to GEOS-2.2.x before installing PostGIS, this will ensure future GEOS upgrades won't require a rebuild of the PostGIS library.

A.13.1 Credits

This release includes code from Mark Cave Ayland for caching of proj4 objects. Markus Schaber added many improvements in his JDBC2 code. Alex Bodnaru helped with PostgreSQL source dependency relief and provided Debian specfiles. Michael Fuhr tested new things on Solaris arch. David Techer and Gerald Fenoy helped testing GEOS C-API connector. Hartmut Tschauner provided code for the azimuth() function. Devrim GUNDUZ provided RPM specfiles. Carl Anderson helped with the new area building functions. See the credits section for more names.

A.13.2 Upgrading

If you are upgrading from release 1.0.3 or later you *DO NOT* need a dump/reload. Simply sourcing the new lwpostgis_upgrade.sql script in all your existing databases will work. See the soft upgrade chapter for more information.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.13.3 New functions

scale() and transscale() companion methods to translate()

line_substring()

line_locate_point()

M(point)

LineMerge(geometry)

shift_longitude(geometry)

azimuth(geometry)

locate_along_measure(geometry, float8)

locate_between_measures(geometry, float8, float8)

SnapToGrid by point offset (up to 4d support)

BuildArea(any_geometry)

OGC BdPolyFromText(linestring_wkt, srid)

OGC BdMPolyFromText(linestring_wkt, srid)

RemovePoint(linestring, offset)

ReplacePoint(linestring, offset, point)

A.13.4 Bug fixes

Fixed memory leak in polygonize()

Fixed bug in lwgeom_as_anytype cast functions

Fixed USE_GEOS, USE_PROJ and USE_STATS elements of postgis_version() output to always reflect library state.

A.13.5 Function semantic changes

SnapToGrid doesn't discard higher dimensions

Changed Z() function to return NULL if requested dimension is not available

A.13.6 Performance improvements

Much faster transform() function, caching proj4 objects

Removed automatic call to fix_geometry_columns() in AddGeometryColumns() and update_geometry_stats()

A.13.7 JDBC2 works

Makefile improvements

JTS support improvements

Improved regression test system

Basic consistency check method for geometry collections

Support for (Hex)(E)wkb

Autoprobing DriverWrapper for HexWKB / EWKT switching

fix compile problems in ValueSetter for ancient jdk releases.

fix EWKT constructors to accept SRID=4711; representation

added preliminary read-only support for java2d geometries

A.13.8 Other new things

Full autoconf-based configuration, with PostgreSQL source dependency relief

GEOS C-API support (2.2.0 and higher)

Initial support for topology modelling

Debian and RPM specfiles

New lwpostgis_upgrade.sql script

A.13.9 Other changes

JTS support improvements

Stricter mapping between DBF and SQL integer and string attributes

Wider and cleaner regression test suite

old jdbc code removed from release

obsoleted direct use of postgis_proc_upgrade.pl

scripts version unified with release version

A.14 Release 1.0.6

Release date: 2005/12/06

Contains a few bug fixes and improvements.

A.14.1 Upgrading

If you are upgrading from release 1.0.3 or later you *DO NOT* need a dump/reload.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.14.2 Bug fixes

Fixed palloc(0) call in collection deserializer (only gives problem with --enable-cassert)

Fixed bbox cache handling bugs

Fixed geom_accum(NULL, NULL) segfault

Fixed segfault in addPoint()

Fixed short-allocation in lwcollection_clone()

Fixed bug in segmentize()

Fixed bbox computation of SnapToGrid output

A.14.3 Improvements

Initial support for postgresql 8.2

Added missing SRID mismatch checks in GEOS ops

A.15 Release 1.0.5

Release date: 2005/11/25

Contains memory-alignment fixes in the library, a segfault fix in loader's handling of UTF8 attributes and a few improvements and cleanups.

Note
Return code of shp2pgsql changed from previous releases to conform to unix standards (return 0 on success).

A.15.1 Upgrading

If you are upgrading from release 1.0.3 or later you *DO NOT* need a dump/reload.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.15.2 Library changes

Fixed memory alignment problems

Fixed computation of null values fraction in analyzer

Fixed a small bug in the getPoint4d_p() low-level function

Speedup of serializer functions

Fixed a bug in force_3dm(), force_3dz() and force_4d()

A.15.3 Loader changes

Fixed return code of shp2pgsql

Fixed back-compatibility issue in loader (load of null shapefiles)

Fixed handling of trailing dots in dbf numerical attributes

Segfault fix in shp2pgsql (utf8 encoding)

A.15.4 Other changes

Schema aware postgis_proc_upgrade.pl, support for pgsql 7.2+

New "Reporting Bugs" chapter in manual

A.16 Release 1.0.4

Release date: 2005/09/09

Contains important bug fixes and a few improvements. In particular, it fixes a memory leak preventing successful build of GiST indexes for large spatial tables.

A.16.1 Upgrading

If you are upgrading from release 1.0.3 you *DO NOT* need a dump/reload.

If you are upgrading from a release *between 1.0.0RC6 and 1.0.2* (inclusive) and really want a live upgrade read the upgrade section of the 1.0.3 release notes chapter.

Upgrade from any release prior to 1.0.0RC6 requires an hard upgrade.

A.16.2 Bug fixes

Memory leak plugged in GiST indexing

Segfault fix in transform() handling of proj4 errors

Fixed some proj4 texts in spatial_ref_sys (missing +proj)

Loader: fixed string functions usage, reworked NULL objects check, fixed segfault on MULTILINESTRING input.

Fixed bug in MakeLine dimension handling

Fixed bug in translate() corrupting output bounding box

A.16.3 Improvements

Documentation improvements

More robust selectivity estimator

Minor speedup in distance()

Minor cleanups

GiST indexing cleanup

Looser syntax acceptance in box3d parser

A.17 Release 1.0.3

Release date: 2005/08/08

Contains some bug fixes - *including a severe one affecting correctness of stored geometries* - and a few improvements.

A.17.1 Upgrading

Due to a bug in a bounding box computation routine, the upgrade procedure requires special attention, as bounding boxes cached in the database could be incorrect.

An hard upgrade procedure (dump/reload) will force recomputation of all bounding boxes (not included in dumps). This is *required* if upgrading from releases prior to 1.0.0RC6.

If you are upgrading from versions 1.0.0RC6 or up, this release includes a perl script (utils/rebuild_bbox_caches.pl) to force recomputation of geometries' bounding boxes and invoke all operations required to propagate eventual changes in them (geometry statistics update, reindexing). Invoke the script after a make install (run with no args for syntax help). Optionally run utils/postgis_proc_upgrade.pl to refresh postgis procedures and functions signatures (see Soft upgrade).

A.17.2 Bug fixes

Severe bugfix in lwgeom's 2d bounding box computation

Bugfix in WKT (-w) POINT handling in loader

Bugfix in dumper on 64bit machines

Bugfix in dumper handling of user-defined queries

Bugfix in create_undef.pl script

A.17.3 Improvements

Small performance improvement in canonical input function

Minor cleanups in loader

Support for multibyte field names in loader

Improvement in the postgis_restore.pl script

New rebuild_bbox_caches.pl util script

A.18 Release 1.0.2

Release date: 2005/07/04

Contains a few bug fixes and improvements.

A.18.1 Upgrading

If you are upgrading from release 1.0.0RC6 or up you *DO NOT* need a dump/reload.

Upgrading from older releases requires a dump/reload. See the upgrading chapter for more informations.

A.18.2 Bug fixes

Fault tolerant btree ops

Memory leak plugged in pg_error

Rtree index fix

Cleaner build scripts (avoided mix of CFLAGS and CXXFLAGS)

A.18.3 Improvements

New index creation capabilities in loader (-I switch)

Initial support for postgresql 8.1dev

A.19 Release 1.0.1

Release date: 2005/05/24

Contains a few bug fixes and some improvements.

A.19.1 Upgrading

If you are upgrading from release 1.0.0RC6 or up you *DO NOT* need a dump/reload.

Upgrading from older releases requires a dump/reload. See the upgrading chapter for more informations.

A.19.2 Library changes

BUGFIX in 3d computation of length_spheroid()

BUGFIX in join selectivity estimator

A.19.3 Other changes/additions

BUGFIX in shp2pgsql escape functions

better support for concurrent postgis in multiple schemas

documentation fixes

jdbc2: compile with "-target 1.2 -source 1.2" by default

NEW -k switch for pgsql2shp

NEW support for custom createdb options in postgis_restore.pl

BUGFIX in pgsql2shp attribute names unicity enforcement

BUGFIX in Paris projections definitions

postgis_restore.pl cleanups

A.20 Release 1.0.0

Release date: 2005/04/19

Final 1.0.0 release. Contains a few bug fixes, some improvements in the loader (most notably support for older postgis versions), and more docs.

A.20.1 Upgrading

If you are upgrading from release 1.0.0RC6 you *DO NOT* need a dump/reload.

Upgrading from any other precedent release requires a dump/reload. See the upgrading chapter for more informations.

A.20.2 Library changes

BUGFIX in transform() releasing random memory address

BUGFIX in force_3dm() allocating less memory then required

BUGFIX in join selectivity estimator (defaults, leaks, tuplecount, sd)

A.20.3 Other changes/additions

BUGFIX in shp2pgsql escape of values starting with tab or single-quote

NEW manual pages for loader/dumper

NEW shp2pgsql support for old (HWGEOM) postgis versions

NEW -p (prepare) flag for shp2pgsql

NEW manual chapter about OGC compliancy enforcement

NEW autoconf support for JTS lib

BUGFIX in estimator testers (support for LWGEOM and schema parsing)

A.21 Release 1.0.0RC6

Release date: 2005/03/30

Sixth release candidate for 1.0.0. Contains a few bug fixes and cleanups.

A.21.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.21.2 Library changes

BUGFIX in multi()

early return [when noop] from multi()

A.21.3 Scripts changes

dropped {x,y}{min,max}(box2d) functions

A.21.4 Other changes

BUGFIX in postgis_restore.pl scrip

BUGFIX in dumper's 64bit support

A.22 Release 1.0.0RC5

Release date: 2005/03/25

Fifth release candidate for 1.0.0. Contains a few bug fixes and a improvements.

A.22.1 Upgrading

If you are upgrading from release 1.0.0RC4 you *DO NOT* need a dump/reload.

Upgrading from any other precedent release requires a dump/reload. See the upgrading chapter for more informations.

A.22.2 Library changes

BUGFIX (segfaulting) in box3d computation (yes, another!).

BUGFIX (segfaulting) in estimated_extent().

A.22.3 Other changes

Small build scripts and utilities refinements.

Additional performance tips documented.

A.23 Release 1.0.0RC4

Release date: 2005/03/18

Fourth release candidate for 1.0.0. Contains bug fixes and a few improvements.

A.23.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.23.2 Library changes

BUGFIX (segfaulting) in geom_accum().

BUGFIX in 64bit architectures support.

BUGFIX in box3d computation function with collections.

NEW subselects support in selectivity estimator.

Early return from force_collection.

Consistency check fix in SnapToGrid().

Box2d output changed back to 15 significant digits.

A.23.3 Scripts changes

NEW distance_sphere() function.

Changed get_proj4_from_srid implementation to use PL/PGSQL instead of SQL.

A.23.4 Other changes

BUGFIX in loader and dumper handling of MultiLine shapes

BUGFIX in loader, skipping all but first hole of polygons.

jdbc2: code cleanups, Makefile improvements

FLEX and YACC variables set *after* pgsql Makefile.global is included and only if the pgsql *stripped* version evaluates to the empty string

Added already generated parser in release

Build scripts refinements

improved version handling, central Version.config

improvements in postgis_restore.pl

A.24 Release 1.0.0RC3

Release date: 2005/02/24

Third release candidate for 1.0.0. Contains many bug fixes and improvements.

A.24.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.24.2 Library changes

BUGFIX in transform(): missing SRID, better error handling.

BUGFIX in memory alignment handling

BUGFIX in force_collection() causing mapserver connector failures on simple (single) geometry types.

BUGFIX in GeometryFromText() missing to add a bbox cache.

reduced precision of box2d output.

prefixed DEBUG macros with PGIS_ to avoid clash with pgsql one

plugged a leak in GEOS2POSTGIS converter

Reduced memory usage by early releasing query-context palloced one.

A.24.3 Scripts changes

BUGFIX in 72 index bindings.

BUGFIX in probe_geometry_columns() to work with PG72 and support multiple geometry columns in a single table

NEW bool::text cast

Some functions made IMMUTABLE from STABLE, for performance improvement.

A.24.4 JDBC changes

jdbc2: small patches, box2d/3d tests, revised docs and license.

jdbc2: bug fix and testcase in for pgjdbc 8.0 type autoregistration

jdbc2: Removed use of jdk1.4 only features to enable build with older jdk releases.

jdbc2: Added support for building against pg72jdbc2.jar

jdbc2: updated and cleaned makefile

jdbc2: added BETA support for jts geometry classes

jdbc2: Skip known-to-fail tests against older PostGIS servers.

jdbc2: Fixed handling of measured geometries in EWKT.

A.24.5 Other changes

new performance tips chapter in manual

documentation updates: pgsql72 requirement, lwpostgis.sql

few changes in autoconf

BUILDDATE extraction made more portable

fixed spatial_ref_sys.sql to avoid vacuuming the whole database.

spatial_ref_sys: changed Paris entries to match the ones distributed with 0.x.

A.25 Release 1.0.0RC2

Release date: 2005/01/26

Second release candidate for 1.0.0 containing bug fixes and a few improvements.

A.25.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.25.2 Library changes

BUGFIX in pointarray box3d computation

BUGFIX in distance_spheroid definition

BUGFIX in transform() missing to update bbox cache

NEW jdbc driver (jdbc2)

GEOMETRYCOLLECTION(EMPTY) syntax support for backward compatibility

Faster binary outputs

Stricter OGC WKB/WKT constructors

A.25.3 Scripts changes

More correct STABLE, IMMUTABLE, STRICT uses in lwpostgis.sql

stricter OGC WKB/WKT constructors

A.25.4 Other changes

Faster and more robust loader (both i18n and not)

Initial autoconf script

A.26 Release 1.0.0RC1

Release date: 2005/01/13

This is the first candidate of a major postgis release, with internal storage of postgis types redesigned to be smaller and faster on indexed queries.

A.26.1 Upgrading

You need a dump/reload to upgrade from precedent releases. See the upgrading chapter for more informations.

A.26.2 Changes

Faster canonical input parsing.

Lossless canonical output.

EWKB Canonical binary IO with PG>73.

Support for up to 4d coordinates, providing lossless shapefile->postgis->shapefile conversion.

New function: UpdateGeometrySRID(), AsGML(), SnapToGrid(), ForceRHR(), estimated_extent(), accum().

Vertical positioning indexed operators.

JOIN selectivity function.

More geometry constructors / editors.

PostGIS extension API.

UTF8 support in loader.