DB2 Spatial Extender and Geodetic Data Management Feature

Version 9
Linux, UNIX, and Windows

User's Guide and Reference

SC18-9749-00

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Note

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Chapter 1. About DB2 Spatial Extender

This section introduces DB2 Spatial Extender by explaining its purpose, describing the data that it supports, and explaining how its underlying concepts fit together.

The purpose of DB2 Spatial Extender

Use DB2® Spatial Extender to generate and analyze spatial information about geographic features, and to store and manage the data on which this information is based. A geographic feature (sometimes called feature in this discussion, for short) is anything in the real world that has an identifiable location, or anything that could be imagined as existing at an identifiable location. A feature can be:

- An object (that is, a concrete entity of any sort); for example, a river, forest, or range of mountains.
- A space; for example, a safety zone around a hazardous site, or the marketing area serviced by a particular business.
- An event that occurs at a definable location; for example, an auto accident that occurred at a particular intersection, or a sales transaction at a specific store.

Features exist in multiple environments. For example, the objects mentioned in the preceding list—river, forest, mountain range—belong to the natural environment. Other objects, such as cities, buildings, and offices, belong to the cultural environment. Still others, such as parks, zoos, and farmland, represent a combination of the natural and cultural environments.

In this discussion, the term spatial information refers to the kind of information that DB2 Spatial Extender makes available to its users—namely, facts and figures about the locations of geographic features. Examples of spatial information are:

- Locations of geographic features on the map (for example, longitude and latitude values that define where cities are situated)
- The location of geographic features with respect to one another (for example, points within a city where hospitals and clinics are located, or the proximity of the city's residences to local earthquake zones)
- Ways in which geographic features are related to each other (for example, information that a certain river system is enclosed within a specific region, or that certain bridges in that region cross over the river system's tributaries)
- Measurements that apply to one or more geographic features (for example, the distance between an office building and its lot line, or the length of a bird preserve's perimeter)

Spatial information, either by itself or in combination with traditional relational data, can help you with such activities as defining the areas in which you provide services, and determining locations of possible markets. For example, suppose that the manager of a county welfare district needs to verify which welfare applicants and recipients actually live within the area that the district services. DB2 Spatial Extender can derive this information from the serviced area's location and from the addresses of the applicants and recipients.

Or suppose that the owner of a restaurant chain wants to do business in nearby cities. To determine where to open new restaurants, the owner needs answers to

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such questions as: Where in these cities are concentrations of clientele who typically frequent my restaurants? Where are the major highways? Where is the crime rate lowest? Where are the competition's restaurants located? DB2 Spatial Extender and DB2 can produce information to answer these questions. Furthermore, front-end tools, though not required, can play a part. To illustrate: a visualization tool can put information produced by DB2 Spatial Extender—for example, the location of concentrations of clientele and the proximity of major highways to proposed restaurants—in graphic form on a map. Business intelligence tools can put associated information—for example, names and descriptions of competing restaurants—in report form.

How data represents geographic features

In DB2® Spatial Extender, a geographic feature can be represented by one or more data items; for example, the data items in a row of a table. (A data item is the value or values that occupy a cell of a relational table.) For example, consider office buildings and residences. In Figure 1, each row of the BRANCHES table represents a branch office of a bank. Similarly, each row of the CUSTOMERS table in Figure 1, taken as a whole, represents a customer of the bank. However, a subset of each row—specifically, the data items that constitute a customer's address—represent the customer's residence.

BRANCHES

ID	NAME	ADDRESS	CITY	POSTAL CODE	STATE_PROV	COUNTRY
937	Airzone-Multern	92467 Airzone Blvd	San Jose	95141	CA	USA

CUSTOMERS

ID	LAST NAME	FIRST NAME	ADDRESS	CITY	POSTAL CODE	STATE_PROV	COUNTRY	CHECKING	SAVINGS
59-6396	Kriner	Endela	9 Concourt Circle	San Jose	95141	CA	USA	A	A

Figure 1. Data that represents geographic features. The row of data in the BRANCHES table represents a branch office of a bank. The address data in the CUSTOMERS table represents the residence of a customer. The names and addresses in both tables are fictional.

The tables in Figure 1 contain data that identifies and describes the bank's branches and customers. This discussion refers to such data as business data.

A subset of the business data—the values that denote the branches' and customers' addresses—can be translated into values from which spatial information is generated. For example, as shown in Figure 1, one branch office's address is 92467 Airzone Blvd., San Jose, CA 95141, USA. A customer's address is 9 Concourt Circle, San Jose, CA 95141, USA. DB2 Spatial Extender can translate these addresses into values that indicate where the branch and the customer's home are located with respect to one another. Figure 2 on page 3 shows the BRANCHES and CUSTOMERS tables with new columns that are designated to contain such values.

BRANCHES

ID	NAME	ADDRESS	CITY	POSTAL CODE	STATE_PROV	COUNTRY	LOCATION
937	Airzone-Multern	92467 Airzone Blvd	San Jose	95141	CA	USA	

CUSTOMERS

ID	LAST NAME	FIRST NAME	ADDRESS	CITY	POSTAL CODE	STATE_PROV	COUNTRY	LOCATION	CHECKING	SAVINGS
59-6396	Kriner	Endela	9 Concourt Circle	San Jose	95141	CA	USA		A	A

Figure 2. Tables with spatial columns added. In each table, the LOCATION column will contain coordinates that correspond to the addresses.

Because spatial information will be derived from the data items stored in the LOCATION column, these data items are referred to in this discussion as spatial data.

The nature of spatial data

Spatial data is made up of coordinates that identify a location. Spatial Extender works with two-dimensional coordinates specified by x and y or longitude and latitude values.

A coordinate is a number that denotes either:

- A position along an axis relative to an origin, given a unit of length.
- A direction relative to a base line or plane, given a unit of angular measure.

For example, latitude is a coordinate that denotes an angle relative to the equatorial plane, usually in degrees. Longitude is a coordinate that denotes an angle relative to the Greenwich meridian, also usually in degrees. Thus, on a map, the position of Yellowstone National Park is defined by latitude 44.45 degrees north of the equator and longitude 110.40 degrees west of the Greenwich meridian. More precisely, these coordinates reference the center of Yellowstone National Park in the USA.

The definitions of latitude and longitude, their points, lines, and planes of reference, units of measure, and other associated parameters are referred to collectively as a coordinate system. Coordinate systems can be based on values other than latitude and longitude. These coordinate systems have their own points, lines, and planes of reference, units of measure, and additional associated parameters (such as the projection transformation).

The simplest spatial data item consists of a single coordinate pair that defines the position of a single geographic location. A more extensive spatial data item consists of several coordinates that define a linear path that a road or river might form. A third kind consists of coordinates that define the boundary of an area; for example, the boundary of a land parcel or flood plain.

Each spatial data item is an instance of a spatial data type. The data type for coordinates that mark a single location is ST_Point; the data type for coordinates that define a linear path is ST_LineString; and the data type for coordinates that define the boundary of an area is ST_Polygon. These types, together with the other spatial data types, are structured types that belong to a single hierarchy.

The nature of geodetic data

Geodetic data is spatial data that is expressed in latitude and longitude coordinates, in a coordinate system that describes a round, continuous, closed surface.

DB2 Geodetic Data Management Feature uses the same data types and functions as Spatial Extender to store geographic data in a DB2 database. Unlike Spatial Extender, which treats the Earth as a flat map, Geodetic Data Management Feature treats the Earth as a globe that has no edges or seams at the poles or the dateline. A flat map requires projected coordinates to transform spherical coordinates to planar coordinates. Whereas, Geodetic Data Management Feature uses latitude and longitude on an ellipsoidal model of the Earth's surface. Calculations such as line intersection, area overlap, distance, and area, are accurate and precise, regardless of location.

Where spatial data comes from

You can obtain spatial data by:

- Deriving it from business data
- Generating it from spatial functions
- Importing it from external sources

Using business data as source data

DB2 Spatial Extender can derive spatial data from business data, such as addresses (as mentioned in "How data represents geographic features" on page 2). This process is called geocoding. To see the sequence involved, consider Figure 2 on page 3 as a "before" picture and Figure 3 as an "after" picture. Figure 2 on page 3 shows that the BRANCHES table and the CUSTOMERS table both have a column designated for spatial data. Suppose that DB2 Spatial Extender geocodes the addresses in these tables to obtain coordinates that correspond to the addresses, and places the coordinates into the columns. Figure 3 illustrates this result.

BRANCHES

ID	NAME	ADDRESS	CITY	POSTAL CODE	STATE_PROV	COUNTRY	LOCATION
937	Airzone-Multern	92467 Airzone Blvd	San Jose	95141	CA	USA	1653 3094

CUSTOMERS

ID	LAST NAME	FIRST NAME	ADDRESS	CITY	POSTAL CODE	STATE_PROV	COUNTRY	LOCATION	CHECKING	SAVINGS
59-6396	Kriner	Endela	9 Concourt Circle	San Jose	95141	CA	USA	953 1527	A	A

Figure 3. Tables that include spatial data derived from source data. The LOCATION column in the CUSTOMERS table contains coordinates that were derived from the address in the ADDRESS, CITY, POSTAL CODE, STATE_PROV, and COUNTRY columns. Similarly, the LOCATION column in the BRANCHES table contains coordinates that were derived from the address in this table's ADDRESS, CITY, POSTAL CODE, STATE_PROV, and COUNTRY columns.

DB2 Spatial Extender uses a function, called a geocoder, to translate business data into coordinates to allow spatial functions to operate on the data.

Using functions to generate spatial data

You can use functions to generate spatial data from input data.

Spatial data can be generated not only by geocoders, but by other functions as well. For example, suppose that the bank whose branches are defined in the

BRANCHES table wants to know how many customers are located within five miles of each branch. Before the bank can obtain this information from the database, it needs to define the zone that lies within a specified radius around each branch. A DB2 Spatial Extender function, ST_Buffer, can create such a definition. Using the coordinates of each branch as input, ST_Buffer can generate the coordinates that demarcate the perimeters of the zones. Figure 4 shows the BRANCHES table with information that is supplied by ST_Buffer.

BRANCHES

ID	NAME	ADDRESS	CITY	POSTAL CODE	STATE_PROV	COUNTRY	LOCATION	SALES_AREA
937	Airzone-Multern	92467 Airzone Blvd	San Jose	95141	CA	USA	1653 3094	1002 2001, 1192 3564, 2502 3415, 1915 3394, 1002 2001

Figure 4. Table that includes new spatial data derived from existing spatial data. The coordinates in the SALES_AREA column were derived by the ST_Buffer function from the coordinates in the LOCATION column. Like the coordinates in the LOCATION column, those in the SALES_AREA column are simulated; they are not actual.

In addition to ST_Buffer, DB2 Spatial Extender provides several other functions that derive new spatial data from existing spatial data.

Importing spatial data

Spatial Extender provides services to import spatial data in Shapefile and SDE Export formats.

Spatial data in Shapefile format is available from many sources through the internet. You can download many datafiles for US and world-wide features such as countries, states, cities, rivers, and more under the Downloads section of the Spatial Extender web site.

You can import spatial data from files provided by external data sources. These files typically contain data that is applied to maps: street networks, flood plains, earthquake faults, and so on. By using such data in combination with spatial data that you produce, you can augment the spatial information available to you. For example, if a public works department needs to determine what hazards a residential community is vulnerable to, it could use ST_Buffer to define a zone around the community. The public works department could then import data on flood plains and earthquake faults to see which of these problem areas overlap this zone.

How features, spatial information, spatial data, and geometries fit together

This section summarizes several basic concepts that underlie the operations of DB2® Spatial Extender: geographic features, spatial information, spatial data, and geometries.

DB2 Spatial Extender lets you obtain facts and figures that pertain to things that can be defined geographically—that is, in terms of their location on earth, or within a region of the earth. The DB2 documentation refers to such facts and figures as *spatial information*, and to the things as *geographic features* (called *features* here, for short).

For example, you could use DB2 Spatial Extender to determine whether any populated areas overlap the proposed site for a landfill. The populated areas and the proposed site are features. A finding as to whether any overlap exists would be an example of spatial information. If overlap is found to exist, the extent of it would also be an example of spatial information.

To produce spatial information, DB2 Spatial Extender must process data that defines the locations of features. Such data, called *spatial data*, consists of coordinates that reference the locations on a map or similar projection. For example, to determine whether one feature overlaps another, DB2 Spatial Extender must determine where the coordinates of one of the features are situated with respect to the coordinates of the other.

In the world of spatial information technology, it is common to think of features as being represented by symbols called *geometries*. Geometries are partly visual and partly mathematical. Consider their visual aspect. The symbol for a feature that has width and breadth, such as a park or town, is a multisided figure. Such a geometry is called a *polygon*. The symbol for a linear feature, such as a river or a road, is a line. Such a geometry is called a *linestring*.

A geometry has properties that correspond to facts about the feature that it represents. Most of these properties can be expressed mathematically. For example, the coordinates for a feature collectively constitute one of the properties of the feature's corresponding geometry. Another property, called *dimension*, is a numerical value that indicates whether a feature has length or breadth.

Spatial data and certain spatial information can be viewed in terms of geometries. Consider the example, described earlier, of the populated areas and the proposed landfill site. The spatial data for the populated areas includes coordinates stored in a column of a table in a DB2 database. The convention is to regard what is stored not simply as data, but as actual geometries. Because populated areas have width and breadth, you can see that these geometries are polygons.

Like spatial data, certain spatial information is also viewed in terms of geometries. For example, to determine whether a populated area overlaps a proposed landfill site, DB2 Spatial Extender must compare the coordinates in the polygon that symbolizes the site with the coordinates of the polygons that represent populated areas. The resulting information—that is, the areas of overlap—are themselves regarded as polygons: geometries with coordinates, dimensions, and other properties.

Chapter 2. About geometries

This chapter discusses entities of information, called geometries, that consist of coordinates and represent geographic features. The topics covered are:

- Geometries
- Properties of geometries

Geometries

Webster's Revised Unabridged Dictionary defines *geometry* as "That branch of mathematics which investigates the relations, properties, and measurement of solids, surfaces, lines, and angles; the science which treats of the properties and relations of magnitudes; the science of the relations of space." The word geometry has also been used to denote the geometric features that, for the past millennium or more, cartographers have used to map the world. An abstract definition of this new meaning of geometry is "a point or aggregate of points representing a feature on the ground."

In DB2 Spatial Extender, the operational definition of geometry is "a model of a geographic feature." The model can be expressed in terms of the feature's coordinates. The model conveys information; for example, the coordinates identify the position of the feature with respect to fixed points of reference. Also, the model can be used to produce information; for example, the ST_Overlaps function can take the coordinates of two proximate regions as input and return information as to whether the regions overlap or not.

The coordinates of a feature that a geometry represents are regarded as properties of the geometry. Several kinds of geometries have other properties as well; for example, area, length, and boundary.

The geometries supported by DB2 Spatial Extender form a hierarchy, which is shown in the following figure. The geometry hierarchy is defined by the OpenGIS Consortium, Inc. (OGC) document ″OpenGIS Simple Features Specification for SQL″. Seven members of the hierarchy are instantiable. That is, they can be defined with specific coordinate values and rendered visually as the figure shows.

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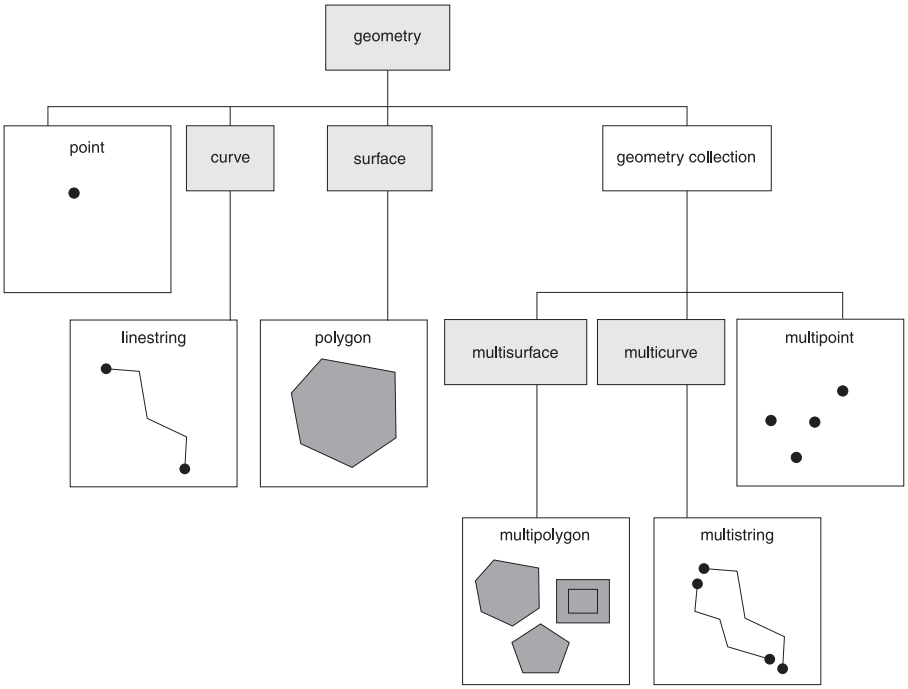

Figure 5. Hierarchy of geometries supported by DB2 Spatial Extender. Instantiable geometries in this figure include examples of how they might be rendered visually.

The spatial data types supported by DB2 Spatial Extender are implementations of the geometries shown in the figure.

As the figure indicates, a superclass called geometry is the root of the hierarchy. The root type and other proper subtypes in the hierarchy are not instantiable. Additionally, users can define their own instantiable or not instantiable proper subtypes.

The subtypes are divided into two categories: the base geometry subtypes, and the homogeneous collection subtypes.

The base geometries include:

Points A single point. Points represent discrete features that are perceived as occupying the locus where an east-west coordinate line (such as a parallel) intersects a north-south coordinate line (such as a meridian). For example, suppose that the notation on a world map shows that each city on the map is located at the intersection of a parallel and a meridian. A point could represent each city.

Linestrings
A line between two or more points. It does not have to be a straight line. Linestrings represent linear geographic features (for example, streets, canals, and pipelines).

Polygons
A polygon or surface within a polygon. Polygons represent multisided geographic features (for example, welfare districts, forests, and wildlife habitats).

The homogeneous collections include:

Multipoints
A multiple point geometry collection. Multipoints represent multipart features whose components are each located at the intersection of an east-west coordinate line and a north-south coordinate line (for example, an island chain whose members are each situated at an intersection of a parallel and meridian).

Multilinestrings
A multiple curve geometry collection with multiple strings. Multilinestrings represent multipart features that are made up (for example, river systems and highway systems).

Multipolygons
A multiple surface geometry collection with multiple polygons. Multipolygons represent multipart features made up of multisided units or components (for example, the collective farmlands in a specific region, or a system of lakes).

As their names imply, the homogeneous collections are collections of base geometries. In addition to sharing base geometry properties, homogeneous collections have some of their own properties as well.

Properties of geometries

This topic describes geometries' properties. These properties are:

- The type that a geometry belongs to
- Geometry coordinates
- A geometry's interior, boundary, and exterior
- The quality of being simple or non-simple
- The quality of being empty or not empty
- A geometry's minimum bounding rectangle or envelope
- Dimension
- The identifier of the spatial reference system with which a geometry is associated

Type

Each geometry belongs to a type in the hierarchy of geometries supported by DB2 Spatial Extender. Seven types in the hierarchy—points, linestrings, polygons, geometry collections, multipoints, multilinestrings, and multipolygons—can be defined with specific coordinate values.

Geometry coordinates

All geometries include at least one X coordinate and one Y coordinate, unless they are empty geometries, in which case they contain no coordinates at all. In addition, a geometry can include one or more Z coordinates and M coordinates. X, Y, Z, and M coordinates are represented as double–precision numbers. The following subsections explain:

- X and Y coordinates
- Z coordinates
- M coordinates

X and Y coordinates

An X coordinate value denotes a location that is relative to a point of reference to the east or west. A Y coordinate value denotes a location that is relative to a point of reference to the north or south.

Z coordinates

Some geometries have an associated altitude or depth. Each of the points that form the geometry of a feature can include an optional Z coordinate that represents an altitude or depth normal to the earth's surface.

M coordinates

An M coordinate (measure) is a value that conveys information about a geographic feature and that is stored together with the coordinates that define the feature's location. For example, suppose that you are representing highways in your application. If you want your application to process values that denote linear distances or mileposts, you can store these values along with the coordinates that define locations along the highway. M coordinates are represented as double–precision numbers.

Interior, boundary, and exterior

All geometries occupy a position in space defined by their interiors, boundaries, and exteriors. The exterior of a geometry is all space not occupied by the geometry. The boundary of a geometry serves as the interface between its interior and exterior. The interior is the space occupied by the geometry.

Simple or non-simple

The values of some geometry subtypes (linestrings, multipoints, and multilinestrings) are either simple or non-simple. A geometry is simple if it obeys all the topological rules imposed on its subtype and non-simple if it doesn't. A linestring is simple if it does not intersect its interior. A multipoint is simple if none of its elements occupy the same coordinate space. Points, surfaces, multisurfaces, and empty geometries are always simple.

Closed

A curve is closed if its start and end points are the same. A multicurve is closed if all of its elements are closed. A ring is a simple, closed curve.

Empty or not empty

A geometry is empty if it does not have any points. The envelope, boundary, interior, and exterior of an empty geometry are not defined and will be represented as null. An empty geometry is always simple. Empty polygons and multipolygons have an area of 0.

Minimum bounding rectangle (MBR)

The MBR of a geometry is the bounding geometry formed by the minimum and maximum (X,Y) coordinates. Except for the following special cases, the MBRs of geometries form a boundary rectangle:

- The MBR of any point is the point itself, because its minimum and maximum X coordinates are the same and its minimum and maximum Y coordinates are the same.

- The MBR of a horizontal or vertical linestring is a linestring represented by the boundary (the endpoints) of the source linestring.

Dimension

A geometry can have a dimension of –1, 0, 1, or 2. The dimensions are listed as follows:

–1 Is empty

0 Has no length and an area of 0 (zero)

1 Has a length larger than 0 (zero) and an area of 0 (zero)

2 Has an area that is larger than 0 (zero)

The point and multipoint subtypes have a dimension of zero. Points represent dimensional features that can be modeled with a single tuple of coordinates, while multipoint subtypes represent data that must be modeled with a set of points.

The linestring and multilinestring subtypes have a dimension of one. They store road segments, branching river systems and any other features that are linear in nature.

Polygon and multipolygon subtypes have a dimension of two. Features whose perimeter encloses a definable area, such as forests, parcels of land, and lakes, can be represented by either the polygon or multipolygon data type.

Spatial reference system identifier

The numeric identifier for a spatial reference system determines which spatial reference system is used to represent the geometry.

All spatial reference systems known to the database can be accessed through the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view.

Chapter 3. How to use DB2 Spatial Extender

How to use DB2 Spatial Extender

Support and use of DB2® Spatial Extender involves two main activities: setting up DB2 Spatial Extender and working on projects that use spatial data. This topic introduces the interfaces you can use to perform spatial tasks.

Interfaces to DB2 Spatial Extender and associated functionality

Several interfaces let you set up DB2 Spatial Extender and create projects that use spatial data. These interfaces are:

- Open source projects that include support for DB2 Spatial and Geodetic Data Management Features. Some open source projects with this support include:
  - GeoTools (http://www.geotools.org/), a Java library for building spatial applications
  - GeoServer (http://docs.codehaus.org/displaly/GEOS/Home), a Web map server and Web feature server
  - uDIG (http://udig.refractions.net/confluence/display/UDIG/Home), a desktop spatial data visualization and analysis application
- The DB2 Control Center, a graphical-user interface that includes windows, notebooks, and menu choices that support DB2 Spatial Extender.
- A command line processor (CLP) provided by DB2 Spatial Extender. It is called the db2se CLP.
- Application programs that call DB2 Spatial Extender's stored procedures.

Other interfaces let you generate spatial information. They include:

- SQL queries that you submit from the DB2 CLP, from a query window in the DB2 Control Center, or from an application program.
- Visualization tools that render spatial information in graphical form. An example is ArcExplorer for DB2, which was created by the Environmental Systems Research Institute (ESRI) for IBM. ArcExplorer for DB2 can be downloaded from the DB2 Spatial Extender Web site: http://www.ibm.com/software/data/spatial/.

Tasks that you perform to set up DB2 Spatial Extender and create projects

This section provides an overview of the tasks you perform to set up DB2 Spatial Extender and work on projects that use spatial data. It includes a scenario that illustrates the tasks. The tasks fall into two categories:

- Setting up DB2 Spatial Extender
- Creating projects that use spatial data

Setting up DB2 Spatial Extender

This section lists the tasks that you perform to set up DB2 Spatial Extender and uses a scenario to illustrate how a fictional company might approach each task.

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To set up DB2 Spatial Extender:

1. Plan and make preparations (decide what projects to create, decide what interface or interfaces to use, select personnel to administer DB2 Spatial Extender and create the projects, and so on).

   Scenario: The Safe Harbor Real Estate Insurance Company's information systems environment includes a DB2 database system and a separate file system for spatial data only. To an extent, query results can include combinations of data from both systems. For example, a DB2 table stores information about revenue, and a file in the file system contains locations of the company's branch offices. Therefore, it is possible to find out which offices bring in revenues of specified amounts, and then to determine where these offices are located. But data from the two systems cannot be integrated (for example, users cannot join DB2 columns with file system records, and DB2 services such as query optimization are unavailable to the file system.) To overcome these disadvantages, Safe Harbor acquires DB2 Spatial Extender and establishes a new Spatial Development department (called a Spatial department, for short).

   The Spatial department's first mission is to include DB2 Spatial Extender in Safe Harbor's DB2 environment:

   - The department's management team appoints a spatial administration team to install and implement DB2 Spatial Extender, and a spatial analysis team to generate and analyze spatial information.
   - Because the administration team has a strong UNIX® background, it decides to use the db2se CLP to administer DB2 Spatial Extender.
   - Because Safe Harbor's business decisions are driven primarily by customers' requirements, the management team decides to install DB2 Spatial Extender in the database that contains information about its customers. Most of this information is stored in a table called CUSTOMERS.

2. Install DB2 Spatial Extender.

   Scenario: The spatial administration team installs DB2 Spatial Extender on a UNIX machine in a DB2 environment.

3. If you have DB2 Spatial Extender Version 8, migrate your spatial data to DB2 Version 9.

   Scenario: The Version 9 release is the first one that Safe Harbor has acquired. No migration is needed.

4. Configure your database to accommodate spatial data. You adjust configuration parameters to ensure that your database has enough memory and space for spatial functions, log files, and DB2 Spatial Extender applications.

   Scenario: A member of the spatial administration team adjusts the transaction log characteristics, application heap size, and application control heap size to values suited to DB2 Spatial Extender's requirements.

5. Set up spatial resources for your database. These resources include a system catalog, spatial data types, spatial functions, a geocoder, and other objects. The task of setting up these resources is referred to as enabling the database for spatial operations.

   The geocoder supplied by DB2 Spatial Extender translates United States addresses into spatial data. It is called DB2SE_USA_GEOCODER. Your organization and others can provide geocoders that translate addresses inside or outside the United States, as well as other kinds of data, into spatial data.

   Scenario: The spatial administration team sets up resources that will be required by the projects that it is planning.

- A member of the team issues a command to obtain the resources that enable the database for spatial operations. These resources include the DB2 Spatial Extender catalog, spatial data types, spatial functions, and so on.
- Because Safe Harbor is starting to extend its business into Canada, the spatial administration team begins soliciting Canadian vendors for geocoders that translate Canadian addresses into spatial data. Safe Harbor does not expect to acquire such geocoders for a few months yet. Therefore, the first locations on which it will gather data will be in the United States.

Creating projects that use spatial data

After you set up DB2 Spatial Extender, you are ready to undertake projects that use spatial data. This section lists the tasks involved in creating such a project and continues the scenario in which the Safe Harbor Real Estate Insurance Company seeks to integrate business and spatial data.

To create a project that uses spatial data:

1. Plan and make preparations (set goals for the project, decide what tables and data you need, determine what coordinate system or systems to use, and so on).

   Scenario: The Spatial department prepares to develop a project; for example:
   - The management team sets these goals for the project:
     - To determine where to establish new branch offices
     - To adjust premiums on the basis of customers' proximity to hazardous areas (areas with high rates of traffic accidents, areas with high rates of crime, flood zones, earthquake faults, and so on)
   - This particular project will be concerned with customers and offices in the United States. Therefore, the spatial administration team decides to:
     - Use a coordinate system for the United States that DB2 Spatial Extender provides. It is called GCS_NORTH_AMERICAN_1983.
     - Use DB2SE_USA_GEOCODER, because it is designed to geocode United States addresses.
   - The spatial administration team decides what data is needed to meet the project's goals and what tables will contain this data.
2. Create a coordinate system if you need to do so.

   Scenario: Because Safe Harbor has decided to use GCS_NORTH_AMERICAN_1983, the company can ignore this step.
3. Decide whether an existing spatial reference system meets your needs. If none does, create one.

   A spatial reference system is a set of parameter values that includes:
   - Coordinates that define the maximum possible extent of space referenced by a given range of coordinates. You need to determine the maximum possible range of coordinates that can be determined from the coordinate system that you are using, and to select or create a spatial reference system that reflects this range.
   - The name of the coordinate system from which the coordinates are derived.
   - Numbers used in mathematical operations to convert coordinates received as input into values that can be processed with maximum efficiency. The coordinates are stored in their converted form and returned to the user in their original form.

Scenario: DB2 Spatial Extender provides a spatial reference system, NAD83_SRS_1, that is designed to be used with GCS_NORTH_AMERICAN_1983. The spatial administration team decides to use NAD83_SRS_1.

4. Create spatial columns as needed. Note that in many cases, if data in a spatial column is to be read by a visualization tool, the column must be the only spatial column in the table or view to which it belongs. Alternatively, if the column is one of multiple spatial columns in a table, it could be included in a view that has no other spatial columns, and visualization tools could read the data from this view.

   Scenario: The spatial administration team defines columns to contain spatial data.

   - The team adds a LOCATION column to the CUSTOMERS table. The table already contains customers' addresses. DB2SE_USA_GEOCODER will translate them into spatial data. Then DB2 will store this data in the LOCATION column.
   - The team creates an OFFICE_LOCATIONS table and an OFFICE_SALES table to contain data that is now stored in the separate file system. This data includes the addresses of Safe Harbor's branch offices, spatial data that was derived from these addresses by a geocoder, and spatial data that defines a zone within a five-mile radius around each office. The data derived by the geocoder will go into a LOCATION column in the OFFICE_LOCATIONS table, and the data that defines the zones will go into a SALES_AREA column in the OFFICE_SALES table.

5. Set up spatial columns for access by visualization tools, as needed. You do this by registering the columns in the DB2 Spatial Extender catalog. When you register a spatial column, DB2 Spatial Extender imposes a constraint that all data in the column must belong to the same spatial reference system. This constraint enforces integrity of the data—a requirement of most visualization tools.

   Scenario: The spatial administration team expects to use visualization tools to render the content of the LOCATION columns and the SALES_AREA column graphically on a map. Therefore, the team registers all three columns.

6. Populate spatial columns:

   For a project that requires spatial data to be imported, import the data.

   For a project that requires a geocoder:

   - Set, in advance, the control information needed when a geocoder is invoked.
   - As an option, set up the geocoder to run automatically each time a new address is added to the database, or an existing address is updated.

   Run the geocoder in batch mode, as needed.

   For a project that requires spatial data to be created by a spatial function, execute this function.

   Scenario: The spatial administration team populates the CUSTOMER table's LOCATION column, the OFFICE_LOCATIONS table, the OFFICE_SALES table, and a new HAZARD_ZONES table:

   - The team uses DB2SE_USA_GEOCODER to geocode addresses in the CUSTOMER table. The coordinates produced by the geocoding are set in the table's LOCATION column.
   - The team uses a utility to load office data from the file system into a file. Then the team imports this data to the new OFFICE_LOCATIONS table.
   - The team creates a HAZARD_ZONES table, registers its spatial columns, and imports data to it. The data comes from a file supplied by a map vendor.

7. Facilitate access to spatial columns, as needed. This involves defining indexes that enable DB2 to access spatial data quickly, and defining views that enable users to retrieve interrelated data efficiently. If you want visualization tools to access the views' spatial columns, you might need to register these columns with DB2 Spatial Extender as well.

   Scenario: The spatial administration team creates indexes for the registered columns. It then creates a view that joins columns from the CUSTOMERS and HAZARD ZONES tables. Next, it registers the spatial columns in this view.

8. Generate spatial information and related business information. Analyze the information. This task involves querying spatial columns and related non-spatial columns. In such queries, you can include DB2 Spatial Extender functions that return a wide variety of information; for example, coordinates that define a proposed safety zone around a hazardous waste site, or the minimum distance between this site and the nearest public building.

   Scenario: The spatial analysis team runs queries to obtain information that will help it meet the original goals: to determine where to establish new branch offices, and to adjust premiums on the basis of customers' proximity to hazard areas.

Chapter 4. Getting started with DB2 Spatial Extender

This chapter provides instructions for installing and configuring Spatial Extender for AIX, HP-UX, Windows, Linux, Linux on IBM System z, and Solaris Operating Environments. This chapter also explains how to trouble shoot some of the installation and configuration problems that you might encounter as you invoke Spatial Extender.

Setting up and installing Spatial Extender

Prerequisites

Before you set up DB2 Spatial Extender, you must have DB2 software installed and configured on the client and the server.

A DB2 Spatial Extender system consists of a DB2 database system, DB2 Spatial Extender, and, for most applications, a geobrowser. A geobrowser is not required but is useful for visually rendering the results of spatial queries, generally in the form of maps. Databases enabled for spatial operations are located on the server. You can use client applications to access spatial data through the DB2 Spatial Extender stored procedures and spatial queries. You can also configure DB2 Spatial Extender in a stand–alone environment, which is a configuration where both the client and server reside on the same machine. In both client-server and stand–alone configurations, you can view spatial data with a geobrowser, such as an open source geobrowser, ArcExplorer for DB2, or ESRI's ArcGIS tool suites running with ArcSDE.

You can download a free copy of ArcExplorer for DB2 from IBM's DB2 Spatial Extender Web site:

http://www.ibm.com/software/data/spatial/

To do this task... :

1. Ensure that your system meets all software requirements.
2. Install Spatial Extender. The steps vary depending on your operating system:
   - Windows
   - AIX
   - HP-UX
   - Solaris Operating Environment
   - Linux
3. For UNIX platforms: Create a DB2 Spatial Extender instance environment.
4. Verify the installation.
5. If necessary, see the troubleshooting tips and take appropriate actions to correct any problems.
6. If you want to access DB2 documentation on your computer and you have not yet installed the DB2 Information Center, then refer to either Installing the DB2 Information Center (UNIX)" or Installing the DB2 Information Center (Windows).The DB2 Information Center contains documentation for the DB2 database system and DB2 database related products.

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Related tasks

"Creating the DB2 Spatial Extender instance environment" on page 28

System requirements for installing Spatial Extender

Before you install DB2 Spatial Extender, ensure that your system meets all the software and disk space requirements described below.

Operating systems

You can install DB2 Spatial Extender on 32–bit Windows or Linux on Intel-based systems. You can also install DB2 Spatial Extender on 64–bit UNIX systems such as AIX, HP-UX, Solaris Operating Environment, Linux, and Linux for System z.

Software requirements

To install Spatial Extender, you must have the following DB2 software installed and configured on the server:

Server software
You must install DB2 *before* you install DB2 Spatial Extender. If you plan to use the DB2 Control Center, create and configure the DB2 Administration Server (DAS). For more information on creating and configuring DAS, see the *IBM DB2 Administration Guide: Implementation*.

Spatial client software
If you install DB2 Spatial Extender on Windows, the default installation for Spatial Extender includes the spatial client. For DB2 Spatial Extender on AIX, HP-UX, Solaris Operating Environment, Linux for Intel, or Linux on System z, you can install the spatial client when you install the DB2 server with the administration or application development client. If you do not install these clients, you must install the spatial client manually by choosing the Custom installation option.

Disk space requirements

To install Spatial Extender, your system must meet the disk space requirements listed in the following table. The library code for DB2 Spatial Extender integrates the code for DB2 Geodetic Data Management Feature but not the Geodetic license key.

Table 1. Disk space requirements for DB2 Spatial Extender

DB2 Spatial Extender software	Disk space
Server software for DB2 Spatial Extender:	596 MB total disk space:
• Spatial Extender and Geodetic Data Management Feature server library code, and documentation	• 33 MB

Table 1 specifies the disk space required when you install a DB2 database system and DB2 Spatial Extender in a typical installation for Windows or with pre-selected components in AIX, HP-UX, Solaris Operating Environment, Linux for Intel, and Linux for System z. If you are installing DB2 Spatial Extender or have installed DB2 database with a different installation type, your disk space calculations will differ.

When your system meets all the software and disk space requirements, you can install Spatial Extender.

Installing DB2 Spatial Extender for Windows

Before you install the DB2 Spatial Extender feature, you must have a DB2 server product installed.

This task is part of the larger task of Setting up DB2 Spatial Extender.

You can install DB2 Spatial Extender on Windows operating systems by using the DB2 Setup wizard or a response file.

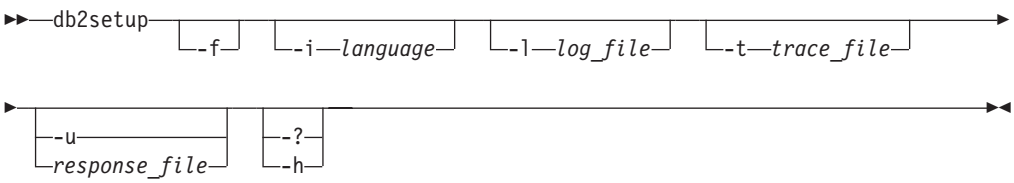
Recommendation:
Use the DB2 Setup wizard to install Spatial Extender. The setup wizard provides an easy-to-use graphical interface with installation help, automated user and group creation, protocol configuration, and instance creation.

If you are using the DB2 Setup wizard to install Spatial Extender, you can click **Cancel** at any point during the installation to exit the process.

To do this task... :

1. To install Spatial Extender for Windows using the DB2 Setup wizard:
   a. Insert the Spatial Extender CD into the CD drive. The DB2 Setup Launchpad, an interface from which you can install DB2 Spatial Extender, opens.
   b. Click **Install a Product**.
   c. Select DB2 Spatial Extender as the product you want to install and click **NEXT**. The DB2 Setup wizard launches. Click **NEXT**. Use the DB2 Setup wizard to guide you through setup, and through the remaining installation steps. At any time during the installation, you can click **Help** to launch the online installation help.
2. To install Spatial Extender for Windows using the response file:
   a. Log on to the system with the user account that you want to use to perform the installation.
   b. Insert the Spatial Extender CD. See the *DB2 Installation and Configuration Supplement* for more information.
   c. Run the setup program by issuing db2setup command from a command prompt.
   d. After the installation is complete, check the messages in the log file.

db2setup command



Where:

-f Forces any DB2 processes to stop before installing.

-i (*language*)
Is the two letter language code of the language in which to perform the installation.

-l (*log_file*)
Is the full path and file name of the log file to use.

-t (*trace_file*)
Generates a fully qualified file with install trace information.

-u (*response_file*)
Specifies the fully qualified response file name. If you changed and renamed the sample response file that is provided, make sure that this parameter matches the new name. This parameter is required. The response file is located at db2\Windows\samples\db2gse.rsp on your DB2 Spatial Extender installation CD.

-?, -h Generates usage information.

Installing DB2 Spatial Extender for AIX

Prerequisites

Before you install Spatial Extender on AIX:

- Ensure your system meets all software, memory, and disk space requirements.
- Update the configuration parameters and restart the system for all DB2 clients and servers on AIX.
- You must have a DB2 Version 9 server product installed if you are installing in a server or standalone environment.

  Note: Check if the DB2 Spatial Client is already installed. The Spatial Extender client and sample components are available with the DB2 client and server. You can install these spatial components when you use the DB2 custom installation type, and you select the **Spatial Extender Client** feature under **Client Support**, and you select the **Spatial Extender Samples** feature under **Application Development Tools**. If you only need spatial client functionality and have already installed these spatial components with DB2, you do not need to perform the following DB2 Spatial Extender installation procedure.
- You must have root authority.

You can install DB2 Spatial Extender for AIX by using the DB2 Setup wizard, by using the db2_install script, or by using the System Management Interface Tool (SMIT).

Recommendation: Use the DB2 Setup wizard to install Spatial Extender. The Setup wizard provides an easy-to-use graphical interface with installation help, automated user and group creation, protocol configuration, and instance creation. If you choose not to use the wizard, you can install Spatial Extender by using the db2_install script or by using AIX's System Management Interface Tool (SMIT). Using SMIT to install Spatial Extender is only recommended for advanced users in situations where greater manual control over the setup process is required.

Spatial Extender is installed in the /usr/opt/db2_09_01 directory along with your other DB2 products. After you install Spatial Extender, create your DB2 instance environment if you did not already do so, and then verify the installation.

DB2 Setup wizard

1. Log in as a user with root authority.
2. Insert and mount the Spatial Extender CD. The DB2 Setup Launchpad, an interface from which you can install DB2 Spatial Extender, opens. For information on how to mount a CD, see the *DB2 Installation and Configuration Supplement*.
3. Select DB2 Spatial Extender as the product you want to install and click **NEXT**.
4. The DB2 Setup wizard window opens. Use the DB2 Setup wizard to guide you through setup and through the remaining installation steps. At any time during the installation, you can click **Help** to launch the online installation help.

db2_install script

1. Log in as a user with root authority.
2. Insert and mount the appropriate CD.
3. Enter the ./db2_install command to start the db2_install script. The db2_install script can be found in the root directory on your DB2 product CD. The db2_install script prompts you for the product keyword.
4. Type **GSE** to install DB2 Spatial Extender.

SMIT

1. Log in as a user with root authority.
2. Insert and mount the Spatial Extender CD.
3. Enter the smit install_latest command.
4. Type /cdrom/db2 in the INPUT device/directory for the software field.
5. Click DO or press Enter to verify that the installation directory exists.
6. In the Software to install field, identify whether to install the client or server components. Refer to the ComponentList.htm file on the DB2 Spatial Extender CD for a complete list of the components that you should install for DB2 Spatial Extender.
7. Click DO or press Enter. You are prompted to confirm the installation parameters. Press Enter to confirm.Log out.

Installing DB2 Spatial Extender for HP-UX

Before you install the DB2 Spatial Extender product for HP-UX:

- Ensure your system meets all hardware, software, and memory requirements.
- You must have a DB2 server product installed.

  Note: Check if the DB2 Spatial Client is already installed. The Spatial Extender client and sample components are available with the DB2 client and server. You can install these spatial components when you use the DB2 custom installation type, and you select the **Spatial Extender Client** feature under **Client Support**, and you select the **Spatial Extender Samples** feature under **Application Development Tools**. If you only need spatial client functionality and have already installed these spatial components with DB2, you do not need to perform the following DB2 Spatial Extender installation procedure.
- Update the configuration parameters and restart the system for all DB2 clients and servers on HP-UX
- You must have root authority.

You can install Spatial Extender using the DB2® Setup wizard, by using the db2_install script, or by using the swinstall command.

Recommendation:
Use the DB2 Setup wizard to install Spatial Extender. The setup wizard provides an easy-to-use graphical interface with installation help, automated user and group creation, protocol configuration, and instance creation. If you choose not to use the wizard, you can install Spatial Extender for HP-UX by using the db2_install script or by using the swinstall command. Using the HP-UX swinstall command to install Spatial Extender is only recommended for advanced users in situations where greater manual control over the setup process is required.

To do this task... :

Install Spatial Extender for HP-UX using the DB2 Setup wizard

1. Insert and mount the DB2 Spatial Extender CD. The DB2 Setup Launchpad, an interface from which you can install DB2 Spatial Extender, opens.
2. Select DB2 Spatial Extender as the product you want to install and click **NEXT**. The DB2 Setup wizard launches. Click **NEXT**. Use the DB2 Setup wizard to guide you through setup, and through the remaining installation steps. At any time during the installation, you can click **Help** to launch the online installation help.

Install Spatial Extender for HP-UX using the db2_install script

1. Log in as a user with root authority.
2. Insert and mount the appropriate CD.
3. Enter the ./db2_install command to start the db2_install script. The db2_install script can be found in the root directory on your DB2 product CD. The db2_install script prompts you for the product keyword.
4. Type **GSE** to install DB2 Spatial Extender.

Install Spatial Extender for HP-UX using the swinstall command

1. Log in as a user with root authority.
2. Insert and mount the Spatial Extender CD.
3. Run the swinstall program. Use the following command:

   ```
   swinstall -x autoselect_dependencies=true
   ```

   This command opens the Software Selection window and the Specify Source window. If necessary, change the value in the **Source host name** field in the Specify Source window.
4. In the **Source Depot Path** field, enter /cdrom/db2/hpux, where /cdrom represents the CD mount directory.
5. Click **OK** to return to the Software Selection window. The Software Selection window contains a list of available software to install.
6. Select the products you are licensed to install.
7. Select **Mark for Install** from the **Actions** menu to choose the product to be installed. A message appears:

   ```
   In addition to the software you just marked, other software was
   automatically marked to resolve dependencies.  This message will
   not appear again.
   ```

8. Select **OK**.
9. Select **Install (analysis)** from the **Actions** menu to begin installing the product and to open the Install Analysis window.
10. Select **OK** in the Install Analysis window when the **Status** field displays a Ready message.
11. Select **Yes** in the Confirmation windows to confirm that you want to install the software.

    View the Install window to read processing data while the software is being installed, until the **Status** field indicates Ready and the Note window opens. The swinstall program loads the file set, and runs the control scripts for the file set.
12. Select **Exit** from the **File** menu to exit from swinstall.
13. When the installation is complete, Spatial Extender will be installed in the /opt/ibm/db2/V9.1 directory along with your other DB2 products.
14. After you install Spatial Extender, create your DB2 instance environment if you did not already do so, and then verify the installation.

Installing DB2 Spatial Extender for Solaris Operating Environment

Before you install the DB2 Spatial Extender product for the Solaris Operating Environment:

- Ensure your system meets all hardware, software, and memory requirements.
- You must have a DB2 Version 9 server product installed if you are installing in a server or stand-alone environment.

  Note: Check if the DB2 Spatial Client is already installed. The Spatial Extender client and sample components are available with the DB2 client and server. You can install these spatial components when you use the DB2 custom installation type, and you select the **Spatial Extender Client** feature under **Client Support**, and you select the **Spatial Extender Samples** feature under **Application Development Tools**. If you only need spatial client functionality and have already installed these spatial components with DB2, you do not need to do the following procedure.
- Update the configuration parameters and restart the system for all DB2 clients and servers in the Solaris Operating Environment.
- You must have root authority.

You can install Spatial Extender using the DB2® Setup wizard, by using the db2_install script, or by using the pkgadd command.

Recommendation: Use the DB2 Setup wizard to install DB2 Spatial Extender.

The setup wizard provides an easy-to-use graphical interface with installation help, automated user and group creation, protocol configuration, and instance creation. If you choose not to use the wizard, you can install Spatial Extender using the db2_install script or by using the Solaris Operating Environment pkgadd command. Using the Solaris Operating Environment pkgadd command is only recommended for advanced users in situations where greater manual control over the setup process is required.

DB2 Spatial Extender is made up of different functions and components that are referred to as packages in the Solaris Operating Environment. When you install Spatial Extender using the pkgadd command, you must install each required

package and each associated package for the optional functions that you want to use. The ComponentList.htm file on your DB2 Spatial Extender CD has a complete list of the packages that you should install for DB2 Spatial Extender. The ComponentList.htm file is located in */cdrom*/db2/solaris, where */cdrom* is the mount point for your DB2 Spatial Extender CD.

Create your DB2 instance environment if you did not already do so, and then verify the installation.

To do this task... :

Install DB2 Spatial Extender for Solaris Operating Environments using the DB2 Setup wizard

1. Log in as a user with root authority.
2. Insert and mount your DB2 Spatial Extender CD. The DB2 Setup Launchpad, an interface from which you can install DB2 Spatial Extender, opens. For information on how to mount a CD, see *DB2 for UNIX Quick Beginnings*.
3. Select **Spatial Extender** as the product you want to install and click **NEXT**.
4. The DB2 Setup wizard launches. Use the DB2 Setup wizard to guide you through the setup, and through the remaining installation steps. At any time during the installation, you can click **HELP** to launch the online installation help.

When the installation is complete, your Spatial Extender software will be installed in the /opt/ibm/db2/V9.1 directory.

Install DB2 Spatial Extender using the db2_install script

1. Log in as a user with root authority.
2. Insert and mount the appropriate CD.
3. Enter the ./db2_install command to start the db2_install script. The db2_install script can be found in the root directory on your DB2 product CD. The db2_install script prompts you for the product keyword.
4. Type **GSE** to install DB2 Spatial Extender. You can install both DB2 Spatial Extender and the DB2 Administration Client by typing **SPATIAL_EXTENDER CLIENT**.

When the installation is complete, your Spatial Extender software will be installed in the /opt/ibm/db2/V9.1 directory.

Install DB2 Spatial Extender for Solaris using the pkgadd command

1. Log in as a user with root authority.
2. Insert and mount the DB2 Spatial Extender CD.
3. Identify the required packages and optional packages that you want to install. See the ComponentList.htm file on your CD for a complete list of the components that you should install for DB2 Spatial Extender.
4. Run the **pkgadd** command for each package that you want to install:

   ```
   pkgadd package_name
   ```

In this command, *package_name* is the package that you want to install. For example, if you want to install the Spatial Extender Base Server Support, you would need to install the db2gssg81 package by entering the following command:

```
pkgadd db2gssg91
```

When the installation is complete, your Spatial Extender software will be installed in the /opt/ibm/db2/V9.1 directory.

Installing DB2 Spatial Extender for Linux

You can install DB2 Spatial Extender for Linux by using the DB2 Setup wizard, by using the db2_install script, or by using the rpm command.

When the installation is complete, Spatial Extender will be installed in the /opt/ibm/db2/V9.1 directory along with your other DB2 products. After you install Spatial Extender, create your DB2 instance environment if you did not already do so, and then verify the installation.

Installing DB2 Spatial Extender using the DB2 Setup wizard

Before you install the DB2 Spatial Extender product for Linux:

- Ensure your system meets all hardware, software, and memory requirements.
- Ensure that you have a DB2 server product installed if you are installing in a server environment or a stand–alone environment.

Note:

- Check if the DB2 Spatial Client is already installed. The DB2 Spatial Extender client and sample components are available with the DB2 client and server.You can install these spatial components when you use the DB2 custom installation type, and you select the **Spatial Extender Client** feature under **Client Support**, and you select the **Spatial Extender Samples** feature under **Application Development Tools**. If you only need spatial client functionality and have already installed these spatial components with DB2, you do not need to perform the following DB2 Spatial Extender installation procedure.
- Update the configuration parameters and restart the system for all DB2 clients and servers on Linux.
- Ensure that you have root authority.

Tip: Use the DB2 Setup wizard to install Spatial Extender. The setup wizard provides an easy-to-use graphical interface with installation help, automated user and group creation, protocol configuration, and instance creation. If you choose not to use the wizard, you can install Spatial Extender by using the db2_install script or by using the rpm command. Using the Linux rpm command to install Spatial Extender is only recommended for advanced users in situations where greater manual control over the setup process is required.

1. Log in as a user with root authority.
2. Insert and mount your DB2 Spatial Extender CD. The DB2 Setup Launchpad, an interface from which you can install DB2 Spatial Extender, opens. For information on how to mount a CD, see the *DB2 Installation and Configuration Supplement*.
3. Click **Install a Product**.
4. Select **Spatial Extender** as the product you want to install and click **NEXT**.

5. Select the option that you want on the DB2 Setup wizard window. You have the option to install either **DB2 Spatial Extender** or **DB2 Application Development Client**.

   Use the DB2 Setup wizard to guide you through setup and through the remaining installation steps.

Install DB2 Spatial Extender using the db2_install script

1. Log in as a user with root authority.
2. Insert and mount the appropriate CD.
3. Enter the ./db2_install command to start the db2_install script. The db2_install script can be found in the root directory of DB2. The db2_install script prompts you for the product keyword.
4. Type **SPATIAL_EXTENDER** to install DB2 Spatial Extender. You can install both DB2 Spatial Extender and the DB2 Administration Client by typing **SPATIAL_EXTENDER CLIENT**.

Creating the DB2 Spatial Extender instance environment

This task is part of the larger task of setting up Spatial Extender.

Restriction: This section applies to UNIX systems.

DB2 instances created before you install Spatial Extender do not include DB2 Spatial Extender in their instance environments. To update existing DB2 instances, use the **db2iupdt** command. If you are using the DB2 Control Center and created an instance for the DB2 Administration server prior to installing DB2 Spatial Extender, then you must update this instance.

To do this task... :

1. To update an instance using the db2iupdt command:
   a. Log in as a user with root authority.
   b. Run the following command:

      ```
      DB2DIR/instance/db2iupdt -a AuthType -u FencedID InstName
      ```

      Where:

      DB2DIR
      The DB2 installation directory.
      - On AIX, the DB2 installation directory is /usr/opt/db2_09_01
      - On all other UNIX-based operating systems, the installation directory is /opt/ibm/db2/V9.1

      -a AuthType
      Represents the authentication type for the instance. AuthType can be one of SERVER, CLIENT, DCS, SERVER_ENCRYPT, DCS_ENCRYPT. SERVER is the default. This parameter is optional.

      -u FencedID
      Represents the name of the user under which fenced user defined functions (UDFs) and fenced stored procedures will run. This flag is not required if you are creating an instance on a DB2 client. Specify the name of the fenced user you created.

InstName
Represents the name of instance. The name of the instance must be the same as the name of the instance owning user. Specify the name of the instance owning user you created. The instance will be created in the instance owning user's home directory.

2. To create an instance using db2icrt: After you create an instance you might want to configure notification for health monitoring. This task can be performed using the Health Center or CLP. See the *DB2 Installation and Configuration Supplement* for more information.
   a. Log in as user with root authority.
   b. Run the following command:

```
DB2DIR/instance/db2icrt -a AuthType -u FencedID InstName
```

Where:

DB2DIR
the DB2 installation directory.
- On AIX, the DB2 installation directory is /usr/opt/db2_09_01
- On all other UNIX-based operating systems, the installation directory is /opt/ibm/db2/V9.1

-a AuthType
Represents the authentication type for the instance. AuthType can be one of SERVER, CLIENT, DCS, SERVER_ENCRYPT, DCS_ENCRYPT. SERVER is the default. This parameter is optional.

-u FencedID
Represents the name of the user under which fenced user defined functions (UDFs) and fenced stored procedures will run. This flag is not required if you are creating an instance on a DB2 client. Specify the name of the fenced user you created.

InstName
Represents the name of instance. The name of the instance must be the same as the name of the instance owning user. Specify the name of the instance owning user you created. The instance will be created in the instance owning user's home directory.

For example, if you are using server authentication, the fenced user is db2fenc1, and the instance owning user is db2inst1. Use the following command to create an instance on an AIX system:

```
/usr/opt/db2_09_01/instance/db2icrt -a server -u db2fenc1 db2inst1
```

Verifying the Spatial Extender installation

Before you execute the runGseDemo program:

- Be sure that you installed the DB2 Spatial Extender product in the appropriate environments.
- Use a new database that does not have any spatial operations associated with it.
- For UNIX (AIX, HP-UX, Solaris Operating Environments, Linux for Intel, and Linux for System z) installations, check that you established the DB2 Spatial Extender instance environment. See the *DB2 Installation and Configuration Supplement* for information on how to run the **db2ilist** program to check your instances. You might need to run the db2start command to start the DB2 instance.

- Increase the application heap size. For more information, see "Configuring a database to accommodate spatial data" on page 37.

This task is part of a larger task of setting up and configuring Spatial Extender.

After you install DB2 Spatial Extender, you can create a database and run the installation check program to verify that DB2 Spatial Extender is installed and configured correctly.

You can verify the installation by using the DB2 Spatial Extender sample program, runGseDemo. The runGseDemo program is designed to surface problems with your installation. During the installation verification, you might receive error messages that can help you diagnose specific system problems. Most of the error messages are caused by a small number of typical problems. To avoid these errors, see "Prerequisites."

The verification steps in this section apply to the following operating systems: Windows, AIX, HP-UX, Solaris Operating Environments, Linux for Intel, and Linux for System z.

To do this task... :

1. UNIX only: Log on as the instance owner.
2. Create a database. Open the DB2 Command Window and enter:
   ```
   db2 create database mydb
   ```
   where *mydb* is the database name.
3. If you receive error messages during the verification process, you need to troubleshoot the installation.
4. Locate the installation check program.
   - For UNIX operating systems, enter:
     ```
     cd $HOME/sqllib/samples/extenders/spatial
     ```
     where *$HOME* is the instance owner's home directory.
   - For Windows, enter:
     ```
     cd c:\Program Files\IBM\sqllib\samples\extenders\spatial
     ```
     where *c:\Program Files\IBM\sqllib* is the directory in which you installed DB2 Spatial Extender.
5. Run the installation check program. At the DB2 command line, enter the runGseDemo command:
   ```
   runGseDemo mydb userID password
   ```
   where *mydb* is the database name.

Post-Installation considerations

After you install Spatial Extender, consider the following:

- Downloading ArcExplorer
- Accessing geocoder reference data

Downloading ArcExplorer for DB2

IBM provides a browser, produced by Environmental Systems Research Institute (ESRI) for IBM, that can directly produce visual results of queries of DB2 Spatial Extender data without requiring an intermediate data server. This browser is ArcExplorer for DB2. You can download a free copy of ArcExplorer for DB2 from IBM's Spatial Extender Web site at the following location:

http://www.ibm.com/software/data/spatial/

For more information on installing and using ArcExplorer for DB2, see *Using ArcExplorer*, which is also available as part of the ArcExplorer for DB2 product download on the DB2 Spatial Extender Web site.

Important: Install ArcExplorer for DB2, to a directory that is separate from DB2.

Chapter 5. Migrating the Spatial Extender environment to a DB2 Version 9 database system

This section explains how you migrate DB2 Spatial Extender from Version 8 to Version 9. It also explains how you use the migration utility to migrate from a 32-bit environment to a 64-bit environment.

Migrating a spatially-enabled database

Prerequisites

Before you start the migration process:

- Terminate all connections to the database before you run the migration utility.
- Ensure that your system meets the installation requirements for DB2 Spatial Extender Version 9.1.
- To back up a database, you must have SYSADM, SYSCTRL, or SYSMAINT authority for the database.
- To migrate a database, you must have SYSADM authority.

If you have been using DB2 Spatial Extender Version 8, you must complete the following steps before using an existing spatially-enabled database with DB2 Spatial Extender Version 9.1 or DB2 Geodetic Data Management Feature Version 9.1. This topic describes the steps required to migrate spatially-enabled databases from a previous version of DB2 Spatial Extender.

To do this task... :

1. Migrate your DB2 server to Version 9.1 as described in the *DB2 Migration Guide*.
2. Migrate your spatially-enabled databases from Version 8 to Version 9.1 using the Spatial Extender command `db2se migrate`.

Check the messages file for details on any errors you receive. The messages file also contains useful information such as indexes, views, and the geocoding setup that was migrated.

The db2se migrate command

Use the db2se migrate command to migrate a spatially-enabled database from Version 8 to Version 9.

This command might drop and re-create spatial indexes to complete the migration, which can take a significant amount of time depending on the sizes of your tables. For example, your indexes will be dropped and re-created if your data is moving from a 32-bit instance to a 64-bit instance, or if your data is on DB2 Version 8 Fixpack 6 or earlier.

Tip: Run the db2se migrate command with the option `-force 0` and specify a messages file to find out which indexes must be migrated without performing additional migration processing.

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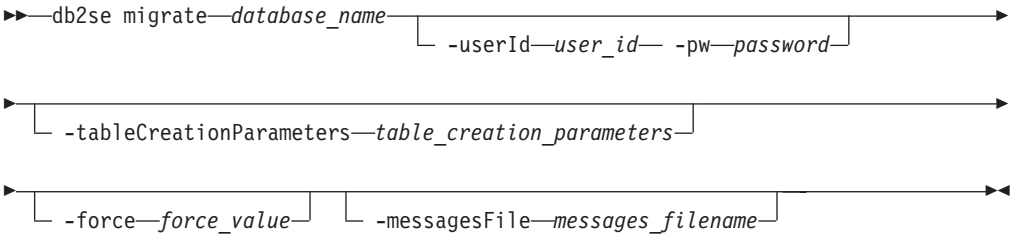
db2se migrate command



Where:

database_name
The name of the database to be migrated.

user_id
The database user ID which has either SYSADM or DBADM authority on the database that is being migrated.

password
Your user password.

table_creation_parameters
The parameters to be used in the creation of the Spatial Extender catalog tables.

force_value

- 0: Default value. Attempt migration, but stop if any application-defined objects such as views, functions, triggers, or spatial indexes have been based on Spatial Extender objects.
- 1: Automatically saves and restores application-defined objects. Saves and restores spatial indexes if necessary.
- Saves and restores spatial indexes.
- 2: Automatically saves and restores application-defined objects. Saves spatial index information, but does not automatically restore spatial indexes.

messages_filename
The file name containing the report of migration actions. The file name you provide must be a fully-qualified file name on the server.

Tip: Specify this parameter to help you troubleshoot migration problems.

Restriction: You cannot specify an existing file.

You might receive one or more of the following errors during migration:

- Database is not currently spatially enabled.
- Database name is not valid.
- Other connections to the database exist. Cannot be run.
- Spatial catalog is not consistent.
- User is not authorized.
- Password is not valid.
- Some user objects could not be migrated.

Migrating from a 32-bit to a 64-bit environment

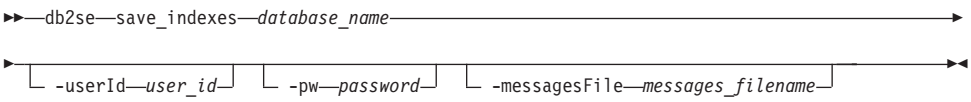
If you have spatial indexes that were created in a 32-bit environment and you want to migrate to a 64-bit environment, complete the following steps.

If you are migrating from a 32-bit Version 8 environment to a 64-bit Version 9 environment, the db2se migrate command migrates the indexes, and you do not need to perform this task.

To do this task... :

1. Back up your database.
2. Save the spatial indexes that are defined by typing the **db2se save_indexes** command from an operating-system command prompt.

   db2se save_indexes command

   Where:

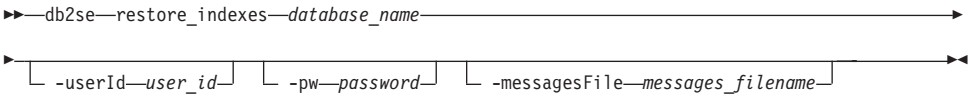
   database_name
   The name of the database to be migrated.

   user_id
   The database user ID which has either SYSADM or DBADM authority on the database that is being migrated.

   password
   Your user password.

   messages_filename
   The file name containing the report of migration actions. The file name you provide must be a fully-qualified file name on the server.
3. Migrate your V8 database from a 32-bit to a 64-bit environment. For more information on switching from a 32-bit environment to a 64-bit environment see *DB2 Migration Guide*.
4. Restore the spatial indexes by using the **db2se restore_indexes** command from an operating-system prompt.

   db2se restore_indexes command

   Where:

   database_name
   The name of the database to be migrated.

   user_id
   The database user ID which has either SYSADM or DBADM authority on the database that is being migrated.

   password
   Your user password.

messages_filename
The file name containing the report of migration actions. The file name you provide must be a fully-qualified file name on the server.

Chapter 6. Setting up a database

This chapter discusses how to configure a database to accommodate spatial data.

Configuring a database to accommodate spatial data

This topic identifies the DB2 configuration parameters that influence the operations of DB2 Spatial Extender.

DB2 Spatial Extender, which runs in the DB2 database environment, works with most default DB2 configuration values. However, several configuration parameters affect spatial operations. You must tune these parameters so that your spatial applications perform as efficiently as possible. When you modify the values of these parameters for a database, the change affects only that database. In certain cases, choosing a value other than the default value is required for spatial operations. In other cases, doing so is recommended, depending on your applications and your overall DB2 environment.

The following sections explain how to tune the DB2 database manager and database configuration parameters that affect DB2 Spatial Extender operations.

Tuning transaction log characteristics

.

Before you enable a database for spatial operations, ensure that you have enough transaction log capacity. The default values for the transaction log configuration parameters do not provide sufficient transaction log capacity if your plans include:

- Enabling a database for spatial operations in a Windows environment
- Using the ST_import_shape stored procedure to import from shape files
- Using geocoding with a large commit scope
- Running concurrent transactions

If your plans include any of these uses now or in the future, you need to increase the capacity of your transaction log for the database by increasing one or more of the transaction log configuration parameters. Otherwise, you can use the default characteristics.

Recommendation: Refer to the following table for the recommended minimum values for the three transaction log configuration parameters.

Table 2. Recommended minimum values for transaction configuration parameters

Parameter	Description	Default value	Recommended minimum value
LOGFILSIZ	Specifies the log file size as a number of 4-KB blocks	1000	1000
LOGPRIMARY	Specifies how many primary log files are to be preallocated to the recovery log files	3	10

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Table 2. Recommended minimum values for transaction configuration parameters (continued)

Parameter	Description	Default value	Recommended minimum value
LOGSECOND	Specifies the number of secondary log files	2	2

If the capacity of your transaction log is inadequate, the following error message is issued when you try to enable a database for spatial operations:

```
GSE0010N Not enough log space is available to DB2.
```

To increase the value of one or more configuration parameters:

1. Issue the command GET DATABASE CONFIGURATION to find the current value for the LOGFILSIZ, LOGPRIMARY, and LOGSECOND parameters or view the **Configure Database** window of the DB2 Control Center.
2. Decide whether to change one, two, or three of the values as indicated in the table above.
3. Change each value that you want to modify. You can change the values by issuing one or more of the following commands, where *db_name* identifies your database:

   ```
   UPDATE DATABASE CONFIGURATION FOR db_name USING LOGFILSZ 1000

   UPDATE DATABASE CONFIGURATION FOR db_name USING LOGPRIMARY 10

   UPDATE DATABASE CONFIGURATION FOR db_name USING LOGSECOND 2
   ```

If the only parameter that you change is LOGSECOND, the change takes effect immediately.

If you change the LOGFILSIZ or LOGPRIMARY parameter, or both:

1. Disconnect all applications from the database.
2. If the database was explicitly activated, deactivate the database.

The changes to the LOGFILSIZ or LOGPRIMARY parameters, or both, take effect the next time either the database is activated or a connection to the database is established.

Tuning the application heap size

You use the database configuration parameter APPLHEAPSZ to specify the size of the application heap (in number of 4-KB pages). This parameter defines the number of private memory pages that are available for use by the database manager on behalf of a specific agent or subagent. The heap is allocated when an agent or subagent is initialized for an application. The allocated amount is the minimum amount that is needed to process the request to the agent or subagent. As the agent or subagent requires more heap space to process larger SQL statements, the database manager allocates memory as needed, up to the maximum that is specified on this parameter. The application heap is allocated out of the agent's private memory.

The default value for the APPLHEAPSZ parameter is 128 (4-KB pages). When you run the ST_enable_db stored procedure, this value must be at least 2048.

Recommendation: For most DB2 Spatial Extender applications, especially those that import from or export to shape files, use an APPLHEAPSZ parameter value of at least 2048.

If the APPLHEAPSZ is set to an inadequate value, the following error message is issued when you try to enable a database for spatial operations:

```
GSE0009N Not enough space is available in DB2's application heap.

GSE0213N A bind operation failed. SQLERROR = "SQL0001N Binding or
precompilation did not complete successfully. SQLSTATE=00000".
```

To change the application heap size:

1. Issue the command GET DATABASE CONFIGURATION to find the current value for the APPLHEAPSZ parameter or view the **Configure Database** window of the DB2 Control Center.
2. Change the value to the recommended value of 2048 or higher. You can change the value to 2048 by issuing the following command, where *db_name* identifies your database:

   ```
   UPDATE DATABASE CONFIGURATION FOR db_name USING APPLHEAPSZ 2048
   ```
3. Disconnect all applications from the database.
4. If the database was explicitly activated, deactivate the database.

The change takes effect the next time either the database is activated or a connection to the database is established.

Tuning the application control heap size

To modify any database configuration parameter, you must be connected to the database. When you modify a value for a database parameter, the change affects only that database.

All DB2 Spatial Extender applications, especially those that import from or export to shape files, can benefit from using the recommended value for the application control heap size. You specify this characteristic with the APP_CTL_HEAP_SZ parameter. This parameter specifies the maximum size, in 4-KB pages, for the application control shared memory. Application control heaps are allocated from this shared memory. One application control heap is allocated for each application at the database where the application is active (or, in the case of a partitioned database system, at each database partition where the application is active). The heap is allocated during connect processing by the first agent that receives a request for the application at the database (or at the database partition). The heap is used for sharing information between agents that work on behalf of the same application. (In a partitioned database environment, the sharing occurs at the database partition level; sharing does not occur across database partitions.) The default value for the APP_CTL_HEAP_SZ parameter is 128.

Recommendation: For most DB2 Spatial Extender applications, use an APP_CTL_HEAP_SZ parameter value of at least 1024 (4-KB pages).

If the APP_CTL_HEAP_SZ is set to an inadequate value, the following error message is issued when you import data into a database from shape files:

```
GSE0214N An INSERT statement failed. SQLERROR = "SQL0973N Not enough storage
 is available in the "APP_CTL_HEAP" heap to process the statement.
```

1. Issue the command GET DATABASE CONFIGURATION to find the current value for the APP_CTL_HEAP_SZ parameter or view the **Configure Database** window of the DB2 Control Center.
2. Change the value to the recommended value of 1024 (4-KB pages) or higher. Issue the following command, where *db_name* identifies your database, to increase the application control heap to 1024 KB:

   ```
   UPDATE DATABASE CONFIGURATION FOR db_name USING APP_CTL_HEAP_SZ 1024
   ```
3. Disconnect all applications from the database.
4. If the database was explicitly activated, deactivate the database.

The change takes effect the next time either the database is activated or a connection to the database is established.

Chapter 7. Setting up spatial resources for a database

After you set up your database to accommodate spatial data, you are ready to supply the database with resources that you will need when you create and manage spatial columns and analyze spatial data. These resources include:

- Objects provided by Spatial Extender to support spatial operations; for example, stored procedures to administrate a database, spatial data types, and spatial utilities for geocoding and importing or exporting spatial data.
- Reference data: Ranges of addresses that DB2SE_USA_GEOCODER uses to convert individual addresses to coordinates.
- Any geocoders that users or vendors provide.

This chapter describes these resources and introduces the tasks through which you make them available: enabling your database for spatial operations, setting up access to reference data, and registering non-default gecoders.

How to set up resources in your database

The first task that you perform after setting up your database to accommodate spatial data is to render the database capable of supporting spatial operations—operations such as populating tables with spatial data and processing spatial queries. This task involves loading the database with certain resources supplied by DB2 Spatial Extender. This section describes these resources and outlines the task.

Inventory of resources supplied for your database

To enable a database to support spatial operations, DB2® Spatial Extender provides the database with the following resources:

- Stored procedures. When you request a spatial operation—for example, when you issue a command to import spatial data—DB2 Spatial Extender invokes one of these stored procedures to perform the operation.
- Spatial data types. You must assign a spatial data type to each table or view column that is to contain spatial data.
- DB2 Spatial Extender's catalog. Certain operations depend on this catalog. For example, before you can access a spatial column from the visualization tools, the tool might require that the spatial column be registered in the catalog.
- A spatial grid index. It lets you to define grid indexes on spatial columns.
- Spatial functions. You use these to work with spatial data in a number of ways; for example, to determine relationships between geometries and to generate more spatial data.
- Definitions of coordinate systems.
- Default spatial reference systems.
- Two schemas: DB2GSE and ST_INFORMTN_SCHEMA. DB2GSE contains the objects just listed: stored procedures, spatial data types, the DB2 Spatial Extender catalog, and so on. Views in the catalog are available also in ST_INFORMTN_SCHEMA to conform with the SQL/MM standard..

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Enabling a database for spatial operations

Before you enable a database for spatial operations, your user ID must have either SYSADM or DBADM authority on the database.

You can enable a database for spatial operations in any of the following ways:

- Use the Enable Database window from the DB2 Spatial Extender menu option. The menu option is available from the database object of the DB2 Control Center.
- Issue the db2se enable_db command.
- Run an application that calls the db2gse.ST_enable_db stored procedure.

You can explicitly choose the table space in which you want the DB2 Spatial Extender catalog to reside. If you do not do so, DB2 will use the default table space.

The task of having DB2 Spatial Extender supply a database with resources for creating spatial columns and manipulating spatial data is generally referred to as "enabling the database for spatial operations".

How to work with reference data

This section explains what reference data is and states what you need to do in order to access it.

Reference data

Reference data is range of addresses that DB2SE_USA_GEOCODER uses to convert individual addresses into coordinates. This data consists of ranges of the most recent addresses that the United States Census Bureau has collected. When DB2SE_USA_GEOCODER reads an address from the database, it searches the reference data for:

- Names of certain streets within the area designated by the address's zip code. The geocoder looks for names that match the name of the street in the address to a specified degree, or to a degree higher than the specified one; for example, 80 percent or higher.
- The address range that corresponds to the address number.

If a match is found and does not have the requested score, the geocoder returns the coordinates of the address it has read. If a match is not found or does not have the requested score, the geocoder returns a null.

An advanced configuration file called the *locator file* can be used to further influence the processing performed by the geocoder, DB2SE_USA_GEOCODER. The default configuration provided by DB2® Spatial Extender usually does not not need to be changed in this file.

Setting up access to reference data

The reference data for DB2SE_USA_GEOCODER is on one of the CDs on which Spatial Extender is shipped. This section describes how to prepare to access it.

To do this task... :

1. Decide whether to keep the reference data on the CD or to store it on your hard drive. If you keep it on the CD, then you save the space (about 700 megabytes' worth) that it would occupy on the hard drive. If you store it on hard drive, you will be able to retrieve it faster than you can retrieve it from the CD.
2. Store the reference data on your hard drive
   a. Verify that the hard drive has enough space to contain the data (about 700 MB).
   b. Copy the data to the hard drive. For instructions, see the README that accompanies the reference data.
   c. Determine whether the copy was successful: To verify on UNIX that the data was loaded properly, look in the $DB2INSTANCE/sqllib/gse/refdata/ directory. To verify on Windows that the data was loaded properly, look in the %DB2PATH%\gse\refdata\ directory.
3. Tell DB2SE_USA_GEOCODER the name and location of the locator file and the base map. You do this by setting DB2SE_USA_GEOCODER's base_map and locator_file parameters to the appropriate values. For more information, see your database administrator or contact your IBM representative.

Registering a geocoder

Before you can register a geocoder, your user ID must hold either SYSADM or DBADM authority on the database in which the geocoder resides.

DB2SE_USA_GEOCODER is registered to DB2 Spatial Extender automatically when a database is enabled for spatial operations. Before other geocoders can be used, they also must be registered.

To do this task... :

You can register a geocoder in any of the following ways:

- Register it from the Register Geocoder window of the DB2 Control Center.
- Issue the db2se register_gc command.
- Run an application that calls the db2gse.ST_register_geocoder stored procedure.

Chapter 8. Setting up spatial resources for a project

After your database is enabled for spatial operations, you are ready to create projects that use spatial data. Among the resources that each project requires are a coordinate system to which spatial data conforms and a spatial reference system that defines the extent of the geographical area that is referenced by the data. This chapter:

- Discusses the nature of coordinate systems and tells how to create them
- Explains what spatial reference systems are and tells how to create them

How to use coordinate systems

When you plan a project that uses spatial data, you need to determine whether the data should be based on one of the coordinate systems that are registered to the Spatial Extender catalog. If none of these coordinate systems meet your requirements, you can create one that does. This discussion explains the concept of coordinate systems and introduces the tasks of selecting one to use and creating a new one.

Coordinate systems

A coordinate system is a framework for defining the relative locations of things in a given area; for example, an area on the earth's surface or the earth's surface as a whole. DB2® Spatial Extender supports the following types of coordinate systems to determine the location of a geographic feature:

Geographic coordinate system
A *geographic coordinate* system is a reference system that uses a three-dimensional spherical surface to determine locations on the earth. Any location on earth can be referenced by a point with latitude and longitude coordinates based on angular units of measure.

Projected coordinate system
A *projected coordinate system* is a flat, two-dimensional representation of the earth. It uses rectilinear (Cartesian) coordinates based on linear units of measure. It is based on a spherical (or spheroidal) earth model, and its coordinates are related to geographic coordinates by a projection transformation.

Geographic coordinate system

A *geographic coordinate system* is a that uses a three-dimensional spherical surface to determine locations on the earth. Any location on earth can be referenced by a point with longitude and latitude coordinates. The values for the points can have the following units of measurement:

- Linear units when the geographic coordinate system has a spatial reference system identifier (SRID) that DB2® Geodetic Data Management Feature recognizes.
- Any of the following units when the geographic coordinate system has an SRID that DB2 Geodetic Data Management Feature does not recognize.
  - Decimal degrees
  - Decimal minutes

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- Decimal seconds
- Gradians
- Radians

For example, Figure 6 shows a geographic coordinate system where a location is represented by the coordinates longitude 80 degree East and latitude 55 degree North.

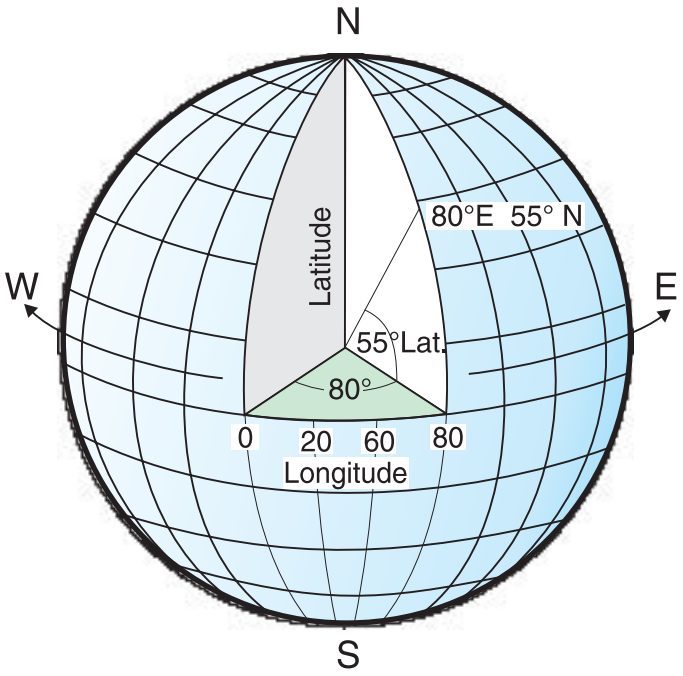


Figure 6. A geographic coordinate system

The lines that run east and west each have a constant latitude value and are called *parallels*. They are equidistant and parallel to one another, and form concentric circles around the earth. The *equator* is the largest circle and divides the earth in half. It is equal in distance from each of the poles, and the value of this latitude line is zero. Locations north of the equator have positive latitudes that range from 0 to +90 degrees, while locations south of the equator have negative latitudes that range from 0 to -90 degrees.

Figure 7 on page 47 illustrates latitude lines.

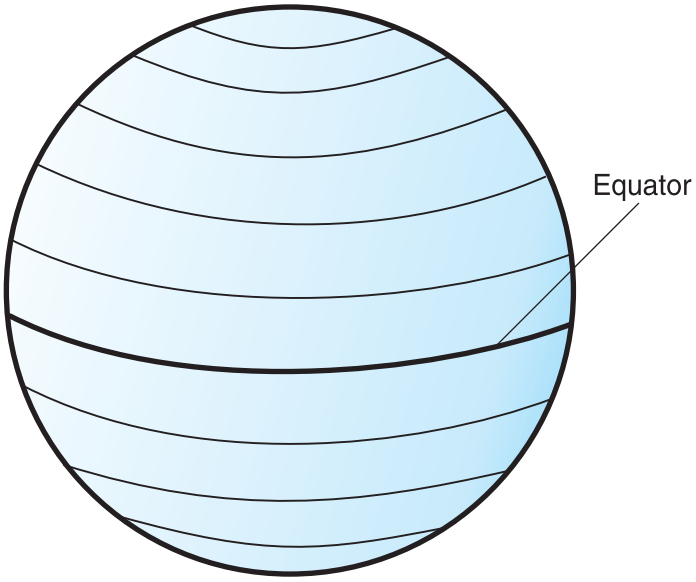


Figure 7. Latitude lines

The lines that run north and south each have a constant longitude value and are called *meridians*. They form circles of the same size around the earth, and intersect at the poles. The *prime meridian* is the line of longitude that defines the origin (zero degrees) for longitude coordinates. One of the most commonly used prime meridian locations is the line that passes through Greenwich, England. However, other longitude lines, such as those that pass through Bern, Bogota, and Paris, have also been used as the prime meridian. Locations east of the prime meridian up to its *antipodal* meridian (the continuation of the prime meridian on the other side of the globe) have positive longitudes ranging from 0 to +180 degrees. Locations west of the prime meridian have negative longitudes ranging from 0 to –180 degrees.

Figure 8 illustrates longitude lines.

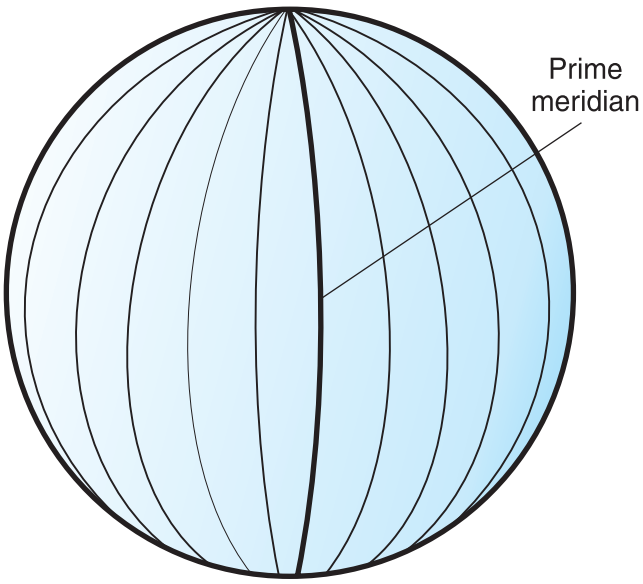


Figure 8. Longitude lines

The latitude and longitude lines can cover the globe to form a grid, called a *graticule*. The point of origin of the graticule is (0,0), where the equator and the prime meridian intersect. The equator is the only place on the graticule where the linear distance corresponding to one degree latitude is approximately equal the distance corresponding to one degree longitude. Because the longitude lines converge at the poles, the distance between two meridians is different at every parallel. Therefore, as you move closer to the poles, the distance corresponding to one degree latitude will be much greater than that corresponding to one degree longitude.

It is also difficult to determine the lengths of the latitude lines using the graticule. The latitude lines are concentric circles that become smaller near the poles. They form a single point at the poles where the meridians begin. At the equator, one degree of longitude is approximately 111.321 kilometers, while at 60 degrees of latitude, one degree of longitude is only 55.802 km (this approximation is based on the Clarke 1866 spheroid). Therefore, because there is no uniform length of degrees of latitude and longitude, the distance between points cannot be measured accurately by using angular units of measure.

Figure 9 shows the different dimensions between locations on the graticule.

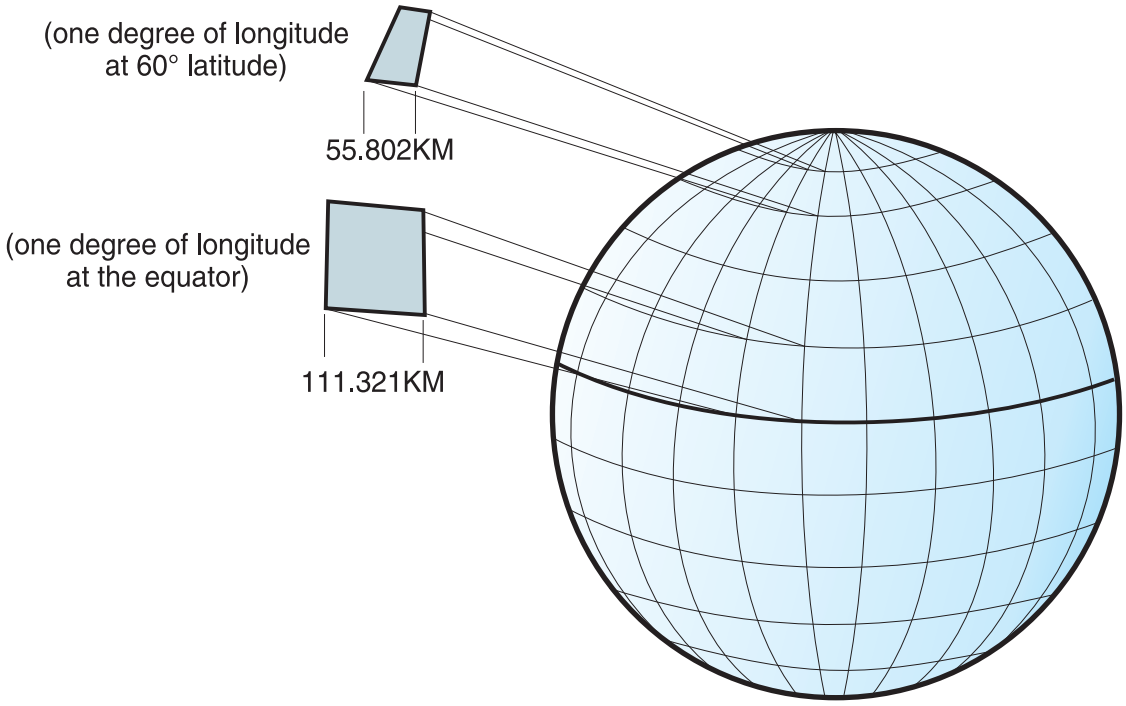
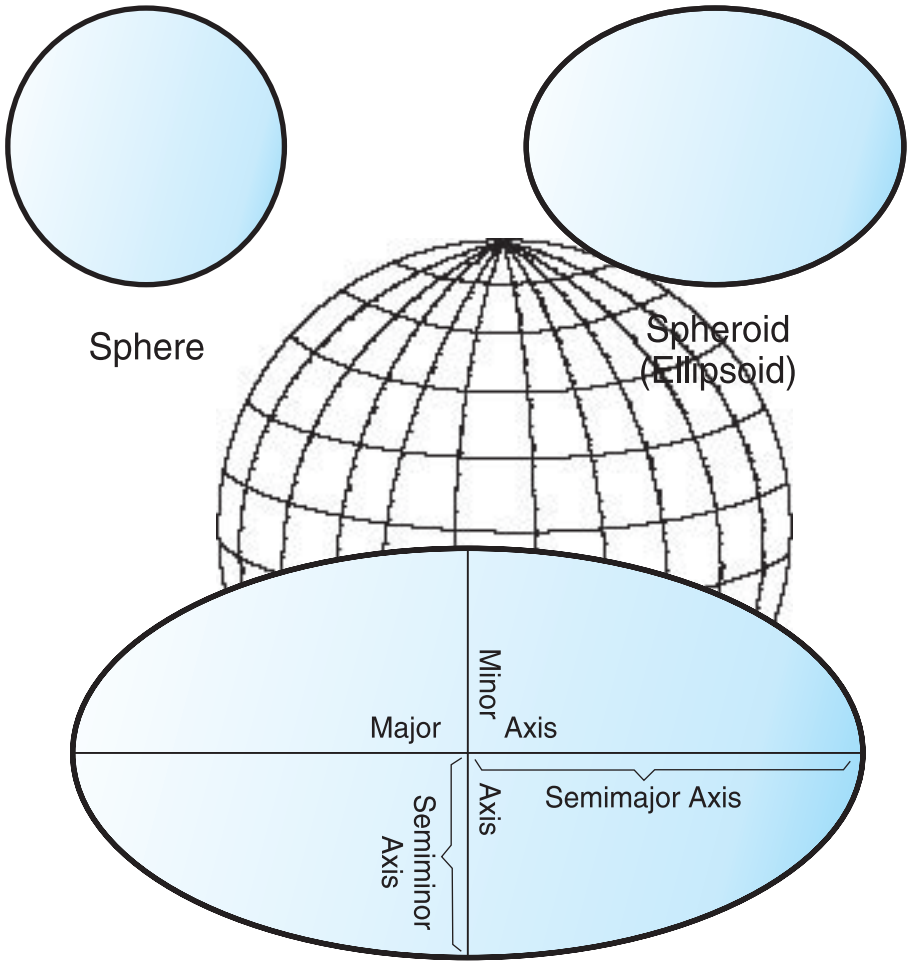


Figure 9. Different dimensions between locations on the graticule

A coordinate system can be defined by either a sphere or a spheroid approximation of the earth's shape. Because the earth is not perfectly round, a spheroid can help maintain accuracy for a map, depending on the location on the earth. A *spheroid* is an ellipsoid, that is based on an ellipse, whereas a sphere is based on a circle.

The shape of the ellipse is determined by two radii. The longer radius is called the semimajor axis, and the shorter radius is called the semiminor axis. An ellipsoid is a three-dimensional shape formed by rotating an ellipse around one of its axes.

Figure 10 shows the sphere and spheroid approximations of the earth and the major and minor axes of an ellipse.



The major and minor axes of an ellipse

Figure 10. Sphere and spheroid approximations

A *datum* is a set of values that defines the position of the spheroid relative to the center of the earth. The datum provides a frame of reference for measuring locations and defines the origin and orientation of latitude and longitude lines. Some datums are global and intend to provide good average accuracy around the world. A local datum aligns its spheroid to closely fit the earth's surface in a particular area. Therefore, the coordinate system's measurements are not be accurate if they are used with an area other than the one that they were designed.

Figure 11 on page 50 shows how different datums align with the earth's surface. The local datum, NAD27, more closely aligns with Earth's surface than the Earth-centered datum, WGS84, at this particular location.

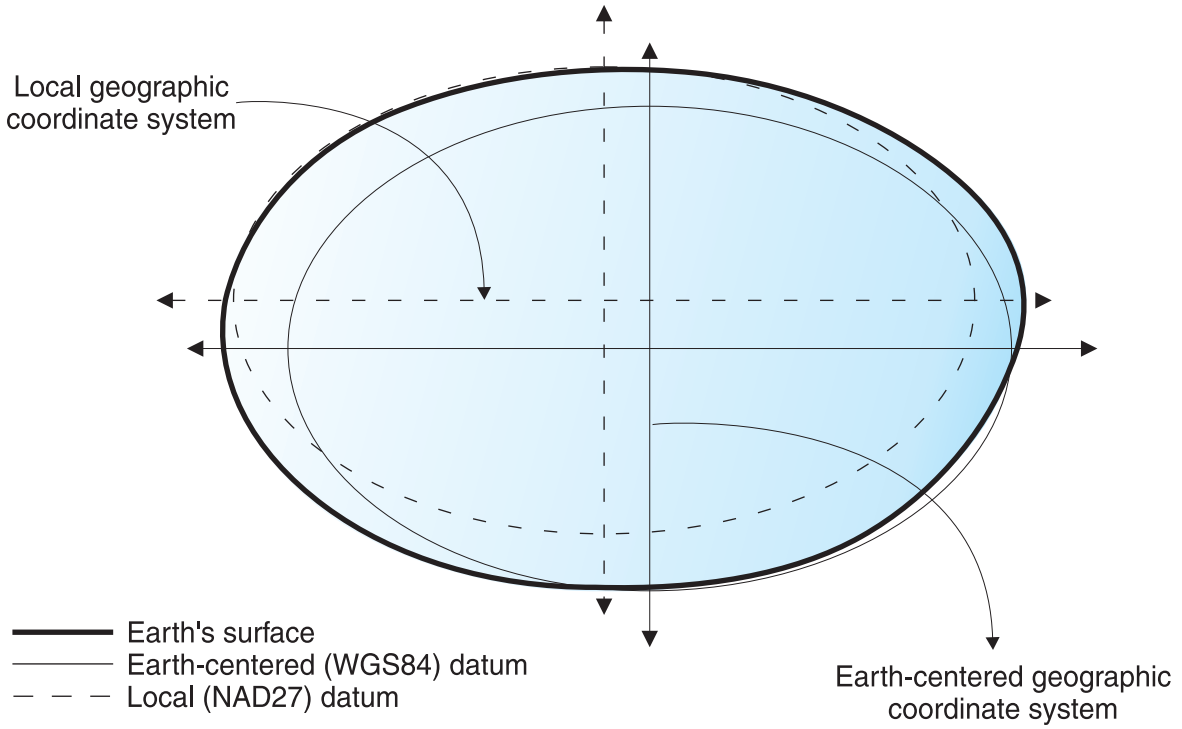


Figure 11. Datum alignments

Whenever you change the datum, the geographic coordinate system is altered and the coordinate values will change. For example, the coordinates in DMS of a control point in Redlands, California using the North American Datum of 1983 (NAD 1983) are: ″-117 12 57.75961 34 01 43.77884″ The coordinates of the same point on the North American Datum of 1927 (NAD 1927) are: ″-117 12 54.61539 34 01 43.72995″.

Projected coordinate systems

A *projected coordinate system* is a flat, two-dimensional representation of the Earth. It is based on a sphere or spheroid geographic coordinate system, but it uses linear units of measure for coordinates, so that calculations of distance and area are easily done in terms of those same units.

The latitude and longitude coordinates are converted to x, y coordinates on the flat projection. The x coordinate is usually the eastward direction of a point, and the y coordinate is usually the northward direction of a point. The center line that runs east and west is referred to as the x axis, and the center line that runs north and south is referred to as the y axis.

The intersection of the x and y axes is the origin and usually has a coordinate of (0,0). The values above the x axis are positive, and the values below the x axis are negative. The lines parallel to the x axis are equidistant from each other. The values to the right of the y axis are positive, and the values to the left of the y axis are negative. The lines parallel to the y axis are equidistant.

Mathematical formulas are used to convert a three-dimensional geographic coordinate system to a two-dimensional flat projected coordinate system. The transformation is referred to as a *map projection*. Map projections usually are classified by the projection surface used, such as conic, cylindrical, and planar

surfaces. Depending on the projection used, different spatial properties will appear distorted. Projections are designed to minimize the distortion of one or two of the data's characteristics, yet the distance, area, shape, direction, or a combination of these properties might not be accurate representations of the data that is being modeled. There are several types of projections available. While most map projections attempt to preserve some accuracy of the spatial properties, there are others that attempt to minimize overall distortion instead, such as the *Robinson* projection. The most common types of map projections include:

Equal area projections
: These projections preserve the area of specific features. These projections distort shape, angle, and scale. The *Albers Equal Area Conic* projection is an example of an equal area projection.

Conformal projections
: These projections preserve local shape for small areas. These projections preserve individual angles to describe spatial relationships by showing perpendicular graticule lines that intersect at 90 degree angles on the map. All of the angles are preserved; however, the area of the map is distorted. The *Mercator* and *Lambert Conformal Conic* projections are examples of conformal projections.

Equidistant projections
: These projections preserve the distances between certain points by maintaining the scale of a given data set. Some of the distances will be true distances, which are the same distances at the same scale as the globe. If you go outside the data set, the scale will become more distorted. The *Sinusoidal* projection and the *Equidistant Conic* projection are examples of equidistant projections.

True-direction or azimuthal projections
: These projections preserve the direction from one point to all other points by maintaining some of the great circle arcs. These projections give the directions or azimuths of all points on the map correctly with respect to the center. Azimuthal maps can be combined with equal area, conformal, and equidistant projections. The *Lambert Equal Area Azimuthal* projection and the *Azimuthal Equidistant* projection are examples of azimuthal projections.

Selecting or creating coordinate systems

A first step in planning a project is to determine what coordinate system to use.

Before you create a coordinate system, your user ID must have either SYSADM or DBADM authority on the database that has been enabled for spatial operations. No authorization is required to use an existing coordinate system.

After you enable a database for spatial operations, you are ready to plan projects that use spatial data. You can use a coordinate system that was shipped with DB2 Spatial Extender or one that was created by elsewhere. Over 2000 coordinate systems are shipped with DB2 Spatial Extender. Among them are:

- A coordinate system that DB2 Spatial Extender refers to as Unspecified. Use this coordinate system when:
  - You need to define locations that have no direct relationship to the earth's surface; for example, locations of offices within an office building or locations of shelves within a storage room.
  - You can define these locations in terms of positive coordinates that include few or no decimal values.

- GCS_NORTH_AMERICAN_1983. Use this coordinate system when you need to define locations in the United States; for example:
  - When you import spatial data for the United States from the Maps and Data CDs that are shipped with DB2 Spatial Extender.
  - When you plan to use the geocoder shipped with DB2 Spatial Extender to geocode addresses within the United States.

To find out more about these coordinate systems, and to determine what other coordinate systems were shipped with DB2 Spatial Extender, and what (if any) coordinate systems have been created by other users, consult the DB2SE.ST_COORDINATE_SYSTEMS catalog view.

To do this task... :

Choose which method to use to create a coordinate system:

- Create it from the Create Coordinate System window of the DB2 Control Center.
- Issue the db2se create_cs command from the db2se command line processor.
- Run an application that invokes the db2se.ST_create_coordsys stored procedure.

How to set up spatial reference systems

When you plan a project that uses spatial data, you need to determine whether any of the spatial reference systems available to you can be used for this data. If none of the available systems are appropriate for the data, you can create one that is. This section explains the concept of spatial reference systems and describes the tasks of selecting which one to use and creating one.

Spatial reference systems

A *spatial reference system* is a set of parameters that includes:

- The name of the coordinate system from which the coordinates are derived.
- The numeric identifier that uniquely identifies the spatial reference system.
- Coordinates that define the maximum possible extent of space that is referenced by a given range of coordinates.
- Numbers that, when applied in certain mathematical operations, convert coordinates received as input into values that can be processed with maximum efficiency.

The following sections discuss the parameter values that define an identifier, a maximum extent of space, and conversion factors.

Spatial reference system identifier

The spatial reference system identifier (SRID) is used as an input parameter for various spatial functions.

For a geodetic spatial reference system, the SRID value must be in the range 2000000000 to 2000001000. DB2® Geodetic Data Management Feature provides 318 predefined geodetic spatial reference systems (SRS).

Defining the space that encompasses coordinates stored in a spatial column

The coordinates in a spatial column typically define locations that span across part of the Earth. The space over which the span extends—from east to west and from north to south—is called a *spatial extent*. For example, consider a body of flood plains whose coordinates are stored in a spatial column. Suppose that the westernmost and easternmost of these coordinates are latitude values of –24.556 and –19.338, respectively, and that the northernmost and southernmost of the coordinates are longitude values of 18.819 and 15.809 degrees, respectively. The spatial extent of the flood plains is a space that extends on a west-east plane between the two latitudes and on a north-south plane between the two longitudes. You can include these values in a spatial reference system by assigning them to certain parameters. If the spatial column includes Z coordinates and measures, you would need to include the highest and lowest Z coordinates and measures in the spatial reference system as well.

The term spatial extent can refer not only to an actual span of locations, as in the previous paragraph; but also to a potential one. Suppose that the flood plains in the preceding example were expected to broaden over the next five years. You could estimate what the westernmost, easternmost, northernmost, and southernmost coordinates of the planes would be at the end of the fifth year. You could then assign these estimates, rather than the current coordinates, to the parameters for a spatial extent. That way, you could retain the spatial reference system as the plains expand and their wider latitudes and longitudes are added to the spatial column. Otherwise, if the spatial reference system is limited to the original latitudes and longitudes, it would need to be altered or replaced as the flood planes grew.

Converting to values that improve performance

Typically, most coordinates in a coordinate system are decimal values; some are integers. In addition, coordinates to the east of the origin are positive; those to the west are negative. Before being stored by Spatial Extender, the negative coordinates are converted to positive values, and the decimal coordinates are converted into integers. As a result, all coordinates are stored by Spatial Extender as positive integers. The purpose is to enhance performance when the coordinates are processed.

Certain parameters in a spatial reference system are used to make the conversions described in the preceding paragraph. One parameter, called an *offset*, is subtracted from each negative coordinate, which leaves a positive value as a remainder. Each decimal coordinate is multiplied by another parameter, called a *scale factor*, which results in an integer whose precision is the same as that of the decimal coordinate. (The offset is subtracted from positive coordinates as well as negative; and the nondecimal coordinates, as well as the decimal coordinates, are multiplied by the scale factor. This way, all positive and non-decimal coordinates remain commensurate with the negative and decimal ones.)

These conversions take place internally, and remain in effect only until coordinates are retrieved. Input and query results always contain coordinates in their original, unconverted form.

Deciding whether to use a default spatial reference system or create a new system

After you determine what coordinate system to use, you are ready to provide a spatial reference system that suits the coordinate data that you are working with. DB2 Spatial Extender provides five spatial reference systems for spatial data, and DB2 Geodetic Data Management Feature provides 318 geodetic spatial reference systems for geodetic data.

Answer the following questions to determine whether you can use one of the default spatial reference systems or predefined geodetic reference systems.

1. Does the coordinate system on which the default spatial reference system is based cover the geographic area that you are working with? These coordinate systems are shown in "Spatial reference systems supplied with DB2 Spatial Extender."
2. Is your data in a geographic coordinate system that uses either Decimal Degrees or Grads as the unit of measure? Does your data span a large portion of the Earth's surface? Do you need to make accurate distance, length and area calculations? Is any of your data near the north pole, south pole, or the international dateline? If you answer yes to any of these questions, you might want to use one of the predefined 318 geodetic spatial reference systems. For information on these predefined geodetic spatial reference systems, see "Datums supported by DB2 Geodetic Data Management Feature" on page 179.
3. Do the conversion factors associated with one of the default spatial reference systems work with your coordinate data?

   Spatial Extender uses offset values and scale factors to convert the coordinate data that you provide to positive integers. To determine if your coordinate data works with the given offset values and scale factors for one of the default spatial reference systems:

   a. Review the information in "Conversion factors that transform coordinate data into integers" on page 56.
   b. Look at how these factors are defined for the default spatial reference systems. If, after applying the offset value to the minimum X and Y coordinates, these coordinates are not both greater than 0, you must create a new spatial reference system and define the offsets yourself. For more information about how to create a new spatial reference system, see "Creating a spatial reference system" on page 58.
4. Does the data that you are working with include height and depth coordinates (Z coordinates) or measures (M coordinates)? If you are working with Z or M coordinates, you might need to create a new spatial reference system with Z or M offsets and scale factors suitable to your data.
5. If the existing spatial reference systems or geodetic reference systems do not work with your data, you need to "Creating a spatial reference system" on page 58.

After you decide which spatial reference system you need, you specify this choice to Spatial Extender when you do one of the following tasks:

- "Spatial reference systems supplied with DB2 Spatial Extender"
- "Datums supported by DB2 Geodetic Data Management Feature" on page 179

Spatial reference systems supplied with DB2 Spatial Extender

The spatial reference system converts the coordinate data to positive integers.

DB2 Spatial Extender provides the spatial reference systems that are shown in the table below, along with the coordinate system on which each spatial reference system is based and the offset values and scale factors that DB2 Spatial Extender uses to convert the coordinate data to positive integers. You can find information about these spatial reference systems in the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view.

If you are working with decimal-degrees (all the data on the DB2 Spatial Extender sample data CDs is in decimal-degrees), the offset values and scale factors for the default spatial reference systems support the full range of latitude-longitude coordinates and preserve 6 decimal positions, equivalent to approximately 10 cm.

If you plan to use the geocoder which works only with U.S. addresses, ensure that you select or create a spatial reference system that handles U.S. coordinates, such as the GCS_NORTH_AMERICAN_1983 coordinate system. If you do not specify what coordinate system your spatial data should derive from, Spatial Extender uses the DEFAULT_SRS spatial reference system.

If none of the default spatial reference systems meet your needs, you can create a new spatial reference system.

Table 3. Spatial reference systems provided with DB2 Spatial Extender

Spatial reference system	SRS ID	Coordinate system	Offset values	Scale factors	When to use
DEFAULT_SRS	0	None	xOffset = 0 yOffset = 0 zOffset = 0 mOffset = 0	xScale = 1 yScale = 1 zScale = 1 mScale = 1	You can select this system when your data is independent of a coordinate system or you cannot or do not need to specify one.
NAD83_SRS_1	1	GCS_NORTH_AMERICAN_1983	xOffset = –180 yOffset = –90 zOffset = 0 mOffset = 0	xScale = 1,000,000 yScale = 1,000,000 zScale = 1 mScale = 1	You can select this spatial reference system if you plan to use the U.S. sample data shipped with DB2 Spatial Extender. If the coordinate data that you are working with was collected after 1983, use this system instead of NAD27_SRS_1002.

Table 3. Spatial reference systems provided with DB2 Spatial Extender (continued)

Spatial reference system	SRS ID	Coordinate system	Offset values	Scale factors	When to use
NAD27_ SRS_1002	1002	GCS_NORTH _AMERICAN _1927	xOffset = –180 yOffset = –90 zOffset = 0 mOffset = 0	xScale = 5,965,232 yScale = 5,965,232 zScale = 1 mScale = 1	You can select this spatial reference system if you plan to use the U.S. sample data shipped with DB2 Spatial Extender. If the coordinate data that you are working with was collected before 1983, use this system instead of NAD83_SRS_1. This system provides a greater degree of precision than the other default spatial reference systems.
WGS84_ SRS_1003	1003	GCS_WGS _1984	xOffset = –180 yOffset = –90 zOffset = 0 mOffset = 0	xScale = 5,965,232 yScale = 5,965,232 zScale = 1 mScale = 1	You can select this spatial reference system if you are working with data outside the U.S. (This system handles worldwide coordinates.) Do not use this system if you plan to use the default geocoder shipped with DB2 Spatial Extender, because the geocoder is only for U.S. addresses.
DE_HDN _SRS_1004	1004	GCSW _DEUTSCHE _HAUPTDRE IECKSNETZ	xOffset = –180 yOffset = –90 zOffset = 0 mOffset = 0	xScale = 5,965,232 yScale = 5,965,232 zScale = 1 mScale = 1	This spatial reference system is based on a coordinate system for German addresses.

Conversion factors that transform coordinate data into integers

DB2 Spatial Extender uses offset values and scale factors to convert the coordinate data that you provide to positive integers. The default spatial reference systems already have offset value and scale factors associated with them. If you are

creating a new spatial reference system, determine the scale factors and, optionally, the offset values that work best with your data.

Offset values

An offset value is a number that is subtracted from all coordinates, leaving only positive values as a remainder. Spatial Extender converts your coordinate data using the following formulas to ensure that all adjusted coordinate values are greater than 0.

Formula notation: In these formulas, the notation "min" represents "the minimum of all". For example, "min(x)" means "the minimum of all x coordinates". The offset for each geographic direction is represented as dimensionOffset. For example, xOffset is the offset value applied to all X coordinates.

$$\min(x) - xOffset \geq 0$$
$$\min(y) - yOffset \geq 0$$
$$\min(z) - zOffset \geq 0$$
$$\min(m) - mOffset \geq 0$$

Scale factors

A scale factor is a value that, when multiplied by decimal coordinates and measures, yields integers with at least the same number of significant digits as the original coordinates and measures. Spatial Extender converts your decimal coordinate data using the following formulas to ensure that all adjusted coordinate values are positive integers. The converted values cannot exceed 2^{53} (approximately $9 * 10^{15}$).

Formula notation: In these formulas, the notation "max" represents "the maximum of all". The offset for each geographic dimension is represented as dimensionOffset (for example, xOffset is the offset value applied to all X coordinates). The scale factor for each geographic dimension is represented as dimensionScale (for example, xScale is the scale factor applied to X coordinates).

$$(\max(x) - xOffset) * xScale \leq 2^{53}$$
$$(\max(y) - yOffset) * yScale \leq 2^{53}$$
$$(\max(z) - zOffset) * zScale \leq 2^{53}$$
$$(\max(m) - mOffset) * mScale \leq 2^{53}$$

When you choose which scale factors work best with your coordinate data, ensure that:

- You use the same scale factor for X and Y coordinates.
- When multiplied by a decimal X coordinate or a decimal Y coordinate, the scale factor yields a value less than 2^{53}. One common technique is to make the scale factor a power of 10. That is, the scale factor should be 10 to the first power (10), 10 to the second power (100), 10 to the third power (1000), or, if necessary, a larger factor.
- The scale factor is large enough to ensure that the number of significant digits in the new integer is the same as the number of significant digits in the original decimal coordinate.

Example

Suppose that the ST_Point function is given input that consists of an X coordinate of 10.01, a Y coordinate of 20.03, and the identifier of a spatial reference system. When ST_Point is invoked, it multiplies the value of 10.01 and the value of 20.03 by the spatial reference system's scale factor for X and Y coordinates. If this scale factor is 10, the resulting integers that Spatial Extender stores will be 100 and 200, respectively. Because the number of significant digits in these integers (3) is less

than the number of significant digits in the coordinates (4), Spatial Extender will not be able to convert these integers back to the original coordinates, or to derive from them values that are consistent with the coordinate system to which these coordinates belong. But if the scale factor is 100, the resulting integers that DB2 Spatial Extender stores will be 1001 and 2003—values that can be converted back to the original coordinates or from which compatible coordinates can be derived.

Units for offset values and scale factors

Whether you use an existing spatial reference system or create a new one, the units for the offset values and scale factors will vary depending on the type of coordinate system that you are using. For example, if you are using a geographic coordinate system, the values are in angular units such as decimal degrees; if you are using a projected coordinate system, the values are in linear units such as meters or feet.

Creating a spatial reference system

Create a new spatial reference system if none of the spatial reference systems that are provided with DB2 Spatial Extender work with your data.

To do this task... :

1. Choose the interface.

   You can create a spatial reference system in any of the following ways:

   - Use the Create Spatial Reference System window in the DB2 Control Center. See the online help for more information about how to use this window.
   - Issue the db2se create_srs command from the db2se command–line processor.
   - Run an application that invokes the db2se.ST_create_srs stored procedure.

2. Specify an appropriate spatial reference system ID (SRID).

   - For geodetic data in a round-earth representation, specify an SRID value in the range of 200000318 to 2000001000.
   - For spatial data in a flat-earth representation, specify an SRID that is not already defined.

3. Decide on the degree of precision that you want.

   You can either:

   - Specify the extents of the geographical area that you are working with and the scale factors that you want to use with your coordinate data. Spatial Extender takes the extents that you specify and calculates the offset for you. You can specify extents in one of the following ways:
     - Choose **Extents** in the Create Spatial Reference System window of the Control Center.
     - Provide the appropriate parameters for the db2se create_srs command or db2se.ST_create_srs stored procedure.
   - Specify both the offset values (required for Spatial Extender to convert negative values to positive values) and scale factors (required for Spatial Extender to convert decimal values to integers). Use this method when you need to follow strict criteria for accuracy or precision. You can specify offset values and scale factors in one of the following ways:
     - Choose **Offset** in the Create Spatial Reference System window of the Control Center
     - Provide the appropriate parameters for the db2se create_srs command or db2se.ST_create_srs stored procedure.

4. Calculate the conversion information that Spatial Extender needs to convert coordinate data to positive integers, and provide this information to the interface that you chose.

   This information differs according to the method that you chose in step 3.

   - If you chose the Extents method in step 3, you need to calculate the following information:
     - Scale factors. If any of the coordinates that you are working with are decimal values, calculate scale factors. Scale factors are numbers that, when multiplied by decimal coordinates and measures, yields integers with at least the same number of significant digits as the original coordinates and measures. If the coordinates are integers, the scale factors can be set to 1. If the coordinates are decimal values, the scale factor should be set to a number that converts the decimal portion to an integer value. For example, if the coordinate units are meters and the accuracy of the data is 1 cm., you would need a scale factor of 100.
     - Minimum and maximum values for your coordinates and measures.
   - If you chose the Offset method in step 3, you need to calculate the following information:
     - Offset values

       If your coordinate data includes negative numbers or measures, you need to specify the offset values that you want to use. An offset is a number that is subtracted from all coordinates, leaving only positive values as a remainder. If you are working with positive coordinates, set all offset values to 0. If you are not working with positive coordinates, select an offset that, when applied against the coordinate data, results in integers that are less than the largest positive integer value (9,007,199,254,740,992).
     - Scale factors

       If any of the coordinates for the locations that you are representing are decimal numbers, determine what scale factors to use and enter these scale factors in the Create Spatial Reference System window.
5. Submit the db2se create_srs command or the db2se.ST_create_srs stored procedure to create the stored procedure.

   For example, the following command creates a spatial reference system named mysrs:

```
db2se create_srs mydb -srsName \"mysrs\"
 -srsID 100 -xScale 10 -coordsysName
\"GCS_North_American_1983\"
```

Calculating scale factors

Prerequisites

If you create a spatial reference system and any of the coordinates that you are working with are decimal values, calculate the appropriate scale factors for your coordinates and measures. Scale factors are numbers that, when multiplied by decimal coordinates and measures, yields integers with at least the same number of significant digits as the original coordinates and measures.

After you calculate scale factors, you need to determine the extent values. Then submit the db2se create_srs command or db2se.ST_create_srs stored procedure.

To calculate the scale factors:

1. Determine which X and Y coordinates are, or are likely to be, decimal numbers. For example, suppose that of the various X and Y coordinates that you will be dealing with, you determine that three of them are decimal numbers: 1.23, 5.1235, and 6.789.
2. Find the decimal coordinate that has the longest decimal precision. Then determine by what power of 10 this coordinate can be multiplied to yield an integer of equal precision. For example, of the three decimal coordinates in the current example, 5.1235 has the longest decimal precision. Multiplying it by 10 to the fourth power (10000) yields the integer 51235.
3. Determine whether the integer produced by the multiplication just described is less than 2^{53}. 51235 is not too large. But suppose that, in addition to 1.23, 5.11235, and 6.789, your range of X and Y coordinates includes a fourth decimal value, 10000000006.789876. Because this coordinate's decimal precision is longer than that of the other three, you would multiply this coordinate—not 5.1235—by a power of 10. To convert it to an integer, you could multiply it by 10 to the sixth power (1000000). But the resulting value, 10000000006789876, is greater than 2^{53}. If DB2 Spatial Extender tried to store it, the results would be unpredictable.

   To avoid this problem, select a power of 10 that, when multiplied by the original coordinate, yields a decimal number that DB2 Spatial Extender can truncate to a storable integer, with minimum loss of precision. In this case, you could select 10 to the fifth power (100000). Multiplying 100000 by 10000000006.789876 yields 1000000000678987.6. DB2 Spatial Extender would round this number to 1000000000678988, reducing its accuracy slightly.

Conversion factors that transform coordinate data into integers

DB2 Spatial Extender uses offset values and scale factors to convert the coordinate data that you provide to positive integers. The default spatial reference systems already have offset value and scale factors associated with them. If you are creating a new spatial reference system, determine the scale factors and, optionally, the offset values that work best with your data.

Determining minimum and maximum coordinates and measures

Use this procedure to determine minimum and maximum coordinates and measures if you:

- Decide to create a new spatial reference system because none of the spatial reference systems provided with DB2 Spatial Extender work with your data.
- Decide to use extent transformations to convert your coordinates.

Determine minimum and maximum coordinates and measures if you decide to specify extent transformations when you create a spatial reference system.

After you determine the extent values, if any of the coordinates are decimal values, you need to calculate scale factors. Otherwise, submit the db2se create_srs command or db2se.ST_create_srs stored procedure.

To determine the minimum and maximum coordinates and measures of the locations that you want to represent:

1. Determine the minimum and maximum X coordinates. To find the minimum X coordinate, identify the X coordinate in your domain that is furthest west. (If the location lies to the west of the point of origin, this coordinate will be a negative value.) To find the maximum X coordinate, identify the X coordinate in your domain that is furthest east. For example, if you are representing oil wells, and each one is defined by a pair of X and Y coordinates, the X coordinate that indicates the location of the oil well that is furthest west is the minimum X coordinate, and the X coordinate that indicates the location of the oil well that is furthest east is the maximum X coordinate.

   Tip: For multifeature types, such as multipolygons, ensure that you pick the furthest point on the furthest polygon in the direction that you are calculating. For example, if you are trying to identify the minimum X coordinate, identify the westernmost X coordinate of the polygon that is furthest west in the multipolygon.
2. Determine the minimum and maximum Y coordinates. To find the minimum Y coordinate, identify the Y coordinate in your domain that is furthest south. (If the location lies to the south of the point of origin, this coordinate will be a negative value.) To determine the maximum Y coordinate, find the Y coordinate in your domain that is furthest north.
3. Determine the minimum and maximum Z coordinates. The minimum Z coordinate is the greatest of the depth coordinates and the maximum Z coordinate is the greatest of the height coordinates.
4. Determine the minimum and maximum measures. If you are going to include measures in your spatial data, determine which measure has the highest numerical value and which has the lowest.

Calculating offset values

You specify offset values if your coordinate data includes negative numbers or measures.

If you create a spatial reference system and your coordinate data includes negative numbers or measures, you need to specify the offset values that you want to use. An offset is a number that is subtracted from all coordinates, leaving only positive values as a remainder. You can improve the performance of spatial operations when the coordinates are positive integers instead of negative numbers or measures.

To calculate the offset values for the coordinates that you are working with:

1. Determine the lowest negative X, Y, and Z coordinates within the range of coordinates for the locations that you want to represent. If your data is to include negative measures, determine the lowest of these measures.
2. Optional but recommended: Indicate to DB2 Spatial Extender that the domain that encompasses the locations that you are concerned with is larger than it actually is. Thus, after you write data about these locations to a spatial column, you can add data about locations of new features as they are added to outer reaches of the domain, without having to replace your spatial reference system with another one.

   For each coordinate and measure that you identified in step 1, add an amount equal to five to ten percent of the coordinate or measure. The result is referred to as an *augmented value*. For example, if the lowest negative X coordinate is –100, you could add –5 to it, yielding an augmented value of –105. Later, when you create the spatial reference system, you will indicate that the lowest X

coordinate is –105, rather than the true value of –100. DB2 Spatial Extender will then interpret –105 as the westernmost limit of your domain.

3. Find a value that, when subtracted from your augmented X value, leaves zero; this is the offset value for X coordinates. DB2 Spatial Extender subtracts this number from all X coordinates to produce only positive values.

   For example, if the augmented X value is –105, you need to subtract –105 from it to get 0. DB2 Spatial Extender will then subtract –105 from all X coordinates that are associated with the features that you are representing. Because none of these coordinates is greater than –100, all the values that result from the subtraction will be positive.

4. Repeat step 3 for the augmented Y value, augmented Z value, and augmented measure.

Creating a spatial reference system

Create a new spatial reference system if none of the spatial reference systems that are provided with DB2 Spatial Extender work with your data.

To do this task... :

1. Choose the interface.

   You can create a spatial reference system in any of the following ways:

   - Use the Create Spatial Reference System window in the DB2 Control Center. See the online help for more information about how to use this window.
   - Issue the db2se create_srs command from the db2se command–line processor.
   - Run an application that invokes the db2se.ST_create_srs stored procedure.

2. Specify an appropriate spatial reference system ID (SRID).

   - For geodetic data in a round-earth representation, specify an SRID value in the range of 200000318 to 2000001000.
   - For spatial data in a flat-earth representation, specify an SRID that is not already defined.

3. Decide on the degree of precision that you want.

   You can either:

   - Specify the extents of the geographical area that you are working with and the scale factors that you want to use with your coordinate data. Spatial Extender takes the extents that you specify and calculates the offset for you. You can specify extents in one of the following ways:
     – Choose **Extents** in the Create Spatial Reference System window of the Control Center.
     – Provide the appropriate parameters for the db2se create_srs command or db2se.ST_create_srs stored procedure.
   - Specify both the offset values (required for Spatial Extender to convert negative values to positive values) and scale factors (required for Spatial Extender to convert decimal values to integers). Use this method when you need to follow strict criteria for accuracy or precision. You can specify offset values and scale factors in one of the following ways:
     – Choose **Offset** in the Create Spatial Reference System window of the Control Center
     – Provide the appropriate parameters for the db2se create_srs command or db2se.ST_create_srs stored procedure.

4. Calculate the conversion information that Spatial Extender needs to convert coordinate data to positive integers, and provide this information to the interface that you chose.

   This information differs according to the method that you chose in step 3.

   - If you chose the Extents method in step 3, you need to calculate the following information:
     - Scale factors. If any of the coordinates that you are working with are decimal values, calculate scale factors. Scale factors are numbers that, when multiplied by decimal coordinates and measures, yields integers with at least the same number of significant digits as the original coordinates and measures. If the coordinates are integers, the scale factors can be set to 1. If the coordinates are decimal values, the scale factor should be set to a number that converts the decimal portion to an integer value. For example, if the coordinate units are meters and the accuracy of the data is 1 cm., you would need a scale factor of 100.
     - Minimum and maximum values for your coordinates and measures.
   - If you chose the Offset method in step 3, you need to calculate the following information:
     - Offset values

       If your coordinate data includes negative numbers or measures, you need to specify the offset values that you want to use. An offset is a number that is subtracted from all coordinates, leaving only positive values as a remainder. If you are working with positive coordinates, set all offset values to 0. If you are not working with positive coordinates, select an offset that, when applied against the coordinate data, results in integers that are less than the largest positive integer value (9,007,199,254,740,992).
     - Scale factors

       If any of the coordinates for the locations that you are representing are decimal numbers, determine what scale factors to use and enter these scale factors in the Create Spatial Reference System window.

5. Submit the db2se create_srs command or the db2se.ST_create_srs stored procedure to create the stored procedure.

   For example, the following command creates a spatial reference system named mysrs:

```
db2se create_srs mydb -srsName \"mysrs\"
 -srsID 100 -xScale 10 -coordsysName
\"GCS_North_American_1983\"
```

Chapter 9. Setting up spatial columns

In preparing to obtain spatial data for a project, you not only choose or create a coordinate system and spatial reference system; you also provide one or more table columns to contain the data. This chapter:

- Notes that results of queries of the columns can be rendered graphically, and provides guidelines for choosing data types for the columns
- Describes the task of providing the columns
- Describes the task of making the columns accessible to tools that can display their content in graphical form

Spatial columns

Spatial columns with viewable content

When you use a visualization tool, such as ArcExplorer for DB2®, to query a spatial column, the tool returns results in the form of a graphical display; for example, a map of parcel boundaries or the layout of a road system. Some visualization tools require all rows of the column to use the same spatial reference system. The way you enforce this constraint is to register the column with a spatial reference system.

Spatial data types

When you enable a database for spatial operations, DB2 Spatial Extender supplies the database with a hierarchy of structured data types.

Figure 12 on page 66 presents this hierarchy. In this figure, the instantiable types have a white background; the uninstantiable types have a shaded background.

Instantiable data types are ST_Point, ST_LineString, ST_Polygon, ST_GeomCollection, ST_MultiPoint, ST_MultiPolygon, and ST_MultiLineString.

Data types that are not instantiable are ST_Geometry, ST_Curve, ST_Surface, ST_MultiSurface, and ST_MultiCurve.

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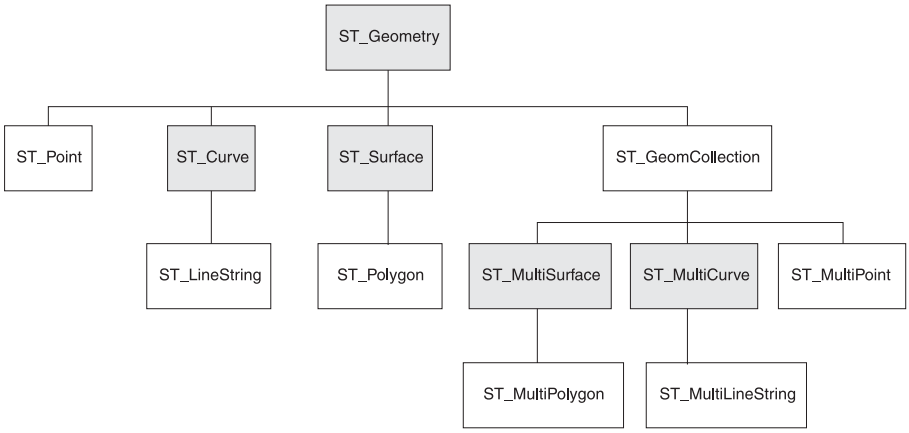

Figure 12. Hierarchy of spatial data types. Data types named in white boxes are instantiable. Data types named in shaded boxes are not instantiable.

The hierarchy in Figure 12 includes:

- Data types for geographic features that can be perceived as forming a single unit; for example, individual residences and isolated lakes.
- Data types for geographic features that are made up of multiple units or components; for example, canal systems and groups of islands in a lake.
- A data type for geographic features of all kinds.

Data types for single-unit features

Use ST_Point, ST_LineString, and ST_Polygon to store coordinates that define the space occupied by features that can be perceived as forming a single unit.

- Use ST_Point when you want to indicate the point in space that is occupied by a discrete geographic feature. The feature might be a very small one, such as a water well; a very large one, such as a city; or one of intermediate size, such as a building complex or park. In each case, the point in space can be located at the intersection of an east-west coordinate line (for example, a parallel) and a north-south coordinate line (for example, a meridian). An ST_Point data item includes an X coordinate and a Y coordinate that define such an intersection. The X coordinate indicates where the intersection lies on the east-west line; the Y coordinate indicates where the intersection lies on the north-south line.
- Use ST_Linestring for coordinates that define the space that is occupied by linear features; for example, streets, canals, and pipelines.
- Use ST_Polygon when you want to indicate the extent of space covered by a multi-sided feature; for example, a voting district, a forest, or a wildlife habitat. An ST_Polygon data item consists of the coordinates that define the boundary of such a feature.

In some cases, ST_Polygon and ST_Point can be used for the same feature. For example, suppose that you need spatial information about an apartment complex. If you want to represent the point in space where each building in the complex is located, you would use ST_Point to store the X and Y coordinates that define each such point. Otherwise, if you want to represent the area occupied by the complex as a whole, you would use ST_Polygon to store the coordinates that define the boundary of this area.

Data types for multi-unit features

Use ST_MultiPoint, ST_MultiLineString, and ST_MultiPolygon to store coordinates that define spaces occupied by features that are made up of multiple units.

- Use ST_MultiPoint when you are representing features made up of units whose locations are each referenced by an X coordinate and a Y coordinate. For example, consider a table whose rows represent island chains. The X coordinate and Y coordinate for each island has been identified. If you want the table to include these coordinates and the coordinates for each chain as a whole, define an ST_MultiPoint column to hold these coordinates.
- Use ST_MultiLineString when you are representing features made up of linear units, and you want to store the coordinates for the locations of these units and the location of each feature as a whole. For example, consider a table whose rows represent river systems. If you want the table to include coordinates for the locations of the systems and their components, define an ST_MultiLineString column to hold these coordinates.
- Use ST_MultiPolygon when you are representing features made up of multi-sided units, and you want to store the coordinates for the locations of these units and the location of each feature as a whole. For example, consider a table whose rows represent rural counties and the farms in each county. If you want the table to include coordinates for the locations of the counties and farms, define an ST_MultiPolygon column to hold these coordinates.

Multi-unit is not meant as a collection of individual entities. Rather, multi-unit refers to an aggregate of the parts that makes up the whole.

A data type for all features

You can use ST_Geometry when you are not sure which of the other data types to use.

Because ST_Geometry is the root of the hierarchy to which the other data types belong, an ST_Geometry column can contain the same kinds of data items that columns of the other data types can contain.

Attention: If you plan to use the supplied geocoder, DB2SE_USA_GEOCODER, to produce data for a spatial column, the column must be of type ST_Point or ST_Geometry. Certain visualization tools, however, do not support ST_Geometry columns, but only columns to which a proper subtype of ST_Geometry has been assigned.

Creating spatial columns

You must create spatial columns to store and retrieve spatial data.

Before you create a spatial column, your user ID must hold the authorizations that are needed for the DB2 SQL CREATE TABLE or ALTER TABLE statement. The user ID must have at least one of the following authorities or privileges:

- SYSADM or DBADM authority on the database where the table that has the column resides
- CREATETAB authority on the database and USE privilege on the table space as well as one of the following:
  - IMPLICIT_SCHEMA authority on the database, if the implicit or explicit schema of the index does not exist
  - CREATEIN privilege on the schema, if the schema name of the index refers to an existing schema
- ALTER privilege on the table to be altered
- CONTROL privilege on the table to be altered
- ALTERIN privilege on the schema of the table

This task is part of a larger task ″Setting up spatial resources for a project.″ After you choose a coordinate system and determine which spatial reference system to use for your data, you create a spatial column in an existing table or import spatial data into a new table.

To do this task... :

You can provide your database with spatial columns in one of several ways:

- Use DB2's CREATE TABLE statement to create a table and to include a spatial column within that table.
- Use DB2's ALTER TABLE statement to add a spatial column to an existing table.
- Use the Create Spatial Column window in the DB2 Control Center. Open the Spatial Columns window from a table.
- If you are importing spatial data from a shape file, use DB2 Spatial Extender to create a table and to provide this table with a column to hold the data. See ″Importing shape data to a new or existing table.″
- If you are importing spatial data from an SDE transfer file, use DB2 Spatial Extender to create a table, to provide this table with a column to hold the data, and to make the column accessible to visualization tools. See ″Importing SDE transfer data to a new or existing table.″

The next task in setting up spatial resources is "Registering spatial columns."

Registering spatial columns

Registering a spatial column creates a constraint on the table, if possible, to ensure that all geometries use the specified spatial reference system.

Prerequisites

You might want to register a spatial column in the following situations:

- Access by visualization tools

  If you want certain visualization tools—for example, ArcExplorer for DB2—to generate graphical displays of the data in a spatial column, you need to ensure the integrity of the column's data. You do this by imposing a constraint that requires all rows of the column to use the same spatial reference system. To impose this constraint, register the column, specifying both its name and the spatial reference system that applies to it.
- Access by spatial indexes

  Use the same coordinate system for all data in a spatial column on which you want to create an index to ensure that the spatial index returns the correct results. You register a spatial column to constrain all data to use the same spatial reference system and, correspondingly, the same coordinate system.

Before you register a spatial column, your user ID must hold one of the following forms of authorization:

If you are using the db2se command–line processor or an application program to import data from an SDE transfer file, you can have DB2 Spatial Extender automatically create and register a column to hold the data. In that case, your user ID must hold SYSADM or DBADM authority on the database.

To do this task... :

1. You can register a spatial column in any of the following ways: Use the Spatial Columns and Select Spatial Reference System windows of the DB2 Control Center to register the column. Issue the db2se register_spatial_column command. Run an application that invokes the db2gse.ST_register_spatial_column stored procedure. If you want to import spatial data from an SDE transfer file, you can use the Import Spatial Data window of the Control Center, the import_sde command, or the db2gse.ST_import_sde stored procedure to create a table with a spatial column, to register this column, and to import the data into the column.
2. Refer to the SRS_NAME column in the DB2GSE.GSE_GEOMETRY_COLUMNS view to check the spatial reference system you chose for a particular column after you register the column.

Chapter 10. Populating spatial columns

After you create spatial columns, and register the ones to be accessed by these visualization tools, you are ready to populate the columns with spatial data. There are three ways to supply the data: import it; use a geocoder to derive it from business data; or use spatial functions to create it or to derive it from business data or other spatial data.

About importing and exporting spatial data

You can use DB2® Spatial Extender to exchange spatial data between your database and external data sources. More precisely, you can import spatial data from external sources by transferring it to your database in files, called data exchange files. You also can export spatial data from your database to data exchange files, from which external sources can acquire it. This section suggests some of the reasons for importing and exporting spatial data, and describes the nature of the data exchange files that DB2 Spatial Extender supports.

Reasons for importing and exporting spatial data

By importing spatial data, you can obtain a great deal of spatial information that is already available in the industry. By exporting it, you can make it available in a standard file format to existing applications. Consider these scenarios:

- Your database contains spatial data that represents your sales offices, customers, and other business concerns. You want to supplement this data with spatial data that represents your organization's cultural environment—cities, streets, points of interest, and so on. The data that you want is available from a map vendor. You can use DB2 Spatial Extender to import it from a data exchange file that the vendor supplies.
- You want to migrate spatial data from an Oracle system to your DB2 environment. You proceed by using an Oracle utility to write the data to a data exchange file. You then use DB2 Spatial Extender to import the data from this file to the database that you have enabled for spatial operations.
- You are not connected to DB2, and want to use a geobrowser to show visual presentations of spatial information to customers. The browser needs only files to work from; it does not need to be connected to a database. You could use DB2 Spatial Extender to export the data to a data exchange file, and then use a browser to render the data in visual form.

Shape files and SDE transfer files

DB2 Spatial Extender supports two types of data exchange files: shape files and SDE transfer files. The term shape file actually refers to a collection of files with the same file name but different file extensions. The collection can include up to four files. They are:

- A file that contains spatial data in shape format, a de facto industry-standard format developed by ESRI. Such data is often called shape data. The extension of a file containing shape data is .shp.
- A file that contains business data that pertains to locations defined by shape data. This file's extension is .dbf.
- A file that contains an index to shape data. This file's extension is .shx.

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- A file that contains a specification of the coordinate system on which the data in a .shp file is based. This file's extension is .prj.

Shape files are often used for importing data that originates in file systems, and for exporting data to files within file systems.

When you use DB2 Spatial Extender to import shape data, you receive at least one .shp file. In most cases, you receive one or more of the other three kinds of shape files as well.

SDE transfer files are often used for importing data that originates in ESRI databases. Each file includes spatial data, a spatial reference system for this data, and business data. The spatial data, whose format is proprietary to ESRI, is intended for a table column that has been registered to the DB2 Spatial Extender catalog. The business data is targeted for other columns in the table to which the registered column belongs.

Importing spatial data

This section provides an overview of the tasks of importing shape data and SDE transfer data to your database. The section includes cross-references to specifics that you need to know (for example, processes and parameters) in order to perform these tasks.

Importing shape data to a new or existing table

You can import shape data to an existing table or view, or you can create a table and import shape data to it in a single operation.

Before you import shape data to an existing table or view, your user ID must hold one of the following forms of authorization:

- SYSADM or DBADM authority on the database that contains the table or view
- CONTROL privilege on the table or view
- The INSERT privilege on the table or view
- The SELECT privilege on the table or view (required only if the table includes an ID column that is not an IDENTITY column)
- Privileges to access the directories to which input files and error files belong
- Read privileges on the input files and write privileges on the error files

Before you begin to create a table automatically and import shape data to it, your user ID must hold the following forms of authorization:

- SYSADM, DBADM, or CREATETAB authority on the database that contains the table
- One of the following permissions:
  - CREATEIN privilege on the schema to which the table belongs (required when the schema already exists)
  - IMPLICIT_SCHEMA authority on the database that contains the table (required when the schema specified for the table does not actually exist)
- Privileges to access the directories to which input files and error files belong
- Read privileges on the input files and write privileges on the error files

Choose one of the following methods to import shape data:

- Import the shape data to a spatial column in an existing table, an existing updateable view, or an existing view on which an INSTEAD OF trigger for INSERTs is defined.
- Automatically create a table with a spatial column and import the shape data to this column.

To do this task... :

Choose the method that you want to use to import shape data:
- Use the Import Shape Data window of the DB2 Control Center.
- Issue the db2se import_shape command.
- Run an application that calls the db2gse.ST_import_shape stored procedure.

Importing SDE transfer data to a new or existing table

You can import SDE transfer data to an existing table, or you can create a table and import SDE transfer data to it in a single operation.

Before you import data to a column in an existing table or view, your user ID must hold one of the following forms of authorization:
- SYSADM or DBADM authority on the database that contains the table or view
- CONTROL privilege on the table or view
- Both the INSERT and SELECT privileges on the table or view

Before you initiate the operation to create a table automatically and import shape data to it, your user ID must hold the following forms of authorization:
- Either SYSADM, DBADM, or CREATETAB authority on the database that contains the table
- One of the following permissions:
  - CREATEIN privilege on the schema to which the table belongs (required when the schema already exists)
  - IMPLICIT_SCHEMA authority on the database that contains the table (required when the schema specified for the table does not actually exist)

Choose one of the following methods to import SDE transfer data:
- Import SDE transfer data to an existing table that includes a spatial column that is already registered to the DB2 Spatial Extender catalog. The transfer data can include spatial data for the column and business data for other columns in the table.
- Automatically create a table that has a spatial column, register this column to the catalog, and import SDE transfer data to this column as well as to the table's other columns.

To do this task... :

Choose which method to use to import SDE transfer data:
- Use the Import window of the DB2 Control Center.
- Issue the db2se import_sde command.
- Run an application that calls the db2gse.GSE_import_sde stored procedure.

Exporting spatial data

This section provides an overview of the tasks of exporting spatial data to shape and SDE transfer files. The section includes cross-references to specifics that you need to know (for example, processes and parameters) in order to perform these tasks.

Exporting data to a shapefile

You can export spatial data returned in query results to a shapefile.

Before you can export data to a shapefile, your user ID must hold the following privileges:

- The privilege to execute a subselect that returns the results that you want to export
- The privilege to write to the directory where the file to which you will be exporting data resides
- The privilege to create a file to contain the exported data (required if such a file does not already exist)

To find out what these privileges are and how to obtain them, consult your database administrator.

The spatial data that you export to a shapefile might come from sources such as a base table, a join or union of multiple tables, result sets returned when you query views, or output of a spatial function.

If a file to which you want to export data exists, DB2 Spatial Extender can append the data to this file. If such a file does not exist, you can use DB2 Spatial Extender to create one.

To do this task... :

Choose a method to export data to a shapefile:

- Initiate the export from the Export Shape File window of the DB2 Control Center.
- Issue the db2se export_shape command from the db2se command line processor.
- Run an application that calls the db2gse.ST_export_shape stored procedure.

Exporting data to an SDE transfer file

You can export a table that contains spatial data to an SDE transfer file.

Before you can export data to an SDE transfer file, your user ID must hold the following permissions:

- Either SYSADM OR DBADM authority.
- The SELECT privilege on the table that is to be exported.
- The privilege to write to the directory where the file to which you will be exporting data resides

Restrictions:

- You can export only one spatial column in each export operation.
- The columns that you export must have data types that the SDE format supports.

- The table must contain exactly one spatial column.
- This column must be registered to the DB2 Spatial Extender catalog.
- You cannot append to existing SDE files.

The table that you export cannot contain more than one spatial column. Moreover, this column must be registered to the DB2 Spatial Extender catalog. If the table contains business data, this data will be exported along with the spatial data. You can export either all rows in the table or a subset of rows. To export a subset, specify a WHERE clause that identifies the subset.

To do this task... :

Choose a method to export spatial and business data to an SDE transfer file:

- Use the Export SDE Files window of the DB2 Control Center.
- Issue the db2se export_sde command.
- Run an application that calls the db2gse.GSE_export_sde stored procedure.

How to use a geocoder

This section discusses the concept of geocoding and introduces the following tasks:

- Defining the work that you want a geocoder to do; for example, specifying how may records the geocoder should process before a commit is issued
- Setting up a geocoder to geocode data as soon as the data is added to, or updated in, a table.
- Running a geocoder in batch mode

Geocoders and geocoding

The terms geocoder and geocoding are used in several contexts. This discussion sorts out these contexts, so that the terms' meanings can be clear each time you come across the terms. The discussion defines geocoder and geocoding, describes the modes in which a geocoder operates, describes a larger activity to which geocoding belongs, and summarizes users' tasks that pertain to geocoding.

In DB2® Spatial Extender, a geocoder is a scalar function that translates existing data (the function's input) into data that you can understand in spatial terms (the function's output). Typically, the existing data is relational data that describes or names a location. For example, the geocoder that is shipped with DB2 Spatial Extender, DB2SE_USA_GEOCODER, translates United States addresses into ST_Point data. DB2 Spatial Extender can support vendor-supplied and user-supplied geocoders as well; and their input and output need not be like that of DB2SE_USA_GEOCODER. To illustrate: One vendor-supplied geocoder might translate addresses into coordinates that DB2 does not store, but rather writes to a file. Another might be able to translate the number of an office in a commercial building into coordinates that define office's location in the building, or to translate the identifier of a shelf in a warehouse into coordinates that define the shelf's location in the warehouse.

In other cases, the existing data that a geocoder translates might be spatial data. For example, a user-supplied geocoder might translate X and Y coordinates into data that conforms to one of DB2 Spatial Extender's data types.

In DB2 Spatial Extender, geocoding is simply the operation in which a geocoder translates its input into output—translating addresses into coordinates, for example.

Modes

A geocoder operates in two modes:

- In batch mode, a geocoder attempts, in a single operation, to translate all its input from a single table. For example, in batch mode, DB2SE_USA_GEOCODER attempts to translate all the addresses in a single table (or, alternatively, all addresses in a specified subset of rows in the table).
- In automatic mode, a geocoder translates data as soon as it is inserted or updated in a table. The geocoder is activated by INSERT and UPDATE triggers that are defined on the table.

Geocoding processes

Geocoding is one of several operations by which the contents of a spatial column in a DB2 table are derived from other data. This discussion refers to these operations collectively as a geocoding process. Geocoding processes can vary from geocoder to geocoder. For example, DB2SE_USA_GEOCODER searches files of known addresses to determine whether each address it receives as input matches a known address to a given degree. Because the known addresses are like reference material that people look up when they do research, these addresses are collectively called reference data. Other geocoders might not need reference data; they might verify their input in other ways. The geocoding process that DB2SE_USA_GEOCODER participates in is as follows:

1. DB2SE_USA_GEOCODER performs operations that it has been designed to carry out:
   a. DB2SE_USA_GEOCODER parses each address that it receives as input.
   b. DB2SE_USA_GEOCODER searches the reference data for street names that, to a certain degree, resemble the street name in the parsed address. It confines its search to streets within the area designated by the address's zip code.
   c. If the search is successful, DB2SE_USA_GEOCODER determines whether any address on the streets it has found match the parsed address to a certain degree.
   d. If DB2SE_USA_GEOCODER finds a match, it geocodes the parsed address. Otherwise, it returns a null.
2. If DB2SE_USA_GEOCODER geocodes the parsed address, DB2 puts the resulting coordinates in a designated spatial column.
3. If DB2SE_USA_GEOCODER is geocoding in batch mode, DB2 Spatial Extender issues a commit either (a) every time DB2SE_USA_GEOCODER finishes processing a certain number of input records or (b) after DB2SE_USA_GEOCODER finishes processing all of its input.

The user's tasks

In DB2 Spatial Extender, the tasks that pertain to geocoding are:

- Prescribing how certain parts of the geocoding process should be executed for a given spatial column; for example, setting the minimum degree to which street names in input records and street names in reference data should match; setting the minimum degree to which addresses in input records and addresses in

reference data should match; and determining how many records should be processed before each commit. This task can be referred to as setting up geocoding or setting up geocoding operations.

- Specifying that data should be automatically geocoded each time that it is added to, or updated in, a table. When automatic geocoding occurs, the instructions that the user specified when he or she set up geocoding operations will take effect (except for the instructions involving commits; they apply only to batch geocoding). This task is referred to as setting up a geocoder to run automatically.
- Running a geocoder in batch mode. If the user has set up geocoding operations already, his or her instructions will remain in effect during each batch session, unless the user overrides them. If the user has not set up geocoding operations before a given session, the user can specify that they should take effect set them up for that particular session. This task can be referred to as running a geocoder in batch mode and running geocoding in batch mode.

Setting up geocoding operations

DB2 Spatial Extender lets you set, in advance, the work that must be done when a geocoder is invoked.

Before you can set geocoding operations for a particular geocoder, your user ID must hold one of the following forms of authorization:

- SYSADM or DBADM authority on the database that contains the tables that the geocoder will operate on
- The SELECT privilege and the CONTROL or UPDATE privilege on each table that the geocoder operates on

You can specify the following parameters when a geocoder is invoked:

- What column the geocoder is to provide data for.
- Whether the input that the geocoder reads from a table or view should be limited to a subset of rows in the table or view.
- The range or number of records that the geocoder should geocode in batch sessions within a unit of work.
- Requirements for geocoder-specific operations. For example, DB2SE_USA_GEOCODER can geocode only those records that match their counterparts in the reference data to a specified degree or higher. This degree is called the minimum match score.

You must specify the parameters in the list above before you set up the geocoder to run in automatic mode. From then on, each time the geocoder is invoked (not only automatically, but also for batch runs), geocoding operations will be performed in accordance with your specifications. For example, if you specify that 45 records should be geocoded in batch mode within each unit of work, a commit will be issued after every forty-fifth record is geocoded. (Exception: You can override your specifications for individual sessions of batch geocoding.)

You do not have to establish defaults for geocoding operations before you run the geocoder in batch mode. Rather, at the time that you initiate a batch session, you can specify how the operations are to be performed for the length of the run. If you do establish defaults for batch sessions, you can override them, as needed, for individual sessions.

To do this task... :

Choose which way you want to set up geocoding operations:

- Invoke it from the Set Up Geocoding window of the DB2 Control Center.
- Issue the db2se setup_gc command.
- Run an application that calls the db2gse.ST_setup_geocoding stored procedure.

Recommendations: When DB2SE_USA_GEOCODER reads a record of address data, it tries to match that record with a counterpart in the reference data. In broad outline, the way it proceeds is as follows: First, it searches the reference data for streets whose zip code is the same as the zip code in the record. If it finds a street name that is similar to the one in the record to a certain minimum degree, or to a degree higher than this minimum, it goes on to look for an entire address. If it finds an entire address that is similar to the one in the record to a certain minimum degree, or to a degree higher than this minimum, it geocodes the record. If it does not find such an address, it returns a null.

The minimum degree to which the street names must match is referred to as spelling sensitivity. The minimum degree to which the entire addresses must match is called the minimum match score. For example, if the spelling sensitivity is 80, then the match between the street names must be at least 80 percent accurate before the geocoder will search for the entire address. If the minimum match score is 60, then the match between the addresses must be at least 60 percent accurate before the geocoder will geocode the record.

You can specify what the spelling sensitivity and minimum match score should be. Be aware that you might need to adjust them. For example, suppose that the spelling sensitivity and minimum match score are both 95. If the addresses that you want geocoded have not been carefully validated, matches of 95 percent accuracy are highly unlikely. As a result, the geocoder is likely to return a null when it processes these records. In such a case, it is advisable to lower the spelling sensitivity and minimum match score, and run the geocoder again. Recommended scores for spelling sensitivity and the minimum match score are 70 and 60, respectively.

As noted at the start of this discussion, you can determine whether the input that the geocoder reads from a table or view should be limited to a subset of rows in the table or view. For example, consider the following scenarios :

- You invoke the geocoder to geocode addresses in a table in batch mode. Unfortunately, the minimum match score is too high, causing the geocoder to return a null when it processes most of the addresses. You reduce the minimum match score when you run the geocoder again. To limit its input to those addresses that were not geocoded, you specify that it should select only those rows that contain the null that it had returned earlier.
- The geocoder selects only rows that were added after a certain date.
- The geocoder selects only rows that contain addresses in a particular area; for example, a block of counties or a state.

As noted at the start of this discussion, you can determine the number of records that the geocoder should process in batch sessions within a unit of work. You can have the geocoder process the same number of records in each unit of work, or you can have it process all the records of a table within a single unit of work. If you choose the latter alternative, be aware that:

- You have less control over the size of the unit of work than the former alternative affords. Consequently, you cannot control how many locks are held or how many log entries are made as the geocoder operates.
- If the geocoder encounters an error that necessitates a rollback, you need to run the geocoder to run against all the records again. The resulting cost in resources can be expensive if the table is extremely large and the error and rollback occur after most records have been processed.

Setting up a geocoder to run automatically

You can set up a geocoder to automatically translate data as soon as the data is added to, or updated in, a table.

Before you can set up a geocoder to run automatically:

- You must set up geocoding operations for each spatial column that is to be populated by output from the geocoder.
- Your user ID must hold the following forms of authorization:
  - SYSADM or DBADM authority on the database that contains the table on which triggers to invoke the geocoder will be defined
  - One or more privileges on this table:
    - The CONTROL privilege.
    - If you do not have the CONTROL privilege, you need the ALTER, SELECT, and UPDATE privileges.
  - The privileges required to create triggers on this table.

You can set up a geocoder to run automatically before you invoke it in batch mode. Therefore, it is possible for automatic geocoding to precede batch geocoding. If that happens, the batch geocoding is likely to involve processing the same data that was processed automatically. This redundancy will not result in duplicate data, because when spatial data is produced twice, the second yield of data overrides the first. However, it can degrade performance.

Before you decide whether to geocode the address data within a table in batch mode or automatic mode, consider that:

- Performance is better in batch geocoding than in automatic geocoding. A batch session opens with one initialization and ends with one cleanup. In automatic geocoding, each data item is geocoded in a single operation that begins with initialization and concludes with cleanup.
- On the whole, a spatial column populated by means of automatic geocoding is likely to be more up to date than a spatial column populated by means of batch geocoding. After a batch session, address data can accumulate and remain ungeocoded until the next session. But if automatic geocoding is already enabled, address data is geocoded as soon as it is stored in the database.

To do this task... :

Choose which method to use to set up automatic geocoding:

- Do so from either the Set Up Geocoding window or the Geocoding window of the DB2 Control Center.
- Issue the db2se enable_autogc command.
- Run an application that calls the db2gse.ST_enable_autogeocoding stored procedure.

Running a geocoder in batch mode

When you run a geocoder in batch mode, you translate multiple records into spatial data that goes into a specific column.

Before you can run a geocoder in batch mode, your user ID must hold one of the following forms of authorization:

- SYSADM or DBADM authority on the database that contains the table whose data is to be geocoded
- The CONTROL or UPDATE privilege on this table
-

You also need the SELECT privilege on this table, so that you can specify the number of records to be processed before each commit. If you specify WHERE clauses to limit the rows on which the geocoder is to operate, you might also require the SELECT privilege on any tables and views that you reference in these clauses. Ask your database administrator.

At any time before you run a geocoder to populate a particular spatial column, you can set up geocoding operations for that column. Setting up the operations involves specifying how certain requirements are to be met when the geocoder is run. For example, suppose that you require DB2 Spatial Extender to issue a commit after every 100 input records are processed by the geocoder. When you set up the operations, you would specify 100 as the required number.

When you are ready to run the geocoder, you can override any of the values that you specified when you set up operations. Your overrides will remain in effect only for the length of the run.

If you do not set up operations, you must, each time you are ready to run the geocoder, specify how the requirements are to be met during the run.

To do this task... :

Choose how to invoke a geocoder to run in batch mode:

- Invoke it from the Run Geocoding window of the DB2 Control Center.
- Issue the db2se run_gc command.
- Run an application that calls the db2gse.ST_run_geocoding stored procedure.

Chapter 11. Using indexes and views to access spatial data

Before you query spatial columns, you can create indexes and views that will facilitate access to them. This chapter:

- Describes the nature of the indexes that Spatial Extender uses to expedite access to spatial data
- Explains how to create such indexes
- Explains how to use views to access spatial data

Types of spatial indexes

Good query performance is related to having efficient indexes defined on the columns of the base tables in a database. The performance of the query is directly related to how quickly values in the column can be found during the query. Queries that use an index can execute more quickly and can provide a significant performance improvement.

Spatial queries are typically queries that involve two or more dimensions. For example, in a spatial query you might want to know if a point is included within an area (polygon). Due to the multidimensional nature of spatial queries, the DB2® native B-tree indexing is inefficient for these queries.

Spatial queries can use the following types of indexes:

- Spatial grid indexes

  DB2 Spatial Extender's indexing technology utilizes *grid indexing*, which is designed to index multi-dimensional spatial data, to index spatial columns. DB2 Spatial Extender provides a grid index that is optimized for two-dimensional data on a flat projection of the Earth.
- Geodetic Voronoi indexes

  DB2 Geodetic Data Management Feature provides support for a new spatial access method that enables you to create indexes on columns containing multi-dimensional geodetic data. A geodetic Voronoi index is more suitable than a grid index for geodetic data because it treats the Earth as a continuous sphere with no distortions around the poles or edges at the 180th meridian.

Spatial grid indexes

Indexes improve application query performance, especially when the queried table or tables contain many rows. If you create appropriate indexes that the query optimizer chooses to run your query, you can greatly reduce the number of rows to process.

DB2 Spatial Extender provides a grid index that is optimized for two dimensional data. The index is created on the X and Y dimensions of a geometry.

The following aspects of a grid index are helpful to understand:

- The generation of the index
- The use of spatial functions in a query
- How a query uses a spatial grid index

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Generation of spatial grid indexes

Spatial Extender generates a spatial grid index using the minimum bounding rectangle (MBR) of a geometry.

For most geometries, the MBR is a rectangle that surrounds the geometry.

A spatial grid index divides a region into logical square grids with a fixed size that you specify when you create the index. The spatial index is constructed on a spatial column by making one or more entries for the intersections of each geometry's MBR with the grid cells. An index entry consists of the grid cell identifier, the geometry MBR, and the internal identifier of the row that contains the geometry.

You can define up to three spatial index levels (grid levels). Using several grid levels is beneficial because it allows you to optimize the index for different sizes of spatial data.

If a geometry intersects four or more grid cells, the geometry is promoted to the next larger level. In general, the larger geometrys will be indexed at the larger levels. If a geometry intersects 10 or more grid cells at the largest grid size, a system-defined overflow index level is used. This overflow level prevents the generation of too many index entries. For best performance, define your grid sizes to avoid the use of this overflow level.

For example, if multiple grid levels exist, the indexing algorithm attempts to use the lowest grid level possible to provide the finest resolution for the indexed data. When a geometry intersects more than four grid cells at a given level, it is promoted to the next higher level, (provided that there is another level). Therefore, a spatial index that has the three grid levels of 10.0, 100.0, and 1000.0 will first intersect each geometry with the level 10.0 grid. If a geometry intersects with more than four grid cells of size 10.0, it is promoted and intersected with the level 100.0 grid. If more than four intersections result at the 100.0 level, the geometry is promoted to the 1000.0 level. If more than 10 intersections result at the 1000.0 level, the geometry is indexed in the overflow level.

Use of spatial functions in a query

The DB2 optimizer considers a spatial grid index for use when a query contains one the following functions in its WHERE clause:

- ST_Contains
- ST_Crosses
- ST_Distance
- ST_EnvIntersects
- EnvelopesIntersect
- ST_Equals
- ST_Intersects
- ST_MBRIntersects
- ST_Overlaps
- ST_Touches
- ST_Within

How a query uses a spatial grid index

When the query optimizer chooses a spatial grid index, the query execution uses a multiple-step filter process.

The filter process includes the following steps:

1. Determine the grid cells that intersect the query window. The *query window* is the geometry that you are interested in and that you specify as the second parameter in a spatial function (see examples below).
2. Scan the index for entries that have matching grid cell identifiers.
3. Compare the geometry MBR values in the index entries with the query window and discard any values that are outside the query window.
4. Perform further analysis as appropriate. The candidate set of geometries from the previous steps might undergo further analysis to determine if they satisfy the spatial function (ST_Contains, ST_Distance, and so on). The spatial function EnvelopesIntersect omits this step and typically has the best performance.

The following examples of spatial queries have a spatial grid index on the column C.GEOMETRY:

```
SELECT name
FROM counties AS c
WHERE EnvelopesIntersect(c.geometry, -73.0, 42.0, -72.0, 43.0, 1) = 1

SELECT name
FROM counties AS c
WHERE ST_Intersects(c.geometry, :geometry2) = 1
```

In the first example, the four coordinate values define the query window. These coordinate values specify the lower-left and upper-right corners (42.0 –73.0 and 43.0 –72.0) of a rectangle.

In the second example, Spatial Extender computes the MBR of the geometry specified by the host variable :geometry2 and uses it as the query window.

When you create a spatial grid index, you should specify appropriate grid sizes for the most common query window sizes that your spatial application is likely to use. If a grid size is larger, index entries for geometries that are outside of the query window must be scanned because they reside in grid cells that intersect the query window, and these extra scans degrade performance. However, a smaller grid size might generate more index entries for each geometry and more index entries must be scanned, which also degrades query performance.

DB2 Spatial Extender provides an Index Advisor utility that analyzes the spatial column data and suggests appropriate grid sizes for typical query window sizes.

Considerations for number of index levels and grid sizes

Use the Index Advisor to determine appropriate grid sizes for your spatial grid indexes because it is the best way to tune the indexes and make your spatial queries most efficient.

Number of grid levels

You can have up to three grid levels.

For each grid level in a spatial grid index, a separate index search is performed during a spatial query. Therefore, if you have more grid levels, your query is less efficient.

If the values in the spatial column are about the same relative size, use a single grid level. However, a typical spatial column does not contain geometries of the same relative size, but geometries in a spatial column can be grouped according to size. You should correspond your grid levels with these geometry groupings.

For example, suppose you have a table of county land parcels with a spatial column that contains groupings of small urban parcels surrounded by larger rural parcels. Because the sizes of the parcels can be grouped into two groups (small urban ones and larger rural ones), you would specify two grid levels for the spatial grid index.

Grid cell sizes

The general rule is to decrease the grid sizes as much as possible to get the finest resolution while minimizing the number of index entries.

- A small value should be used for the finest grid size to optimize the overall index for small geometries in the column. This avoids the overhead of evaluating geometries that are not within the search area. However, the finest grid size also produces the highest number of index entries. Consequently, the number of index entries processed at query time increases, as does the amount of storage needed for the index. These factors reduce overall performance.
- Using larger grid sizes, the index can be optimized further for larger geometries. The larger grid sizes produce fewer index entries for large geometries than the finest grid size would. Consequently, storage requirements for the index are reduced, increasing overall performance.

The following figures show the effects of different grid sizes.

Figure 13 on page 85 shows a map of land parcels, each parcel represented by a polygon geometry. The black rectangle represents a query window. Suppose you want to find all of the geometries whose MBR intersects the query window. Figure 13 on page 85 shows that 28 geometries (highlighted in pink) have an MBR that intersects the query window.

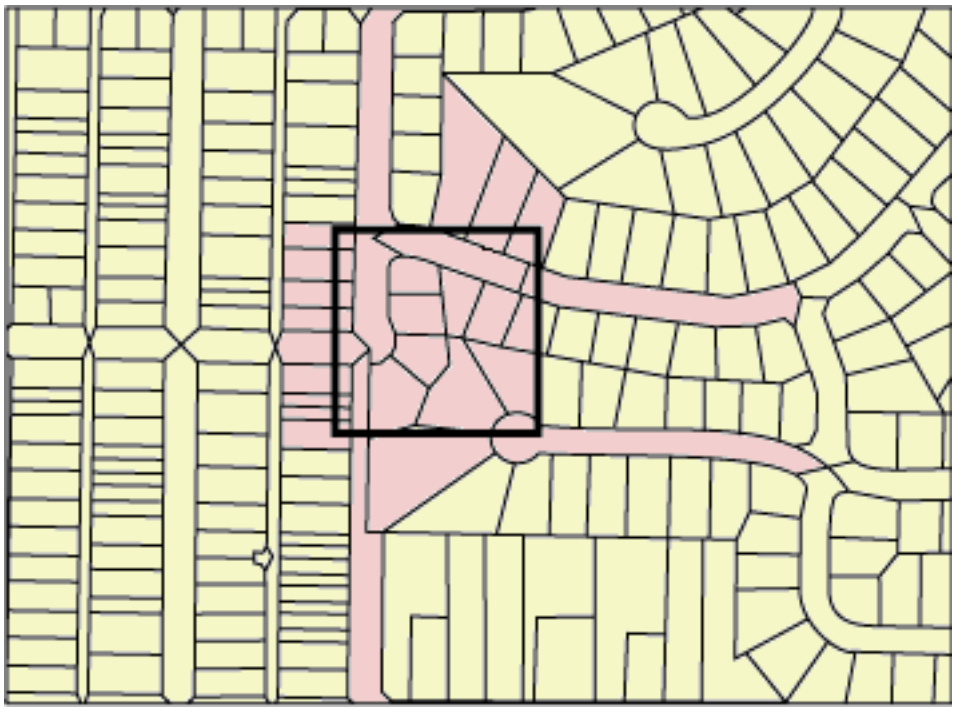


Figure 13. Land parcels in a neighborhood

Figure 14 on page 86 shows a small grid size (25) that provides a close fit to the query window.

- The query returns only the 28 geometries that are highlighted, but the query must examine and discard three additional geometries whose MBRs intersect the query window.
- This small grid size results in many index entries per geometry. During execution, the query accesses all index entries for these 31 geometries. Figure 14 on page 86 shows 256 grid cells that overlay the query window. However, the query execution accesses 578 index entries because many geometries are indexed with the same grid cells.

For this query window, this small grid size results in an excessive number of index entries to scan.

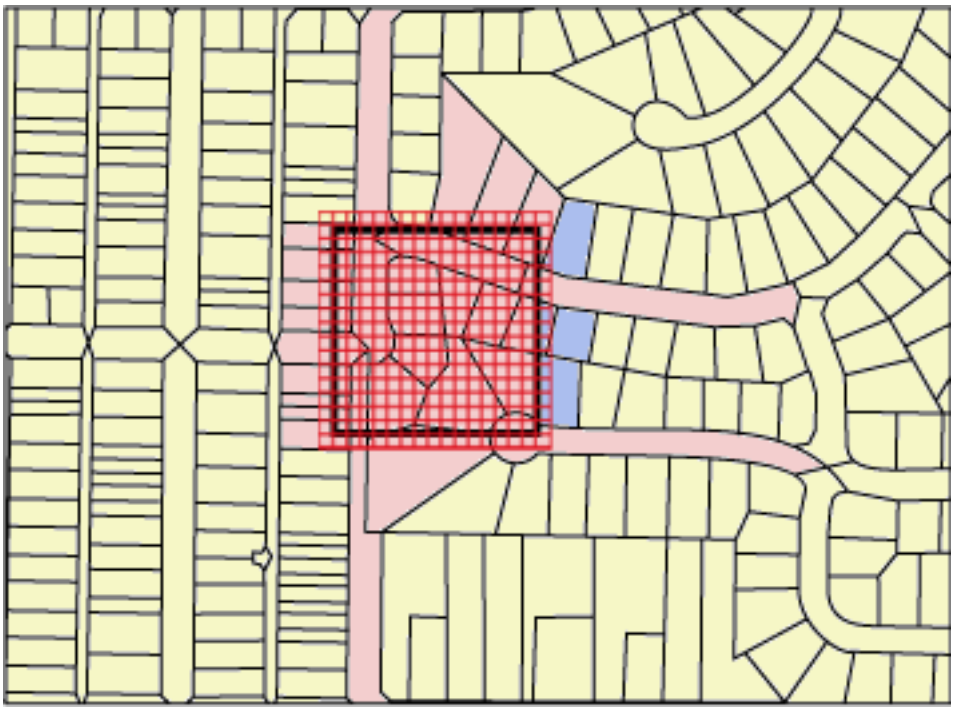


Figure 14. Small grid size (25) on land parcels

Figure 15 on page 87 shows a large grid size (400) that encompasses a considerably larger area with many more geometries than the query window.

- This large grid size results in only one index entry per geometry, but the query must examine and discard 59 additional geometries whose MBRs intersect the grid cell.
- During execution, the query accesses all index entries for the 28 geometries that intersect the query window, plus the index entries for the 59 additional geometries, for a total of 112 index entries.

For this query window, this large grid size results in an excessive number of geometries to examine.

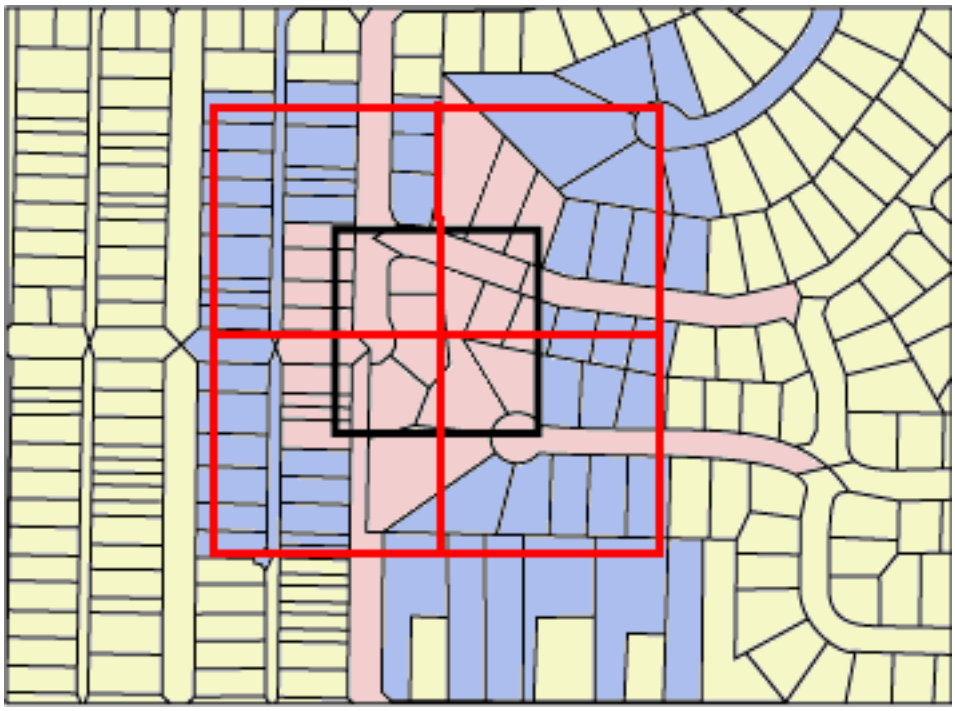


Figure 15. Large grid size (400) on land parcels

Figure 16 on page 88 shows a medium grid size (100) that provides a close fit to the query window.

- The query returns only the 28 geometries that are highlighted, but the query must examine and discard five additional geometries whose MBRs intersect the query window.
- During execution, the query accesses all index entries for the 28 geometries that intersect the query window, plus the index entries for the 5 additional geometries, for a total of 91 index entries.

For this query window, this medium grid size is the best because it results in significantly fewer index entries than the small grid size and the query examines fewer additional geometries than the large grid size.

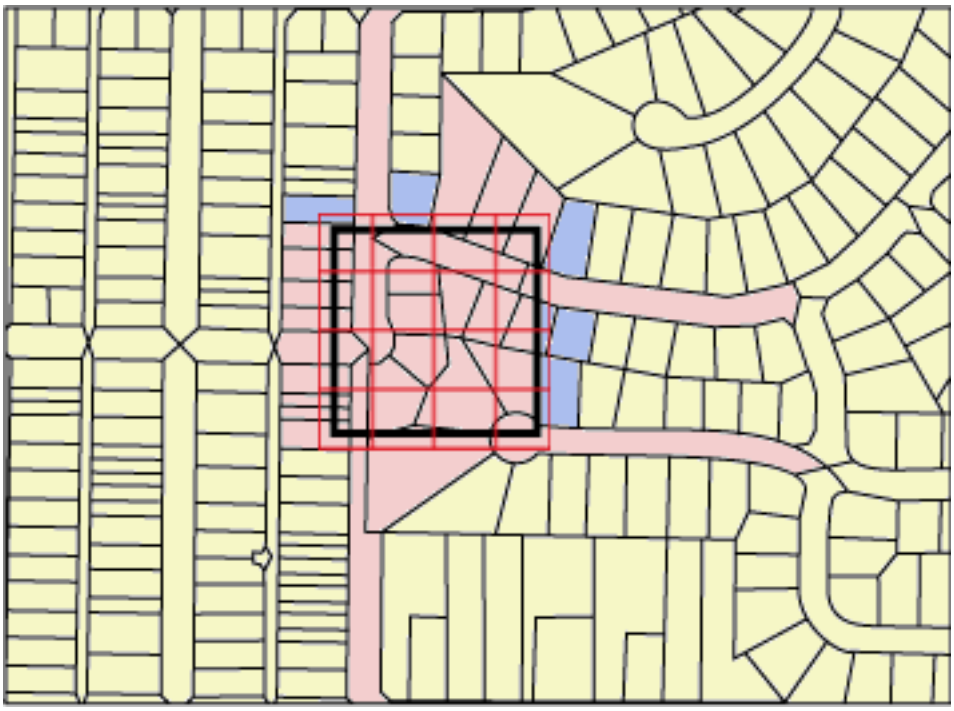


Figure 16. Medium grid size (100) on land parcels

Creating spatial grid indexes

Create spatial grid indexes to define two-dimensional grid indexes on spatial columns to help optimize spatial queries.

Before you create a spatial grid index:

- Your user ID must hold the authorizations that are needed for the DB2 SQL CREATE INDEX statement. The user ID must have at least one of the following authorities or privileges:
  - SYSADM or DBADM authority on the database where the table that has the column resides
  - Both of the following authorities or privileges:
    - One of the following table privileges:
      - CONTROL privilege on the table
      - INDEX privilege on the table
    - One of the following authorizations or privileges on the schema:
      - IMPLICIT_SCHEMA authority on the database, if the implicit or explicit schema of the index does not exist
      - CREATEIN privilege on the schema, if the schema name of the index refers to an existing schema
- You must know the values that you want to specify for the fully qualified spatial grid index name and the three grid sizes that the index will use.

Recommendations:

- Before you create a spatial grid index on a column, use the Index Advisor to determine the parameters for the index. The Index Advisor can analyze the spatial column data and suggest appropriate grid sizes for your spatial grid index.
- If you plan to do an initial load of data into the column, you should create the spatial grid index after you complete the load process. That way, you can choose optimal grid cell sizes that are based on the characteristics of the data by using the Index Advisor. In addition, loading the data before creating the index will improve the performance of the load process because then the spatial grid index does not need to be maintained during the load process.

Restriction:
The same restrictions for creating indexes using the CREATE INDEX statement are in effect when you create a spatial grid index. That is, the column on which you create an index must be a base table column, not a view column or a nickname column. The DB2 database system will resolve aliases in the process.

You create spatial grid indexes to improve the performance of queries on spatial columns.

When you create a spatial grid index, you give it the following information:
- A name
- The name of the spatial column on which it is to be defined
- The combination of the three grid sizes helps optimize performance by minimizing the total number of index entries and the number of index entries that need to be scanned to satisfy a query.

You can create a spatial grid index in one of the following ways:
- Use the Spatial Extender window of the DB2 Control Center.
- Use the SQL CREATE INDEX statement with the db2gse.spatial_index extension in the EXTEND USING clause.
- Use a GIS tool that works with DB2 Spatial Extender. If you use such a tool to create the index, the tool will issue the appropriate SQL CREATE INDEX statement.

This topic presents the steps for the first two methods. For information about using a GIS tool to create a spatial grid index, see the documentation that comes with that tool.

To do this task... :

Creating a spatial grid index using SQL CREATE INDEX

1. Determine the CREATE INDEX statement using the EXTEND USING clause and the db2gse.spatial_index grid index extension. For example, the following statement creates the spatial grid index TERRIDX for table BRANCHES that has a spatial column TERRITORY.

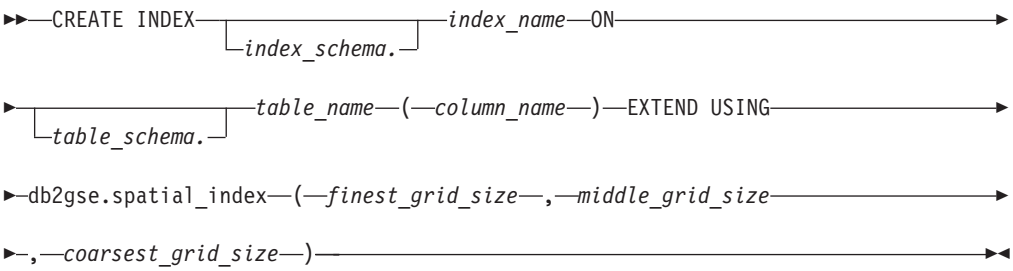
   ```
   CREATE INDEX terridx
      ON branches (territory)
      EXTEND USING db2gse.spatial_index (1.0, 10.0, 100.0)
   ```

2. Issue the CREATE INDEX command on the DB2 Command Editor, the DB2 Command Window, or the DB2 command line processor.

CREATE INDEX statement for a spatial grid index

Use the CREATE INDEX statement with the EXTEND USING clause to create a spatial grid index.

Syntax



Parameters

index_schema.
Name of the schema to which the index that you are creating is to belong. If you do not specify a name, the DB2 database system uses the schema name that is stored in the CURRENT SCHEMA special register.

index_name
Unqualified name of the grid index that you are creating.

table_schema.
Name of the schema to which the table that contains *column_name* belongs. If you do not specify a name, DB2 uses the schema name that is stored in the CURRENT SCHEMA special register.

table_name
Unqualified name of the table that contains *column_name*.

column_name
Name of the spatial column on which the spatial grid index is created.

finest_grid_size, middle_grid_size, coarsest_grid_size
Grid sizes for the spatial grid index. These parameters must adhere to the following conditions:

- *finest_grid_size* must be larger than 0.
- *middle_grid_size* must either be larger than *finest_grid_size* or be 0.
- *coarsest_grid_size* must either be larger than *middle_grid_size* or be 0.

Whether you create the spatial grid index using the Control Center or the CREATE INDEX statement, the validity of the grid sizes are checked when the first geometry is indexed. Therefore, if the grid sizes that you specify do not meet the conditions of their values, an error condition is raised at the times described in these situations:

- If all of the geometries in the spatial column are null, Spatial Extender successfully creates the index without verifying the validity of the grid sizes. Spatial Extender validates the grid sizes when you insert or update a non-null geometry in that spatial column. If the specified grid sizes are not valid, an error occurs when you insert or update the non-null geometry.

- If non-null geometries exist in the spatial column when you create the index, Spatial Extender validates the grid sizes at that time. If the specified grid sizes are not valid, an error occurs immediately, and the spatial grid index is not created.

Example

The following example CREATE INDEX statement creates the TERRIDX spatial grid index on the spatial column TERRITORY in the BRANCHES table:

```
CREATE INDEX terridx
   ON branches (territory)
   EXTEND USING db2gse.spatial_index (1.0, 10.0, 100.0)
```

Tuning spatial grid indexes with the Index Advisor

Tuning spatial grid indexes with the Index Advisor—Overview

DB2® Spatial Extender provides a utility, called the Index Advisor, that you can use to:

- Determine appropriate grid sizes for your spatial grid indexes.

  The Index Advisor analyzes the geometries in a spatial column and recommends optimal grid sizes for your spatial grid index.
- Analyze an existing grid index.

  The Index Advisor can collect and display statistics from which you can determine how well the current grid cell sizes facilitate retrieval of the spatial data.

Determining grid sizes for a spatial grid index

Prerequisites

Before you can analyze the data that you want to index:

- Your user ID must hold the SELECT privilege on this table.
- If your table has more than one million rows, you might want to use the ANALYZE clause to analyze a subset of the rows to have reasonable processing time. You must have a USER TEMPORARY table space available to use the ANALYZE clause. Set the page size of this table space to at least 8 KB and ensure that you have USE privileges on it. For example, the following DDL statements create a buffer pool with the same page size as the user temporary table space and grant the USE privilege to anyone:

  ```
  CREATE BUFFERPOOL bp8k  SIZE 1000 PAGESIZE 8 K;
  CREATE USER TEMPORARY TABLESPACE usertempts
     PAGESIZE 8K
     MANAGED BY SYSTEM USING ('c:\tempts')
     BUFFERPOOL bp8k
  GRANT USE OF TABLESPACE usertempts TO PUBLIC;
  ```

  Alternatively, you can use the DB2 Control Center to create a user table space and the corresponding buffer pool.

Before you create a spatial grid index on a column, you can use the Index Advisor to determine appropriate grid sizes.

To do this task... :

To determine appropriate grid sizes for a spatial grid index:

1. Ask the Index Advisor to recommend grid cell sizes for the index that you want to create.
   a. Enter the command that invokes the Index Advisor with the ADVISE keyword to request grid cell sizes. For example, to invoke the Index Advisor for the SHAPE column in the COUNTIES table, enter:

      ```
      gseidx CONNECT TO mydb USER userID USING password GET GEOMETRY
      STATISTICS FOR COLUMN userID.counties(shape) ADVISE
      ```

      Restriction: If you enter the above gseidx command from an operating system prompt, you must type the entire command on a single line. Alternatively, you can run gseidx commands from a CLP file, which allows you to split the command over multiple lines.

      The Index Advisor returns recommended grid cell sizes. For example, the above gseidx command with the ADVISE keyword returns the following recommended cell sizes for the SHAPE column:

      ```
      Query Window Size  Suggested Grid Sizes             Cost
      -----------------  --------------------------       ----
             0.1          0.7,       2.8,      14.0        2.7
             0.2          0.7,       2.8,      14.0        2.9
             0.5          1.4,       3.5,      14.0        3.5
               1          1.4,       3.5,      14.0        4.8
               2          1.4,       3.5,      14.0        8.2
               5          1.4,       3.5,      14.0         24
              10          2.8,       8.4,      21.0         66
              20          4.2,      14.7,      37.0        190
              50          7.0,      14.0,      70.0        900
             100         42.0,         0,         0       2800
      ```

   b. Choose an appropriate query window size from the gseidx output, based on the width of the coordinates that you display on your screen.

      In this example, latitude and longitude values in decimal degrees represent the coordinates. If your typical map display has a width of about 0.5 degrees (approximately 55 kilometers), go to the row that has the value 0.5 in the Query Window Size column. This row has suggested grid sizes of 1.4, 3.5, and 14.0.

2. Create the index with the suggested grid sizes. For the example in the previous step, you can execute the following SQL statement:

   ```
   CREATE INDEX counties_shape_idx ON userID.counties(shape)
   EXTEND USING DB2GSE.SPATIAL_INDEX(1.4,3.5,14.0);
   ```

Analyzing spatial grid index statistics

Prerequisites

Before you can analyze the data that you want to index:

- Your user ID must hold the SELECT privilege on this table.
- If your table has more than one million rows, you might want to use the ANALYZE clause to analyze a subset of the rows to have reasonable processing time. You must have a USER TEMPORARY table space available to use the ANALYZE clause. Set the page size of this table space to at least 8 KB and ensure that you have USE privileges on it. For example, the following DDL statements create a buffer pool with the same page size as the user temporary table space and grant the USE privilege to anyone:

  ```
  CREATE BUFFERPOOL bp8k  SIZE 1000 PAGESIZE 8 K;
  CREATE USER TEMPORARY TABLESPACE usertempts
     PAGESIZE 8K
  ```

```
    MANAGED BY SYSTEM USING ('c:\tempts')
    BUFFERPOOL bp8k
GRANT USE OF TABLESPACE usertempts TO PUBLIC;
```

Alternatively, you can use the DB2 Control Center to create a user table space and the corresponding buffer pool.

Statistics on an existing spatial grid index can tell you whether the index is efficient, or whether it should be replaced by a more efficient index. Use the Index Advisor to obtain these statistics and, if necessary, to replace the index.

Tip: Equally important to tuning your index is verifying that it is being used by your queries. To determine if a spatial index is being used, run Visual Explain in the DB2 Control Center or a command line tool such db2exfmt on your query. In the "Access Plan" section of the explain output, if you see an EISCAN operator and the name of your spatial index, then the query uses your index.

To do this task... :

Obtain statistics on a spatial grid index and, if necessary, to replace the index:

1. Have the Index Advisor collect statistics based on the grid cell sizes of the existing index. You can ask for statistics on either a subset of the indexed data or all of the data.
   - To obtain statistics on indexed data in a subset of rows, enter the gseidx command and specify the ANALYZE keyword and its parameters in addition to the existing-index clause and DETAIL keyword. You can specify either the number or percentage of rows that the Index Advisor is to analyze to obtain statistics. For example, to obtain statistics on a subset of the data indexed by the COUNTIES_SHAPE_IDX index, enter:

     ```
     gseidx CONNECT TO mydb USER userID USING password GET GEOMETRY
     STATISTICS FOR INDEX userID.counties_shape_idx DETAIL ANALYZE 25 PERCENT
      ADVISE
     ```

   - To obtain statistics on all indexed data, enter the gseidx command and specify its existing-index clause. Include the DETAIL keyword. For example, to invoke the Index Advisor for the COUNTIES_SHAPE_IDX index, enter:

     ```
     gseidx CONNECT TO mydb USER userID USING password GET GEOMETRY
     STATISTICS FOR INDEX userID.counties_shape_idx DETAIL SHOW HISTOGRAM ADVISE
     ```

   The Index Advisor returns statistics, a histogram of the data, and recommended cell sizes for the existing index. For example, the above gseidx command for all data indexed by COUNTIES_SHAPE_IDX returns the following statistics:

```
Grid Level 1
------------

Grid Size                     : 0.5
Number of Geometries          : 2936
Number of Index Entries       : 12197

Number of occupied Grid Cells : 2922
Index Entry/Geometry ratio    : 4.154292
Geometry/Grid Cell ratio      : 1.004791
Maximum number of Geometries per Grid Cell: 14
Minimum number of Geometries per Grid Cell: 1

Index Entries :  1      2      3      4      10
---------------  ------ ------ ------ ------ ------
Absolute      :  86     564    72     1519   695
Percentage (%):  2.93   19.21  2.45   51.74  23.67
```

```
Grid Level 2
------------

Grid Size                     : 0.0
No geometries indexed on this level.


Grid Level 3
------------

Grid Size                     : 0.0
No geometries indexed on this level.


Grid Level X
------------

Number of Geometries          : 205
Number of Index Entries       : 205
```

2. Determine how well the grid cell sizes of the existing index facilitate retrieval. Assess the statistics returned in the previous step.

   Tip:

   - The statistic "Index Entry/Geometry ratio" should be a value in the range of 1 to 4, preferably values closer to 1.
   - The number of index entries per geometry should be less that 10 at the largest grid size to avoid the overflow level.

     The appearance of the "Grid Level X" section in the Index Advisor output indicates that an overflow level exists.

   The index statistics obtained in the previous step for the COUNTIES_SHAPE_IDX indicate that the grid sizes (0.5, 0, 0) are not appropriate for the data in this column because:

   - For Grid Level 1, the "Index Entry/Geometry ratio"value `4.154292` is greater than the guideline of 4.

     The "Index Entries" line has the values 1, 2, 3, 4, and 10, which indicates the number of index entries per geometry. The "Absolute" values below each "Index Entries" column indicates the number of geometries that have that specific number of index entries. For example, the output in the previous step shows 1519 geometries have 4 index entries. The "Absolute" value for 10 index entries is 695 which indicates that 695 geometries have between 5 and 10 index entries.
   - The appearance of the "Grid Level X" section indicates that an overflow index level exists. The statistics show that 205 geometries have more than 10 index entries each.

3. If the statistics are not satisfactory, look at the Histogram section and the appropriate rows in the Query Window Size and Suggested Grid Sizes columns in the Index Advisor output.

   a. Find the MBR size with the largest number of geometries. The "Histogram" section lists the MBR sizes and the number of geometries that have that MBR size. In the following sample histogram, the largest number of geometries (437) is in MBR size 0.5.

      ```
      Histogram:
      ----------
          MBR Size             Geometry Count
      ```

```
------------------- -------------------
           0.040000                   1
           0.045000                   3
           0.050000                   1
           0.055000                   3
           0.060000                   3
           0.070000                   4
           0.075000                   3
           0.080000                   4
           0.085000                   1
           0.090000                   2
           0.095000                   1
           0.150000                  10
           0.200000                   9
           0.250000                  15
           0.300000                  23
           0.350000                  83
           0.400000                 156
           0.450000                 282
           0.500000                 437
           0.550000                 397
           0.600000                 341
           0.650000                 246
           0.700000                 201
           0.750000                 154
           0.800000                 120
           0.850000                  66
           0.900000                  79
           0.950000                  59
           1.000000                  47
           1.500000                 230
           2.000000                  89
           2.500000                  34
           3.000000                  10
           3.500000                   5
           4.000000                   3
           5.000000                   3
           5.500000                   2
           6.000000                   2
           6.500000                   3
           7.000000                   2
           8.000000                   1
          15.000000                   3
          25.000000                   2
          30.000000                   1
```

b. Go to the Query Window Size row with the value 0.5 to obtain the suggested grid sizes (1.4, 3.5, 14.0).

```
Query Window Size  Suggested Grid Sizes            Cost
-----------------  -------------------------      ----
              0.1          0.7,       2.8,      14.0       2.7
              0.2          0.7,       2.8,      14.0       2.9
              0.5          1.4,       3.5,      14.0       3.5
                1          1.4,       3.5,      14.0       4.8
                2          1.4,       3.5,      14.0       8.2
                5          1.4,       3.5,      14.0        24
               10          2.8,       8.4,      21.0        66
               20          4.2,      14.7,      37.0       190
               50          7.0,      14.0,      70.0       900
              100         42.0,         0,         0      2800
```

4. Verify that the recommended sizes meet the guidelines in step 2. Run the gseidx command with the suggested grid sizes:

```
gseidx CONNECT TO mydb USER userID USING  password GET GEOMETRY
 STATISTICS FOR COLUMN userID.counties(shape) USING GRID SIZES (1.4, 3.5, 14.0)
```

```
Grid Level 1
------------

Grid Size                     : 1.4
Number of Geometries          : 3065
Number of Index Entries       : 5951

Number of occupied Grid Cells : 513
Index Entry/Geometry ratio    : 1.941599
Geometry/Grid Cell ratio      : 5.974659
Maximum number of Geometries per Grid Cell: 42
Minimum number of Geometries per Grid Cell: 1

Index Entries :  1      2      3      4      10
---------------  ------ ------ ------ ------ ------
Absolute      :  1180   1377   15     493    0
Percentage (%):  38.50  44.93  0.49   16.08  0.00


Grid Level 2
------------

Grid Size                     : 3.5
Number of Geometries          : 61
Number of Index Entries       : 143

Number of occupied Grid Cells : 56
Index Entry/Geometry ratio    : 2.344262
Geometry/Grid Cell ratio      : 1.089286
Maximum number of Geometries per Grid Cell: 10
Minimum number of Geometries per Grid Cell: 1

Index Entries :  1      2      3      4      10
---------------  ------ ------ ------ ------ ------
Absolute      :  15     28     0      18     0
Percentage (%):  24.59  45.90  0.00   29.51  0.00


Grid Level 3
------------

Grid Size                     : 14.0
Number of Geometries          : 15
Number of Index Entries       : 28

Number of occupied Grid Cells : 9
Index Entry/Geometry ratio    : 1.866667
Geometry/Grid Cell ratio      : 1.666667
Maximum number of Geometries per Grid Cell: 10
Minimum number of Geometries per Grid Cell: 1

Index Entries :  1      2      3      4      10
---------------  ------ ------ ------ ------ ------
Absolute      :  7      5      1      2      0
Percentage (%):  46.67  33.33  6.67   13.33  0.00
```

The statistics now show values within the guidelines:

- The “Index Entry/Geometry ratio” values are 1.941599 for Grid Level 1, 2.344262 for Grid Level 2, and 1.866667 for Grid Level 3. These values are all within the guideline value range of 1 to 4.
- The absence of the “Grid Level X” section indicates that no index entries are in the overflow level.

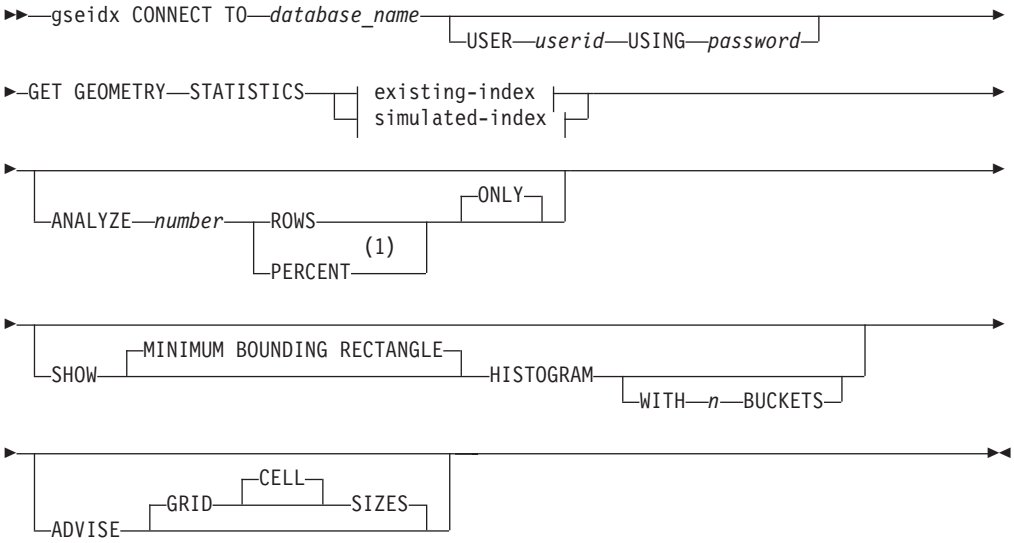
5. Drop the existing index and replace it with an index that specifies the advised grid sizes. For the sample in the previous step, run the following DDL statements:

```
DROP INDEX userID.counties_shape_idx;
CREATE INDEX counties_shape_idx ON userID.counties(shape) EXTEND USING
  DB2GSE.SPATIAL_INDEX(1.4,3.5,14.0);
```

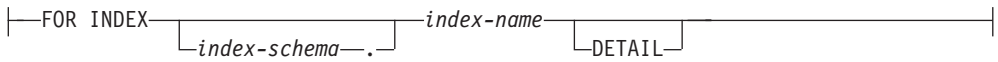
The gseidx command

Use the gseidx command to invoke the Index Advisor for spatial grid indexes.

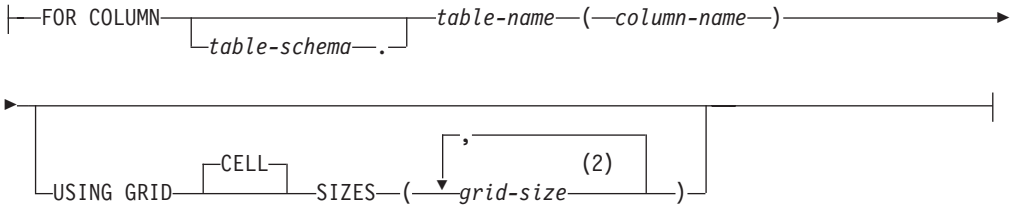
Syntax



existing-index:



simulated-index:



Notes:

1 Instead of the PERCENT keyword, you can specify a percentage sign (%).

2 You can specify cell sizes for one, two, or three grid levels.

Parameters

database_name
The name of the database in which the spatial table resides.

userid The user ID that has either SYSADM or DBADM authority on the database in which the index or table resides or SELECT authority on the table. If you log on to the DB2 command environment with the user ID of the database owner, you do not need to specify *userid* and *password* in the gseidx command.

password
Password for the user ID.

existing-index

References an existing index to gather statistics on.

index-schema
Name of the schema that includes the existing index.

index-name
Unqualified name of the existing index.

DETAIL
Shows the following information about each grid level:

- The size of the grid cells
- The number of geometries indexed
- The number of index entries
- The number of grid cells that contain geometries
- The average number of index entries per geometry
- The average number of geometries per grid cell
- The number of geometries in the cell that contains the most geometries
- The number of geometries in the cell that contains the fewest geometries

simulated-index

References a table column and a simulated index for this column.

table-schema
Name of the schema that includes the table with the column for which the simulated index is intended.

table-name
Unqualified name of the table with the column for which the simulated index is intended.

column-name
Unqualified name of the table column for which the simulated index is intended.

grid-size
Sizes of the cells in each grid level (finest level, middle level, and coarsest level) of a simulated index. You must specify a cell size for at least one level. If you do not want to include a level, either do not specify a grid cell size for it or specify a grid cell size of zero (0.0) for it.

When you specify the *grid-size* parameter, the Index Adviser returns the same kinds of statistics that it returns when you include the DETAIL keyword in the existing-index clause.

ANALYZE number ROWS | PERCENT ONLY
Gathers statistics on data in a subset of table rows. If your table has more than one million rows, you might want to use the ANALYZE clause to have

reasonable processing time. Specify the approximate quantity or approximate percentage of the rows to be included in this subset.

SHOW MINIMUM BOUNDING RECTANGLE HISTOGRAM
Displays a chart that shows the sizes of the geometries' minimum bounding rectangles (MBRs) and the number of geometries whose MBRs are of the same size.

WITH n BUCKETS
Specifies to the number of groupings for the MBRs of all analyzed geometries. Small MBRs are grouped together with other small geometries. The larger MBRs are grouped with other larger geometries.

If you do not specify this parameter or specify 0 buckets, the Index Advisor displays logarithmic bucket sizes. For example, the MBR sizes might be logarithmic values such as 1.0, 2.0, 3.0,... 10.0, 20.0, 30.0,... 100.0, 200.0, 300.0,...

If you specify a number of buckets greater than 0, the Index Advisor displays equal–sized values. For example, the MBR sizes might be equal–sized values such as 8.0, 16.0, 24.0,... 320.0, 328.0, 334.0.

The default is to use logarithmic–sized buckets.

ADVISE GRID CELL SIZES
Computes close-to-optimal grid cell sizes.

Usage note

If you enter the gseidx command from an operating system prompt, you must type the entire command on a single line.

Example

The following example is a request to return detailed information about an existing grid index whose name is COUNTIES_SHAPE_IDX and suggest appropriate grid index sizes:

```
gseidx CONNECT TO mydb USER user ID USING password GET GEOMETRY
STATISTICS FOR INDEX userID.counties_shape_idx DETAIL ADVISE
```

Using views to access spatial columns

You can define a view that uses a spatial column in the same way as you define views in DB2 for other data types.

If you have a table that has a spatial column and you want a view to use it, use the following sources of information.

Chapter 12. Analyzing and Generating spatial information

After you populate spatial columns, you are ready to query them. This chapter:

- Describes the environments in which you can submit queries
- Provides examples of the various types of spatial functions that you can invoke in a query
- Provides guidelines on using spatial functions in conjunction with spatial indexes

Environments for performing spatial analysis

You can perform spatial analysis by using SQL and spatial functions in the following programming environments:

- Interactive SQL statements.

  You can enter interactive SQL statements from the DB2® Command Editor, the DB2 Command Window, or the DB2 command line processor.
- Application programs in all languages supported by DB2.

Examples of how spatial functions operate

DB2 Spatial Extender provides functions that perform various operations on spatial data. Generally speaking, these functions can be categorized according to the type of operation that they perform. Table 4 lists these categories, along with examples. The text following Table 4 shows coding for these examples.

Table 4. Spatial functions and operations

Category of function	Example of operation
Returns information about specific geometries.	Return the extent, in square miles, of the sales area of Store 10.
Makes comparisons.	Determine whether the location of a customer's home lies within the sales area of Store 10.
Derives new geometries from existing ones.	Derive the sales area of a store from its location.
Converts geometries to and from data exchange formats.	Convert customer information in GML format into a geometry, so that the information can be added to a DB2 database.

Example 1: Returns information about specific geometries

In this example, the ST_Area function returns a numeric value that represents the sales area of store 10. The function will return the area in the same units as the units of the coordinate system that is being used to define the area's location.

```
SELECT db2gse.ST_Area(sales_area)
FROM   stores
WHERE  id = 10
```

The following example shows the same operation as the preceding one, but with ST_Area invoked as a method and returning the area in units of square miles.

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```
SELECT saleas_area..ST_Area('STATUTE MILE')
FROM   stores
WHERE  id = 10
```

Example 2: Makes comparisons

In this example, the ST_Within function compares the coordinates of the geometry representing a customer's residence with the coordinates of a geometry representing the sales area of store 10. The function's output will signify whether the residence lies within the sales area.

```
SELECT c.first_name, c.last_name, db2gse.ST_Within(c.location, s.sales_area)
FROM   customers as c. stores AS s
WHERE  s.id = 10
```

Example 3: Derives new geometries from existing ones

In this example, the function ST_Buffer derives a geometry representing a store's sales area from a geometry representing the store's location.

```
UPDATE stores
SET    sales_area = db2gse.ST_Buffer(location, 10, 'KILOMETERS')
WHERE  id = 10
```

The following example shows the same operation as the preceding one, but with ST_Buffer invoked as a method.

```
UPDATE stores
SET    sales_area = location..ST_Buffer(10, 'KILOMETERS')
WHERE  id = 10
```

Example 4: Converts geometries to and from data exchange formats.

In this example, customer information coded in GML is converted into a geometry, so that it can be stored in a DB2 database.

```
INSERT
INTO   c.name,c.phoneNo,c.address
VALUES ( 123, 'Mary Anne', Smith', db2gse.ST_Point('
<gml:Point><gml:coord><gml=X>-130.876</gml:X>
<gml:Y>41.120'</gml:Y></gml:coord></gml:Point>, 1) )
```

Functions that use indexes to optimize queries

A specialized group of spatial functions, called *comparison functions*, can improve query performance by exploiting either a spatial grid index or a geodetic Voronoi index (both known as *spatial indexes*). Each of these functions compares two geometries with one another. If the results of the comparison meet certain criteria, the function returns a value of 1; if the results fail to meet the criteria, the function returns a value of 0. If the comparison cannot be performed, the function can return a null value.

For example, the function ST_Overlaps compares two geometries that have the same dimension (for example, two linestrings or two polygons). If the geometries overlap partway, and if the space covered by the overlap has the same dimension as the geometries, ST_Overlaps returns a value of 1.

Table 5 on page 103 shows which comparison functions can use a spatial grid index and which ones can use a geodetic Voronoi index:

Table 5. Comparison functions that can use a spatial grid index or a geodetic Voronoi index

Comparison function	Can use spatial grid index	Can use geodetic Voronoi index
EnvelopesIntersect	Yes	Yes
ST_Contains	Yes	Yes
ST_Crosses	Yes	No
ST_Distance	Yes	Yes
ST_EnvIntersects	Yes	Yes
ST_Equals	Yes	No
ST_Intersects	Yes	Yes
ST_MBRIntersects	Yes	Yes
ST_Overlaps	Yes	No
ST_Touches	Yes	No
ST_Within	Yes	Yes

Because of the time and memory required to execute a function, such execution can involve considerable processing. Furthermore, the more complex the geometries that are being compared, the more complex and time-intensive the comparison will be. The specialized functions listed above can complete their operations more quickly if they can use a spatial index to locate geometries. To enable such a function to use a spatial index, observe all of the following rules:

- The function must be specified in a WHERE clause. If it is specified in a SELECT, HAVING, or GROUP BY clause, a spatial index cannot be used.
- The function must be the expression on left of the predicate.
- The operator that is used in the predicate that compares the result of the function with another expression must be an equal sign, with one exception: the ST_Distance function must use the less than operator.
- The expression on the right of the predicate must be the constant 1, except when ST_Distance is the function on the left.
- The operation must involve a search in a spatial column on which a spatial index is defined.

For example:

```
SELECT   c.name, c.address, c.phone
FROM customers AS c, bank_branches AS b
WHERE db2gse.ST_Distance(c.location, b.location) < 10000
  and b.branch_id = 3
```

Table 6 shows correct and incorrect ways of creating spatial queries to utilize a spatial index.

Table 6. Demonstration of how spatial functions can adhere to and violate rules for utilizing a spatial index.

Queries that reference spatial functions	Rules violated

`SELECT *`
`FROM stores AS s`
`WHERE db2gse.ST_Contains(s.sales_zone,`
`ST_Point(-121.8,37.3, 1)) = 1`
	No condition is violated in this example.

Table 6. Demonstration of how spatial functions can adhere to and violate rules for utilizing a spatial index. (continued)

Queries that reference spatial functions	Rules violated

`SELECT *`
`FROM stores AS s`
`WHERE db2gse.ST_Length(s.location) > 10`
	The spatial function ST_Length does not compare geometries and cannot utilize a spatial index.

`SELECT *`
`FROM stores AS s`
`WHERE 1=db2gse.ST_Within(s.location,:BayArea)`
	The function must be an expression on the left side of the predicate.

`SELECT *`
`FROM stores AS s`
`WHERE db2gse.ST_Contains(s.sales_zone,`
`ST_Point(-121.8,37.3, 1)) <> 0`
	Equality comparisons must use the integer constant 1.

`SELECT *`
`FROM stores AS s`
`WHERE db2gse.ST_Contains(ST_Polygon`
`('polygon((10 10, 10 20, 20 20, 20 10, 10 10))', 1),`
`ST_Point(-121.8, 37.3, 1) = 1`
	No spatial index exists on either of the arguments for the function, so no index can be utilized.

Chapter 13. DB2 Spatial Extender commands

This chapter explains the commands used to set up DB2 Spatial Extender. It also explains how you use these commands to develop projects.

Invoking commands for setting up DB2 Spatial Extender and developing projects

Use a command–line processor (CLP), called db2se, to set up Spatial Extender and create projects that use spatial data. This topic explains how to use db2se to run DB2 Spatial Extender commands.

Prerequisites

Before you can issue db2se commands, you must be authorized to do so. To find out what authorization is required for a given command, consult Table 7 on page 106 for the associated stored procedure topic for the command. For example, the db2se create_srs command requires the same authorities as the db2.ST_create_srs stored procedure.

Exception: The db2se shape_info command does not call a stored procedure. Rather, it displays information about the contents of shape files.

Enter db2se commands from an operating system prompt.

To find out what subcommands and parameters you can specify:

- Type db2se or db2se -h; then press Enter. A list of db2se subcommands is displayed.
- Type db2se and a subcommand, or db2se and a subcommand followed by -h. Then press Enter. The syntax required for the subcommand is displayed. In this syntax:
  - Each parameter is preceded by a dash and followed by a placeholder for a parameter value.
  - Parameters enclosed by brackets are optional. The other parameters are required.

Important: For your convenience, command syntax can be retrieved interactively on your monitor; you do not need to look up the syntax elsewhere.

To issue a db2se command, type `db2se`. Then type a subcommand, followed by the parameters and parameter values that the subcommand requires. Finally, press Enter.

You might need to type the user ID and password that give you access to the database that you just specified. For example, type the ID and password if you want to connect to the database as a user other than yourself. Always precede the ID with the parameter userId and precede the password with the parameter pw.

If you do not specify a user ID and password, your current user ID and password will be used by default. Values that you enter are not case–sensitive by default. To

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make them case-sensitive, enclose them in double quotation marks. For example, to specify the lowercase table name mytable type the following: ″mytable″.

You might have to escape the quotation marks to ensure they are not interpreted by the system prompt (shell), for example, specify the following: \″mytable\″ If a case-sensitive value is qualified by another case-sensitive value, delimit the two values individually; for example: ″myschema″.″mytable″ Enclose strings in double quotation marks; for example: ″select * from newtable″

When the db2se command is executed, the stored procedure that corresponds to the command will be invoked, and the operation that you requested will be performed.

Overview of db2se commands

The following table indicates what db2se commands to issue to perform the tasks involved in setting up Spatial Extender and creating projects that use spatial data. This table also provides examples of db2se commands and refers you to information about authorizations and command-specific parameters. To the right of the task, in the second column, you will see a link or reference to information about a stored procedure. This stored procedure is called when the command is issued. Authorization to use the stored procedure is the same as the authorization to use the command; also, the command and stored procedure share the same parameters. For more information about authorization and the meanings of the parameters, see the section identified by the reference.

Table 7. db2se commands indexed by task

Task	Command and example
Create a coordinate system.	db2se create_cs Command-specific parameters and required authorizations are the same as those for the db2gse.ST_create_coordsys stored procedure. The following example creates a coordinate system named “mycoordsys”. `db2se create_cs mydb -coordsysName \"mycoordsys\" -definition GEOCS[\"GCS_NORTH_AMERICAN_1983\", DATUM[\"D_North_American_1983\", SPHEROID[\"GRS_1980\",6387137,298.257222101]], PRIMEM[\"Greenwich\",0],UNIT[\"Degree\", 0.01745329251994329 55]]`
Create a spatial reference system.	db2se create_srs Command-specific parameters are the same as those for the stored procedure. No authorization is required. The following example creates a spatial reference system named “mysrs”. `db2se create_srs mydb -srsName \"mysrs\" -srsID 100 -xScale 10 -coordsysName \"GCS_North_American_1983\"`

Table 7. db2se commands indexed by task (continued)

Task	Command and example
Drop a spatial reference system.	db2se drop_srs Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example drops a spatial reference system named "mysrs". `db2se drop_srs mydb -srsName \"mysrs\"`
Delete a coordinate system definition.	db2se drop_cs Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example drops a coordinate system named "mycoordsys". `db2se drop_cs mydb -coordsysName \"mycoordsys\"`
Disable a setup to geocode data automatically.	db2se disable_autogc Command-specific parameters and required authorizations are the same as those for the db2gse.ST_disable_autogeocoding stored procedure. The following example disables the automatic geocoding for a geocoded column named MYCOLUMN in table MYTABLE. `db2se disable_autogc mydb -tableName \"mytable\" -columnName \"mycolumn\"`
Enable a database for spatial operations.	db2se enable_db Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example enables a database named MYDB for spatial operations. `db2se enable_db mydb`

Export data to an SDE transfer file.	db2se export_sde
	
	Command-specific parameters and required authorizations are the same as those for the stored procedure.
	
	The following example exports data from table MYSDETABLE, which contains spatial column MYSPATIALCOLUMN, to an SDE transfer file named mysdefile.
	`db2se export_sde mydb -tableName \"mySDEtable\" -columnName \"mySpatialcolumn\" -fileName /home/myaccount/mysdefile`
	
	The next example exports data from a table named SPATIALTABLE to an SDE file named sdex, which will be created on the DB2 client. Errors and informational messages (for example, time the export started and finished and how many rows were exported) are written to a file called sdex.export.log.
	`db2se export_sde mydb -client -fileName sdex -selectStatement "SELECT * FROM spatialTable" -messagesFile sdex.export.log`

Table 7. db2se commands indexed by task (continued)

Task	Command and example
Export data to shape files.	db2se export_shape Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example exports a spatial column named MYCOLUMN and its associated table, MYTABLE, to a shape file named myshapefile. `db2se export_shape mydb -fileName /home/myaccount/myshapefile -selectStatement "select * from mytable"`

Import an SDE transfer file.	db2se import_sde
	
	Command-specific parameters and required authorizations are the same as those for the stored procedure.
	
	The following example imports an SDE transfer file named mysdefile to table MYSDETABLE, which contains a spatial column named MYSPATIALCOLUMN. A commit is to be issued for every ten records.
	`db2se import_sde mydb -tableName \"mysdetable\" -columnName \"mySpatialcolumn\" -fileName /home/myaccount/"mysdefile" -commitScope 10`
	
	The next example shows how to import an SDE file named sdex, which resides on the DB2 client. In this example, the data is imported into a table named SDETABLE (to a column named ID) and a commit is issued every 100 records. Any errors are written to a file called sdex.exceptions.
	`db2se import_sde mydb -client -filename sdex -srsId 1234 -tableName sdeTable -idColumn id -commitScope 100 -messagesFile sdex.exceptions`

Import shape files.	db2se import_shape Command-specific parameters and required authorizations are the same as those for the stored procedure. The following command imports a shape file named myfile to a table named MYTABLE. During the import, the spatial data in myfile is inserted into a MYTABLE column named MYCOLUMN. `db2se import_shape mydb -fileName \"myfile\" -srsName NAD83_SRS_1 -tableName \"mytable\" -spatialColumnName \"mycolumn\"`
Register a geocoder.	db2se register_gc Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example registers a geocoder named “mygeocoder”, which is implemented by a function named “myschema.myfunction”. `db2se register_gc mydb -geocoderName \"mygeocoder"\ -functionSchema \"myschema\" -functionName \"myfnction\" -defaultParameterValues "1, 'string',,cast(null as varchar(50))" -vendor myvendor -description "myvendor geocoder returning well-known text"`

Table 7. db2se commands indexed by task (continued)

Task	Command and example
Register a spatial column.	db2se register_spatial_column Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example registers a spatial column named MYCOLUMN in table MYTABLE, with spatial reference system "USA_SRS_1". `db2se register_spatial_column mydb -tableName \"mytable\" -columnName \"mycolumn\" -srsName USA_SRS_1`
Remove the resources that enable a database for spatial operations.	db2se disable_db Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example removes the resources that enable database MYDB for spatial operations. `db2se disable_db mydb`
Remove a setup for geocoding operations.	db2se remove_gc_setup Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example removes a setup for geocoding operations that apply to a spatial column named MYCOLUMN in table MYTABLE. `db2se remove_geocoding_setup mydb -tableName \"mytable\" -columnName \"mycolumn\"`
Run a geocoder in batch mode.	db2se run_gc Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example runs a geocoder in batch mode to populate a column named MYCOLUMN in a table named MYTABLE. `db2se run_gc mydb -tableName \"mytable\" -columnName \"mycolumn\"`
Set up a geocoder to run automatically.	db2se enable_autogeocoding Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example sets up automatic geocoding for a column named MYCOLUMN in table MYTABLE `db2se enable_autogeocoding mydb -tableName \"mytable\" -columnName \"mycolumn\"`

Table 7. db2se commands indexed by task (continued)

Task	Command and example
Set up geocoding operations.	db2se setup_gc Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example sets up geocoding operations to populate a spatial column named MYCOLUMN in table MYTABLE. `db2se setup_gc mydb -tableName \"mytable\" -columnName \"mycolumn\" -geocoderName \"db2se_USA_GEOCODER\" -parameterValues "address,city,state,zip,2,90,70,20,1.1,'meter',4.." -autogeocodingColumns address,city,state,zip commitScope 10`

Show information about a shape file and its contents.	db2se shape_info
	
	To use this command, you must:
	• Have permission to read the file that the command references.
	• Be able to connect to the database that contains this file (if you use the *–database* parameter, which specifies that the system searches the named database for compatible coordinate systems and spatial reference systems).
	
	The following example shows information about a shape file named myfile, which is located in the current directory.
	`db2se shape_info -fileName myfile`
	
	The following example shows information about a sample UNIX shape file named offices. The *–database* parameter finds all compatible coordinate systems and spatial reference systems in the named database (in this case, MYDB).
	`db2se shape_info -fileName ~/sqllib/samples/extenders/spatial/data/offices -database myDB`

Show information about an SDE file and its contents.	db2se sde_info
	
	To use this command, you must:
	• Have permission to read the file that the command refers to.
	• Be able to connect to the database that contains this file (if you use the *–database* parameter, which specifies that the system searches the named database for compatible coordinate systems and spatial reference systems).
	
	The following example shows information about an SDE file named sdefile, which is located in the current directory.
	`db2se sde_info -fileName myfile`
	
	The next example shows information about an SDE file named sdex and searches a database named MYDB for all compatible coordinate systems and spatial reference systems.
	`db2se sde_info -fileName data/sdex -database myDB`

Table 7. db2se commands indexed by task (continued)

Task	Command and example
Unregister a geocoder.	db2se unregister_gc Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example unregisters a geocoder named "mygeocoder". `db2se unregister_gc mydb -geocoderName \"mygeoco der\"`
Unregister a spatial column.	db2se unregister_spatial_column Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example unregisters a spatial column named MYCOLUMN in table MYTABLE. `db2se unregister_spatial_column mydb -tableName \"mytable\" -columnName \"mycolumn\"`
Update a coordinate system definition.	db2se alter_cs Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example updates the definition of a coordinate system named "mycoordsys" with a new organization name. `db2se alter_cs mydb -coordsysName \"mycoordsys\" -organization myNeworganizationb -tableName \"mytable\"`
Update a spatial reference system definition.	db2se alter_srs Command-specific parameters and required authorizations are the same as those for the stored procedure. The following example alters a spatial reference system named "mysrs" with a different xOffset and description. `db2se alter_srs mydb -srsName \"mysrs\" -xOffset 35 -description "This is my own spatial reference system."`

Chapter 14. Writing applications and using the sample program

This chapter explains how you write Spatial Extender applications.

Writing applications for DB2 Spatial Extender

If you plan to write application programs that invoke DB2 Spatial Extender stored procedures or functions, read the following task and reference information.

To do this task... :

Including the DB2 Spatial Extender header file in spatial applications

DB2 Spatial Extender provides a header file that defines constants that can be used with the stored procedures and functions of the DB2 Spatial Extender.

Recommendation:
If you plan to call DB2 Spatial Extender stored procedures or functions from C or C++ programs, include this header file in your spatial applications.

To do this task... :

1. Ensure that your DB2 Spatial Extender applications can use the necessary definitions in this header file.
   a. Include the DB2 Spatial Extender header file in your application program. The header file has the following name:

      `db2gse.h`

      The header file is located in the *db2path*/include directory, where *db2path* is the installation directory where the DB2 database system is installed.
   b. Ensure that the path of the include directory is specified in your `makefile` with the compilation option.
2. If you are building Windows 64-bit applications on a Windows 32-bit system, change the DB2_LIBS parameter in the `samples/extenders/spatial/makefile.nt` file to accommodate 64–bit applications. The necessary changes are highlighted below:

   ```
   DB2_LIBS = $(DB2_DIR)\lib\Win64\db2api.lib
   ```

Calling DB2 Spatial Extender stored procedures from an application

If you plan to write application programs that call any of the DB2 Spatial Extender stored procedures, you use the SQL CALL statement and specify the name of the stored procedure.

DB2 Spatial Extender stored procedures are created when you enable the database for spatial operations.

To do this task... :

1. Call the ST_enable_db stored procedure to enable a database for spatial operations.

   Specify the stored procedure name as follows:

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```
CALL db2gse!ST_enable_db
```

The db2gse! in this call represents the DB2 Spatial Extender library name. The ST_enable_db stored procedure is the only one in which you need to include an exclamation mark in the call (that is, db2gse!).

2. Call other DB2 Spatial Extender stored procedures. Specify the stored procedure name in the following form, where db2gse is the schema name for all DB2 Spatial Extender stored procedures, and *spatial_procedure_name* is the name of the stored procedure. Do not include an exclamation mark in the call.

   ```
   CALL db2gse.spatial_procedure_name
   ```

   The DB2 Spatial Extender stored procedures are shown in the following table.

Table 8.

Stored procedure	Description
GSE_export_sde	Exports a spatial column and its associated table to an SDE transfer file.
GSE_import_sde	Imports an SDE transfer file to a database.
ST_alter_coordsys	Updates an attribute of a coordinate system in the database.
ST_alter_srs	Updates an attribute of a spatial reference system in the database.
ST_create_coordsys	Creates a coordinate system in the database.
ST_create_srs	Creates a spatial reference system in the database.
ST_disable_autogeocoding	Specifies that DB2 Spatial Extender is to stop synchronizing a geocoded column with its associated geocoding columns.
ST_disable_db	Removes resources that allow DB2 Spatial Extender to store spatial data and to support operations that are performed on this data.
ST_drop_coordsys	Deletes a coordinate system from the database.
ST_drop_srs	Deletes a spatial reference system from the database.
ST_enable_autogeocoding	Specifies that DB2 Spatial Extender is to synchronize a geocoded column with its associated geocoding columns.
ST_enable_db	Supplies a database with the resources that it needs to store spatial data and to support operations.
ST_export_shape	Exports selected data in the database to a shape file.
ST_import_shape	Imports a shape file to a database.
ST_register_geocoder	Registers a geocoder other than DB2SE_USA_GEOCODER, which is part of the DB2 Spatial Extender product.
ST_register_spatial_column	Registers a spatial column and associates a spatial reference system with it.
ST_remove_geocoding_setup	Removes all the geocoding setup information for the geocoded column.
ST_run_geocoding	Runs a geocoder in batch mode.

Table 8. (continued)

Stored procedure	Description
ST_setup_geocoding	Associates a column that is to be geocoded with a geocoder and sets up the corresponding geocoding parameter values.
ST_unregister_geocoder	Unregisters a geocoder other than DB2SE_USA_GEOCODER.
ST_unregister_spatial_column	Removes the registration of a spatial column.

The DB2 Spatial Extender sample program

The DB2® Spatial Extender sample program, `runGseDemo`, has two purposes. You can use the sample program to become familiar with application programming for DB2 Spatial Extender, and you can use the program to verify the DB2 Spatial Extender installation.

- On UNIX®, you can locate the runGseDemo program in the following path:
  `$HOME/sqllib/samples/extenders/spatial`

  where `$HOME` is the instance owner's home directory.
- On Windows®, you can locate the runGseDemo program in the following path:
  `c:\Program Files\IBM\sqllib\samples\extenders\spatial`

  where `c:\Program Files\IBM\sqllib` is the directory in which you installed DB2 Spatial Extender.

The DB2 Spatial Extender `runGseDemo` sample program makes application programming easier. Using this sample program, you can enable a database for spatial operations and perform spatial analysis on data in that database. This database will contain tables with fictitious information about customers and flood zones. From this information you can experiment with Spatial Extender and determine which customers are at risk of suffering damage from a flood.

With the sample program, you can:

- See the steps typically required to create and maintain a spatially-enabled database.
- Understand how to call spatial stored procedures from an application program.
- Cut and paste sample code into your own applications.

Use the following sample program to code tasks for DB2 Spatial Extender. For example, suppose that you write an application that uses the database interface to call DB2 Spatial Extender stored procedures. From the sample program, you can copy code to customize your application. If you are unfamiliar with the programming steps for DB2 Spatial Extender, you can run the sample program, which shows each step in detail. For instructions on running the sample program, see "Related tasks" at the end of this topic.

The following table describes each step in the sample program. In each step you will perform an action and, in many cases, reverse or undo that action. For example, in the first step you will enable the spatial database and then disable the spatial database. In this way, you will become familiar with many of the Spatial Extender stored procedures.

Table 9. DB2 Spatial Extender sample program steps

Steps	Action and description
Enable or disable the spatial database	• Enable the spatial database This is the first step needed to use DB2 Spatial Extender. A database that has been enabled for spatial operations has a set of spatial types, a set of spatial functions, a set of spatial predicates, new index types, and a set of spatial catalog tables and views. • Disable the spatial database This step is usually performed when you have enabled spatial capabilities for the wrong database, or you no longer need to perform spatial operations in this database. When you disable a spatial database, you remove the set of spatial types, the set of spatial functions, the set of spatial predicates, new index types, and the set of spatial catalog tables and views associated with that database. • Enable the spatial database Same as above.
Create or drop a coordinate system	• Create a coordinate system named NORTH_AMERICAN This step creates a new coordinate system in the database. • Drop the coordinate system named NORTH_AMERICAN This step drops the coordinate system NORTH_AMERICAN from the database. • Create a coordinate system named KY_STATE_PLANE This step creates a new coordinate system, KY_STATE_PLANE, which will be used by the spatial reference system created in the next step.
Create or drop a spatial reference system	• Create a spatial reference system named SRSDEMO1 This step defines a new spatial reference system (SRS) that is used to interpret the coordinates. The SRS includes geometry data in a form that can be stored in a column of a spatially-enabled database. After the SRS is registered to a specific spatial column, the coordinates that are applicable to that spatial column can be stored in the associated column of the CUSTOMERS table. • Drop the SRS named SRSDEMO1 This step is performed if you no longer need the SRS in the database. When you drop an SRS, you remove the SRS definition from the database. • Create the SRS named KY_STATE_SRS

Table 9. DB2 Spatial Extender sample program steps (continued)

Steps	Action and description
Create and populate the spatial tables	• Create the CUSTOMERS table • Populate the CUSTOMERS table The CUSTOMERS table represents business data that has been stored in the database for several years. • Alter the CUSTOMERS table by adding the LOCATION column The ALTER TABLE statement adds a new column (LOCATION) of type ST_Point. This column will be populated by geocoding the address columns in a subsequent step. • Create the OFFICES table The OFFICES table represents, among other data, the sales zone for each office of an insurance company. The entire table will be populated with the attribute data from a non-DB2 database in a subsequent step. This subsequent step involves importing attribute data into the OFFICES table from a shape file.
Populate the columns	• Geocode the addresses data for the LOCATION column of the CUSTOMERS table with the geocoder named KY_STATE_GC This step performs batch spatial geocoding by invoking the geocoder utility. Batch geocoding is usually performed when a significant portion of the table needs to be geocoded or re-geocoded. • Load the previously-created OFFICES table from the shape file using spatial reference system KY_STATE_SRS This step loads the OFFICES table with existing spatial data in the form of a shape file. Because the OFFICES table exists, the LOAD utility will append the new records to an existing table. • Create and load the FLOODZONES table from the shape file using spatial reference system KY_STATE_SRS This step loads the FLOODZONES table with existing data in the form of a shape file. Because the table does not exist, the LOAD utility will create the table before the data is loaded. • Create and load the REGIONS table from the shape file using spatial reference system KY_STATE_SRS
Register or unregister the geocoder	• Register the geocoder named SAMPLEGC • Unregister the geocoder named SAMPLEGC • Register the geocoder KY_STATE_GC These steps register and unregister the geocoder named SAMPLEGC and then create a new geocoder, KY_STATE_GC, to use in the sample program.

Table 9. DB2 Spatial Extender sample program steps (continued)

Steps	Action and description
Create spatial indexes	• Create the spatial grid index for the LOCATION column of the CUSTOMERS table • Drop the spatial grid index for the LOCATION column of the CUSTOMERS table • Create the spatial grid index for the LOCATION column of the CUSTOMERS table • Create the spatial grid index for the LOCATION column of the OFFICES table • Create the spatial grid index for the LOCATION column of the FLOODZONES table • Create the spatial grid index for the LOCATION column of the REGIONS table These steps create the spatial grid index for the CUSTOMERS, OFFICES, FLOODZONES, and REGIONS tables.
Enable automatic geocoding	• Set up geocoding for the LOCATION column of the CUSTOMERS table with geocoder KY_STATE_GC This step associates the LOCATION column of the CUSTOMERS table with geocoder KY_STATE_GC and sets up the corresponding values for geocoding parameters. • Enable automatic geocoding for the LOCATION column of the CUSTOMERS table This step turns on the automatic invocation of the geocoder. Using automatic geocoding causes the LOCATION, STREET, CITY, STATE, and ZIP columns of the CUSTOMERS table to be synchronized with each other for subsequent insert and update operations.
Perform insert, update, and delete operations on the CUSTOMERS table	• Insert some records with a different street • Update some records with a new address • Delete all records from the table These steps demonstrate insert, update, and delete operations on the STREET, CITY, STATE, and ZIP columns of the CUSTOMERS table. After the automatic geocoding is enabled, data that is inserted or updated in these columns is automatically geocoded into the LOCATION column. This process was enabled in the previous step.
Disable automatic geocoding	• Disable automatic geocoding for the LOCATION column in the CUSTOMERS table • Remove the geocoding setup for the LOCATION column of the CUSTOMERS table • Drop the spatial index for the LOCATION column of the CUSTOMERS table These steps disable the automatic invocation of the geocoder and the spatial index in preparation for the next step. The next step involves re-geocoding the entire CUSTOMERS table. **Recommendation:** If you are loading a large amount of geodata, drop the spatial index before you load the data, and then recreate it after the data is loaded.

Table 9. DB2 Spatial Extender sample program steps (continued)

Steps	Action and description
Re-geocode the CUSTOMERS table	• Geocode the LOCATION column of the CUSTOMERS table again with a lower precision level: 90% instead of 100% • Recreate the spatial index for the LOCATION column of the CUSTOMERS table • Re-enable automatic geocoding with a lower precision level: 90% instead of 100% These steps run the geocoder in batch mode, recreate the spatial index, and re-enable the automatic geocoding with a new precision level. This action is recommended when a spatial administrator notices a high failure rate in the geocoding process. If the precision level is set to 100%, it might fail to geocode an address because it cannot find a matching address in the reference data. By reducing the precision level, the geocoder might be more successful in finding matching data. After the table is re-geocoded in batch mode, the automatic geocoding is re-enabled and the spatial index is recreated. This allows you to incrementally maintain the spatial index and the spatial column for subsequent insert and update operations.
Create a view and register the spatial column in the view	• Create a view called HIGHRISKCUSTOMERS based on the join of the CUSTOMERS table and the FLOODZONES table • Register the view's spatial column These steps create a view and register its spatial column.
Perform spatial analysis	• Find the number of customers served by each region (ST_Within) • For offices and customers with the same region, find the number of customers that are within a specific distance of each office (ST_Within, ST_Distance) • For each region, find the average income and premium of each customer (ST_Within) • Find the number of flood zones that each office zone overlaps (ST_Overlaps) • Find the nearest office from a specific customer location, assuming that the office is located in the centroid of the office zone (ST_Distance) • Find the customers whose location is close to the boundary of a specific flood zone (ST_Buffer, ST_Intersects) • Find those high-risk customers within a specified distance from a specific office (ST_Within) All of these steps use the sqlRunSpatialQueries stored procedure. These steps perform spatial analysis using the spatial predicates and functions in DB2 SQL. The DB2 query optimizer exploits the spatial index on the spatial columns to improve the query performance whenever possible.

Table 9. DB2 Spatial Extender sample program steps (continued)

Steps	Action and description
Export spatial data into shape files	• Export the HIGHRISKCUSTOMERS view to shape files This step shows an example of exporting the HIGHRISKCUSTOMERS view to shape files. Exporting data from a database format to another file format enables the information to be used by other tools (such as ArcExplorer for DB2). This step is included in the runGseDemo.c program but is commented out for reference only. You can modify the sample program to specify the location for the export shape file, and rerun the sample program.
Export and import SDE files	• Export the CUSTOMERS table to an SDE transfer file • Import data from the newly exported SDE transfer file These steps show examples of exporting and importing SDE transfer files. These steps are included in the runGseDemo.c program but are commented out for reference only. You can modify the sample program to specify the location for the export SDE file, and rerun the sample program.

Chapter 15. Identifying DB2 Spatial Extender problems

If you encounter a problem working with DB2 Spatial Extender, you need to determine the cause of the problem.

You can troubleshoot problems with DB2 Spatial Extender in these ways:

- You can use message information to diagnose the problem.
- When working with Spatial Extender stored procedures and functions, DB2 returns information about the success or failure of the stored procedure or function. The information returned will be a message code (in the form of an integer), message text, or both depending on the interface that you use to work with DB2 Spatial Extender.
- You can view the DB2 administration notification file, which records diagnostic information about errors.
- If you have a recurring and reproducible Spatial Extender problem, an IBM customer support representative might ask you to use the DB2 trace facility to help them diagnose the problem.

How to interpret DB2 Spatial Extender messages

You can work with DB2® Spatial Extender through four different interfaces:

- DB2 Spatial Extender stored procedures
- DB2 Spatial Extender functions
- DB2 Spatial Extender Command Line Processor (CLP)
- DB2 Control Center

All interfaces return DB2 Spatial Extender messages to help you determine whether the spatial operation that you requested completed successfully or resulted in an error.

The following table explains each part of this sample DB2 Spatial Extender message text:

```
GSE0000I: The operation was completed successfully.
```

Table 10. The parts of the DB2 Spatial Extender message text

Message text part	Description
GSE	The message identifier. All DB2 Spatial Extender messages begin with the three-letter prefix GSE.
0000	The message number. A four digit number that ranges from 0000 through 9999.
I	The message type. A single letter that indicates the severity of message: **C** Critical error messages **N** Non-critical error messages **W** Warning messages **I** Informational messages
The operation was completed successfully.	The message explanation.

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The explanation that appears in the message text is the brief explanation. You can retrieve additional information about the message that includes the detailed explanation and suggestions to avoid or correct the problem. To display this additional information:

1. Open an operating system command prompt.
2. Enter the DB2 help command with the message identifier and message number to display additional information about the message. For example:

   ```
   DB2 "? GSEnnnn"
   ```

   where *nnnn* is the message number.

You can type the GSE message identifier and letter indicating the message type in uppercase or lowercase. Typing `DB2 "? GSE0000I"` will yield the same result as typing `db2 "? gse0000i"`.

You can omit the letter after the message number when you type the command. For example, typing `DB2 "? GSE0000"` will yield the same result as typing `DB2 "? GSE0000I"`.

Suppose the message code is `GSE4107N`. When you type `DB2 "? GSE4107N"` at the command prompt, the following information is displayed:

```
GSE4107N Grid size value "<grid-size>" is not valid where it is used.

Explanation: The specified grid size "<grid-size>" is not valid.

 One of the following invalid specifications was made when the grid index
 was created with the CREATE INDEX statement:

  -  A number less than 0 (zero) was specified as the grid size for the
     first, second, or third grid level.

  -  0 (zero) was specified as the grid size for the first grid level.

  -  The grid size specified for the second grid level is less than the grid
     size of the first grid level but it is not 0 (zero).

  -  The grid size specified for the third grid level is less than the grid
     size of the second grid level but it is not 0 (zero).

  -  The grid size specified for the third grid level is greater than 0 (zero)
     but the grid size specified for the second grid level is 0 (zero).

User Response: Specify a valid value for the grid size.

msgcode: -4107

sqlstate: 38SC7
```

If the information is too long to display on a single screen and your operating system supports the **more** executable program and pipes, type this command:

```
db2 "? GSEnnnn" | more
```

Using the **more** program will force the display to pause after each screen of data so that you can read the information.

DB2 Spatial Extender stored procedure output parameters

DB2® Spatial Extender stored procedures are invoked implicitly when you enable and use Spatial Extender from the DB2 Control Center or when you use the DB2 Spatial Extender CLP (db2se). You can invoke stored procedures explicitly in an application program or from the DB2 command line.

This topic describes how to diagnose problems when stored procedures are invoked explicitly in application programs or from the DB2 command line. To diagnose stored procedures invoked implicitly, you use the messages returned by the DB2 Spatial Extender CLP or the messages returned by the DB2 Control Center. These messages are discussed in separate topics.

DB2 Spatial Extender stored procedures have two output parameters: the message code (msg_code) and the message text (msg_text). The parameter values indicate the success or failure of a stored procedure.

msg_code

The msg_code parameter is an integer, which can be positive, negative, or zero (0). Positive numbers are used for warnings, negative numbers are used for errors (both critical and non-critical), and zero (0) is used for informational messages.

The absolute value of the msg_code is included in the msg_text as the message number. For example

- If the msg_code is 0, the message number is 0000.
- If the msg_code is –219 , the message number is 0219. The negative msg_code indicates that the message is a critical or non-critical error.
- If the msg_code is +1036, the message number is 1036. The positive msg_code number indicates that the message is a warning.

The msg_code numbers for Spatial Extender stored procedures are divided into the three categories shown in the following table:

Table 11. Stored procedure message codes

Codes	Category
0000 – 0999	Common messages
1000 – 1999	Administrative messages
2000 – 2999	Import and export messages

msg_text

The msg_text parameter is comprised of the message identifier, the message number, the message type, and the explanation. An example of a stored procedure msg_text value is:

```
GSE0219N   An EXECUTE IMMEDIATE statement
           failed. SQLERROR = "<sql-error>".
```

The explanation that appears in the msg_text parameter is the brief explanation. You can retrieve additional information about the message that includes the detailed explanation and suggestions to avoid or correct the problem.

For a detailed explanation of the parts of the msg_text parameter, and information on how to retrieve additional information about the message, see the topic: How to interpret DB2 Spatial Extender messages.

Working with stored procedures in applications

When you call a DB2 Spatial Extender stored procedure from an application, you will receive the msg_code and msg_text as output parameters. You can:

- Program your application to return the output parameter values to the application user.
- Perform some action based on the type of msg_code value returned.

Working with stored procedures from the DB2 command line

When you invoke a DB2 Spatial Extender stored procedure from the DB2 command line, you receive the msg_code and the msg_text output parameters. These output parameters indicate the success or failure of the stored procedure.

Suppose you connect to a database and want to invoke the ST_disable_db stored procedure. The example below uses a DB2 CALL command to disable the database for spatial operations and shows the output value results. A force parameter value of 0 is used, along with two question marks at the end of the CALL command to represent the msg_code and msg_text output parameters. The values for these output parameters are displayed after the stored procedure runs.

```
call db2gse.st_disable_db(0, ?, ?)

  Value of output parameters
  --------------------------
  Parameter Name  : MSGCODE
  Parameter Value : 0

  Parameter Name  : MSGTEXT
  Parameter Value : GSE0000I  The operation was completed successfully.

  Return Status = 0
```

Suppose the msg_text returned is GSE2110N. Use the DB2 help command to display more information about the message. For example:

```
"? GSE2110"
```

The following information is displayed:

```
GSE2110N    The spatial reference system for the
            geomentry in row "<row-number>" is invalid.
            The spatial reference system's
            numerical identifier is "<srs-id>".

Explanation: In row row-number, the geometry that is
to be exported uses an invalid spatial reference system.
The geometry cannot be exported.

User Response: Correct the indicated geometry or
exclude the row from the export operation by
modifying the SELECT statement accordingly.

msg_code: -2110

sqlstate: 38S9A
```

DB2 Spatial Extender function messages

The messages returned by DB2® Spatial Extender functions are typically embedded in an SQL message. The SQLCODE returned in the message indicates if an error occurred with the function or that a warning is associated with the function. For example:

- The SQLCODE –443 (message number SQL0443) indicates that an error occurred with the function.
- The SQLCODE +462 (message number SQL0462) indicates that a warning is associated with the function.

The following table explains the significant parts of this sample message:

```
DB21034E  The command was processed as an SQL statement because it was
not a valid Command Line Processor command.  During SQL processing it
returned: SQL0443N  Routine "DB2GSE.GSEGEOMFROMWKT"
(specific name "GSEGEOMWKT1") has returned an error
SQLSTATE with diagnostic text "GSE3421N  Polygon is not closed.".
SQLSTATE=38SSL
```

Table 12. The significant parts of DB2 Spatial Extender function messages

Message part	Description
SQL0443N	The SQLCODE indicates the type of problem.
GSE3421N	The DB2 Spatial Extender message number and message type. The message numbers for functions range from GSE3000 to GSE3999. Additionally, common messages can be returned when you work with DB2 Spatial Extender functions. The message numbers for common messages range from GSE0001 to GSE0999.
Polygon is not closed	The DB2 Spatial Extender message explanation.
SQLSTATE=38SSL	An SQLSTATE code that further identifies the error. An SQLSTATE code is returned for each statement or row. • The SQLSTATE codes for Spatial Extender function errors are 38S*xx*, where each *x* is a character letter or number. • The SQLSTATE codes for Spatial Extender function warnings are 01HS*x*, where the *x* is a character letter or number.

An example of an SQL0443 error message

Suppose that you attempt to insert the values for a polygon into the table POLYGON_TABLE, as shown below:

```
INSERT INTO polygon_table ( geometry )
VALUES ( ST_Polygon ( 'polygon (( 0 0, 0 2, 2 2, 1 2)) ') )
```

This results in an error message because you did not provide the end value to close the polygon. The error message returned is:

```
DB21034E  The command was processed as an SQL statement because it was
not a valid Command Line Processor command.  During SQL processing it
returned: SQL0443N  Routine "DB2GSE.GSEGEOMFROMWKT"
(specific name "GSEGEOMWKT1") has returned an error
SQLSTATE with diagnostic text "GSE3421N  Polygon is not closed.".
SQLSTATE=38SSL
```

The SQL message number SQL0443N indicates that an error occurred and the message includes the Spatial Extender message text GSE3421N Polygon is not closed.

When you receive this type of message:

1. Locate the GSE message number within the DB2 or SQL error message.
2. Use the DB2 help command (DB2 ?) to see the Spatial Extender message explanation and user response. Using the above example, type the following command in an operating system command line prompt:

   ```
   DB2 "? GSE3421"
   ```

The message is repeated, along with a detailed explanation and recommended user response.

DB2 Spatial Extender CLP messages

The DB2® Spatial Extender CLP (db2se) returns messages for:

- Stored procedures, if invoked implicitly.
- Shape information, if you have invoked the **shape_info** subcommand program from the DB2 Spatial Extender CLP. These are informational messages.
- Migration operations.
- Import and export shape operations to and from the client.

Examples of stored procedure messages returned by the DB2 Spatial Extender CLP

Most of the messages returned through the DB2 Spatial Extender CLP are for DB2 Spatial Extender stored procedures. When you invoke a stored procedure from the DB2 Spatial Extender CLP, you will receive message text that indicates the success or failure of the stored procedure.

The message text is comprised of the message identifier, the message number, the message type, and the explanation. For example, if you enable a database using the command db2se enable_db testdb, the message text returned by the Spatial Extender CLP is:

```
Enabling database. Please wait ...

GSE1036W   The operation was successful.  But
           values of certain database manager and
           database configuration parameters
           should be increased.
```

Likewise, if you disable a database using the command db2se disable_db testdb the message text returned by the Spatial Extender CLP is:

```
GSE0000I  The operation was completed successfully.
```

The explanation that appears in the message text is the brief explanation. You can retrieve additional information about the message that includes the detailed explanation and suggestions to avoid or correct the problem. The steps to retrieve this information, and a detailed explanation of how to interpret the parts of the message text, are discussed in a separate topic.

If you are invoking stored procedures through an application program or from the DB2 command line, there is a separate topic that discusses diagnosing the output parameters.

Example of shape information messages returned by the Spatial Extender CLP

Suppose you decide to display information for a shape file named `office`. Through the Spatial Extender CLP (db2se) you would issue this command:

```
db2se shape_info -fileName /tmp/offices
```

This is an example of the information that displays:

```
Shape file information
----------------------
File code                 = 9994
File length (16-bit words) = 484
Shape file version        = 1000
Shape type                = 1 (ST_POINT)
Number of records         = 31

Minimum X coordinate = -87.053834
Maximum X coordinate = -83.408752
Minimum Y coordinate = 36.939628
Maximum Y coordinate = 39.016477
Shapes do not have Z coordinates.
Shapes do not have M coordinates.

Shape index file (extension .shx) is present.

Attribute file information
--------------------------
dBase file code               = 3
Date of last update           = 1901-08-15
Number of records             = 31
Number of bytes in header     = 129
Number of bytes in each record = 39
Number of columns             = 3

Column Number  Column Name      Data Type       Length  Decimal

           1   NAME             C ( Character)      16        0
           2   EMPLOYEES        N (   Numeric)      11        0
           3   ID               N (   Numeric)      11        0

Coordinate system definition: "GEOGCS["GCS_North_American_1983",
DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137,298.257222101]],
PRIMEM["Greenwich",0],UNIT["Degree",0.017453292519943295]]"
```

Examples of migration messages returned by the Spatial Extender CLP

When you invoke commands that perform migration operations, messages are returned that indicate the success or failure of that operation.

Suppose you invoke the migration of the database `mydb` using the command `db2se migrate mydb -messagesFile /tmp/migrate.msg`. The message text returned by the Spatial Extender CLP is:

```
Migrating database. Please wait ...
GSE0000I  The operation was completed successfully.
```

DB2 Control Center messages

DB2 Spatial Extender messages

When you work with DB2® Spatial Extender through the DB2 Control Center, messages will appear in the DB2 Message window. Most of the messages that you will encounter will be DB2 Spatial Extender messages. Occasionally, you will receive an SQL message. The SQL messages are returned when an error involves licensing, locking, or when a DAS service is not available. The following sections provide examples of how DB2 Spatial Extender messages and SQL messages will appear in the DB2 Control Center.

When you receive a DB2 Spatial Extender message through the Control Center, the entire message text appears in the text area of DB2 Message window, for example:

```
GSE0219N   An EXECUTE IMMEDIATE statement
           failed. SQLERROR = "<sql-error>".
```

SQL messages

When you receive an SQL message through the Control Center that pertains to DB2 Spatial Extender:

- The message identifier, message number, and message type appear on the left side of the DB2 Message window, for example: `SQL0612N`.
- The message text appears in the text area of the DB2 Message window.

The message text that appears in the DB2 Message window might contain the SQL message text and the SQLSTATE, or it might contain the message text and the detailed explanation and user response.

An example of an SQL message that contains the SQL message text and the SQLSTATE is:

```
[IBM][CLI Driver][DB2/NT] SQL0612N "<name>" is a duplicate name. SQLSTATE=42711
```

An example of an SQL message that contains the message text and the detailed explanation and user response is:

```
SQL8008N
The product "DB2 Spatial Extender" does not have a valid
license key installed and the evaluation period has expired.

Explanation:

A valid license key could not be found and the evaluation
period has expired.

User Response:

Install a license key for the fully entitled version of the
product.  You can obtain a license key for the product by
contacting your IBM® representative or authorized dealer.
```

Tracing DB2 Spatial Extender problems with the db2trc command

When you have a recurring and reproducible DB2 Spatial Extender problem, you can use the DB2 trace facility to capture information about the problem.

The DB2 trace facility is activated by the **db2trc** system command. The DB2 trace facility can:

- Trace events
- Dump the trace data to a file
- Format trace data into a readable format

Restriction:

- Activate this facility only when directed by a DB2 technical support representative.
- On UNIX operating systems, you must have SYSADM, SYSCTRL, or SYSMAINT authorization to trace a DB2 instance.
- On Windows operating systems, no special authorization is required.

To do this task... :

1. Shut down all other applications.
2. Turn the trace on.

   The DB2 Support technical support representative will provide you with the specific parameters for this step. The basic command is:

   ```
   db2trc on
   ```

   Restriction: The **db2trc** command must be entered at a operating–system command prompt or in a shell script. It cannot be used in the DB2 Spatial Extender command–line interface (db2se) or in the DB2 CLP.

   You can trace to memory or to a file. The preferred method for tracing is to trace to memory. If the problem being recreated suspends the workstation and prevents you from dumping the trace, trace to a file.
3. Reproduce the problem.
4. Dump the trace to a file immediately after the problem occurs.

   For example:

   ```
   db2trc dump january23trace.dmp
   ```

   This command creates a file (*january23trace.dmp*) in the current directory with the name that you specify, and dumps the trace information in that file. You can specify a different directory by including the file path. For example, to place the dump file in the /tmp/spatial/errors directory, the syntax is:

   ```
   db2trc dump /tmp/spatial/errors/january23trace.dmp
   ```
5. Turn the trace off.

   For example:

   ```
   db2trc off
   ```
6. Format the data as an ASCII file. You can sort the data two ways:
   - Use the flw option to sort the data by process or thread. For example:

     ```
     db2trc flw january23trace.dmp january23trace.flw
     ```
   - Use the fmt option to list every event chronologically. For example:

     ```
     db2trc fmt january23trace.dmp january23trace.fmt
     ```

The administration notification file

Diagnostic information about errors is recorded in the administration notification file. This information is used for problem determination and is intended for DB2® technical support.

The administration notification file contains text information logged by DB2 as well as DB2 Spatial Extender. It is located in the directory specified by the DIAGPATH database manager configuration parameter. On Windows® NT, Windows 2000, and

Windows XP systems, the DB2 administration notification file is found in the event log and can be reviewed through the Windows Event Viewer.

The information that DB2 records in the administration log is determined by the DIAGLEVEL and NOTIFYLEVEL settings.

Use a text editor to view the file on the machine where you suspect a problem to have occurred. The most recent events recorded are the furthest down the file. Generally, each entry contains the following parts:

- A timestamp.
- The location reporting the error. Application identifiers allow you to match up entries pertaining to an application on the logs of servers and clients.
- A diagnostic message (usually beginning with ″DIA″ or ″ADM″) explaining the error.
- Any available supporting data, such as SQLCA data structures and pointers to the location of any extra dump or trap files.

If the database is behaving normally, this type of information is not important and can be ignored.

The administration notification file grows continuously. When it gets too large, back it up and then erase the file. A new file is generated automatically the next time it is required by the system.

Chapter 16. DB2 Geodetic Data Management Feature

This chapter introduces DB2 Geodetic Data Management Feature by explaining its purpose, describing when to use it, and explaining geodetic concepts.

DB2 Geodetic Data Management Feature

The DB2® Geodetic Data Management Feature enables you to treat the Earth as a globe. Using the same spatial data types and functions as for any other Spatial Extender operations, you can use Geodetic Data Management Feature to run seamless queries of data around the poles and data that crosses the 180th meridian. You can maintain data that is referenced to a precise location on the surface of the Earth.

Geodetic Data Management Feature is named for the discipline known as *geodesy*. Geodesy is the study of the size and shape of the Earth (or any body modeled by an ellipsoid, such as the Sun or a celestial sphere). Geodetic Data Management Feature is designed to handle objects defined on the Earth's surface with a high degree of precision.

To obtain this precision, Geodetic Data Management Feature uses a latitude and longitude coordinate system on an ellipsoidal Earth model, or *geodetic datum*, rather than a planar, *x*- and *y*-coordinate system. An ellipsoidal model avoids distortions, inaccuracies, and imprecision that can be introduced using flat-plane projections.

To access geodetic rather than spatial operations, you must define a geodetic spatial reference system for your data. These systems have spatial reference system IDs (SRIDs) in the range 2000000000 to 2000001000. DB2 Geodetic Data Management Feature provides 318 predefined geodetic spatial reference systems.

DB2 Spatial Extender must be installed before you can use DB2 Geodetic Data Management Feature. To enable the Geodetic Data Management Feature, you must purchase a separate license.

When to use DB2 Geodetic Data Management Feature and when to use DB2 Spatial Extender

DB2® Spatial Extender and DB2 Geodetic Data Management Feature both manage geographic information system (GIS) data in a DB2 database. Each extender uses different core technologies that solve different problems and complement each other:

- Geodetic Data Management Feature treats the Earth as a globe. It uses a latitude and longitude coordinate system on an ellipsoidal Earth model. Geometric operations are precise, regardless of location. It is built on the Hipparchus library, which is licensed from Geodyssey Limited. Refer to http://www.geodyssey.com for more geodetic information.

  Geodetic Data Management Feature is best used for global data sets and applications that cover large areas on the Earth, where a single map projection cannot provide the accuracy required by the application.

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- Spatial Extender treats the Earth as a flat map. It uses planimetric (flat-plane) geometry, which means that it approximates the round surface of the Earth by projecting it onto a flat plane. This projection causes distortions, which can vary across the extent of the data, but the distortions generally increase toward the edges of the projected region. Every flat-map projection has distortions of some kind. Spatial Extender is built on the ESRI shape library, which is licensed from ESRI. Refer to http://www.esri.com for more spatial information.

  Spatial Extender is best used for local and regional data sets that are well represented in projected coordinates, and for applications where location accuracy is not important. For example, a medical insurance company might want to know the locations of hospitals and clinics within a state or province.

Geodetic datums

A geodetic datum is a reference system that describes the surface of the Earth. Many such reference systems have been developed over the centuries as science has developed new tools for measuring the Earth. Both ground and satellite measurements have been used to create datums, which in turn are used to create flat-map projections.

Geodetic datums are based on an approximation of the general shape of the Earth by an ellipsoid of rotation (also called a *spheroid*). A spheroid is the three-dimensional shape described by an ellipse when it is rotated around one of its axes.

Every spatial object that you define must be referenced to a specific datum. You specify a datum by its spatial reference system identifier (SRID). You can choose any datum that is supported by DB2® Geodetic Data Management Feature. These systems have SRIDs in the range 2000000000 to 2000001000.

- ″Datums supported by DB2 Geodetic Data Management Feature″ lists the 318 predefined geodetic spatial reference systems that Geodetic Data Management Feature provides.
- You can also define a new datum by creating a spatial reference system with an ID in the range of 2000000318 to 2000001000.

Restriction: Functions that take more than one geo-spatial object as arguments cannot handle combinations of datums. Geodetic Data Management Feature does not perform datum conversions.

Geodetic latitude and longitude

DB2 Geodetic Data Management Feature's coordinate reference system uses *geodetic latitude* and *longitude* to describe locations relative to the Earth. Geodetic latitude and longitude are always based on a specific datum.

Geodetic latitude
The geodetic latitude of a point is the angle between the equatorial plane and the perpendicular line that intersects the normal line at the point on the surface of the Earth.

Geodetic longitude
Geodetic longitude is the angle in the equatorial plane between the line *a* that connects the Earth's center with the prime meridian and the line *b* that

connects the center with the meridian on which the point lies. A *meridian* is a direct path on the surface of the datum that is the shortest distance between the poles.

The ellipsoid in Figure 17 shows the angles that represent geodetic latitude and longitude. The angle for the geodetic latitude does not start at the very center because of the Earth's ellipsoidal shape.

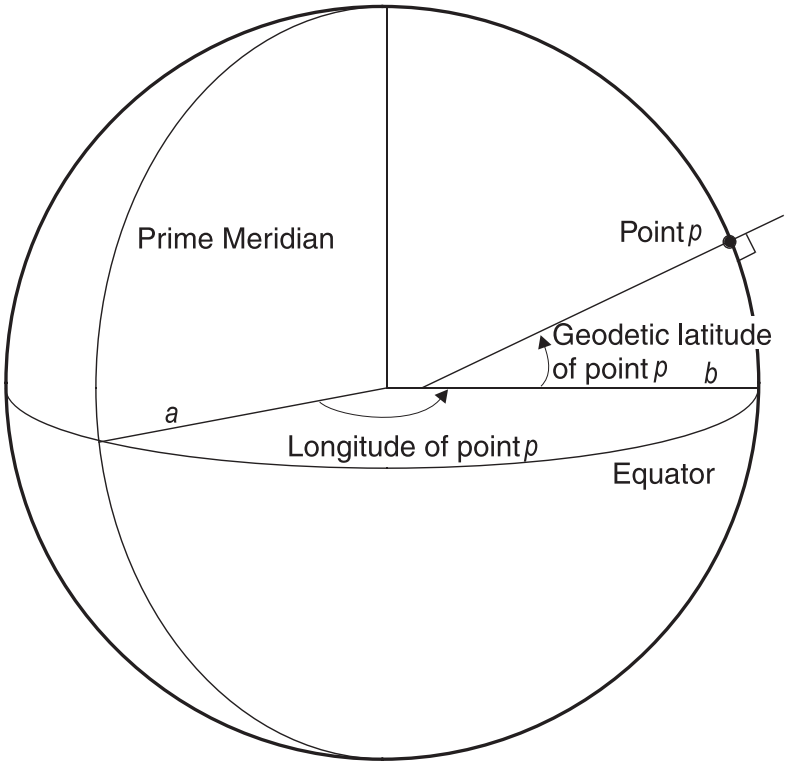

Figure 17. Geodetic latitude and longitude angles

Latitude and longitude coordinates are expressed in degrees with a decimal fraction. There are 360 degrees of longitude, starting at the prime meridian (0° longitude) and proceeding eastward in a positive direction through 180° and west in negative values through –180°. Latitude degrees begin at the equator (0° latitude) and proceed to the North Pole (90° latitude) and South Pole (–90° latitude).

Geodesic distances

DB2® Geodetic Data Management Feature measures distance between two points along a *geodesic*. A geodesic is the shortest path between two points on the ellipsoidal shape of the Earth, and this shortest path might not follow a line of constant latitude even though the two end points are at the same latitude.

Because line segments are computed as geodesics, a four-point polygon with widely separated points, as Figure 18 on page 134 shows, might not enclose the intended region. This polygon covers a region with longitude lines that are about 120 degrees apart, and the top two points have the same latitude values and the bottom two points have the same latitude values. The geodesic between the two longitude lines follows the curve on the ellipsoidal shape of the Earth. The latitude

increases along the geodesic to 20 degrees more in the middle than on either end of the geodesic.

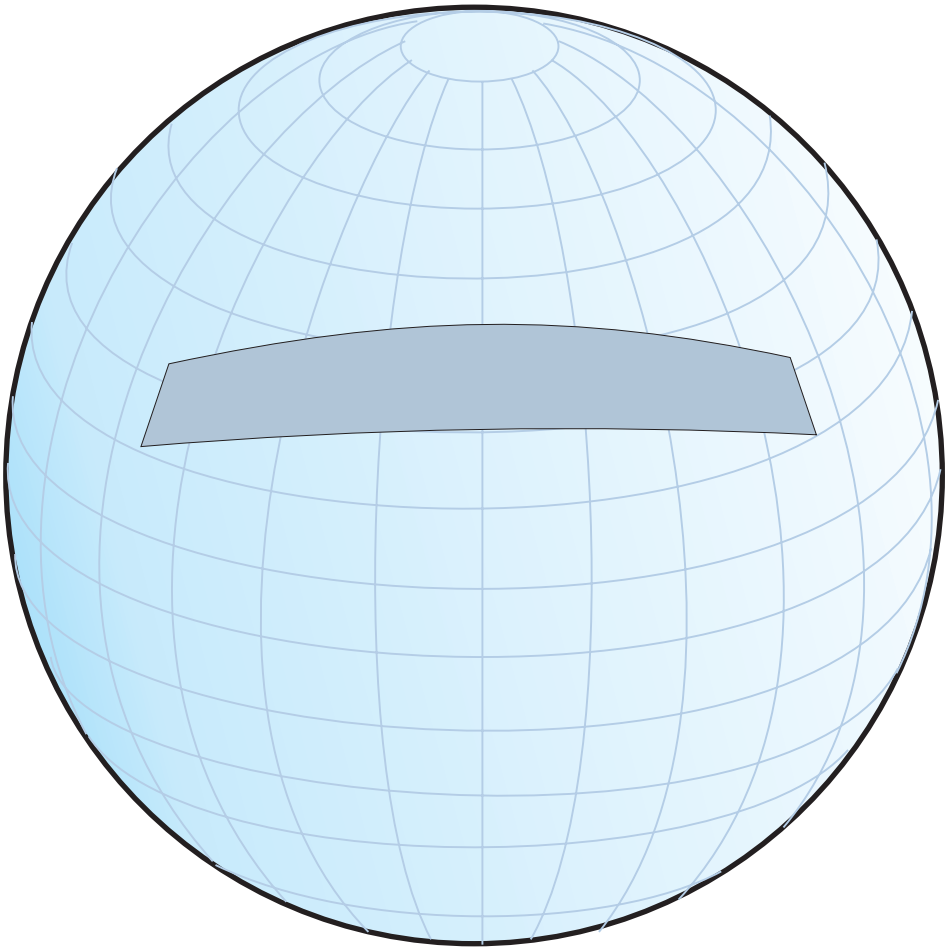

Figure 18. Region enclosed by a polygon with widely separated points

To represent a path that is not a geodesic, for example, if you want a line segment to follow a constant latitude, you need to insert additional intermediate points.

Geodetic regions

A geodetic region (polygon) is an area on the Earth's surface that has some characteristic specific to an application. Examples of regions include an area of market influence or an area seen by a satellite over a specified time.

Geodetic Data Management Feature defines a region by an ordered sequence of points that form a closed ring. The order in which you specify points in a polygon is significant. As you follow a polygon from vertex to vertex in the order defined, the area to the left is inside the polygon.

You can use an ST_Polygon data type to define a region enclosed by one or more rings, as Figure 19 on page 135 shows. Define the polygon by the latitude and longitude coordinates of the points (vertices) that make up its rings.

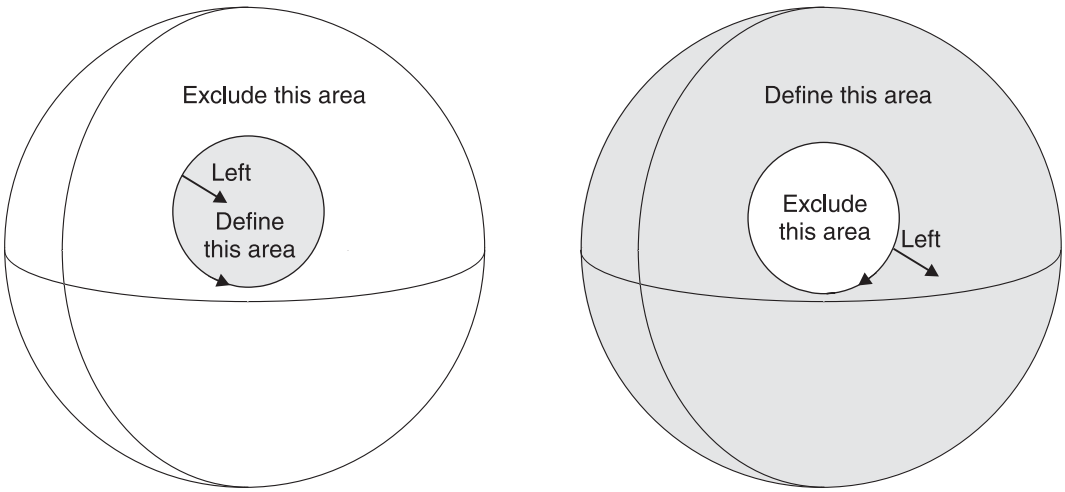

Figure 19. Defining and excluding areas

A ring divides the surface of the Earth into two regions: one region inside the polygon and one outside the polygon. The left side of Figure 19 shows a ring with vertices specified in counter-clockwise sequence so that all points to the left are inside the ring. The right side of the figure shows a ring with vertices in clockwise sequence so that all points to the left are outside the ring.

To define a region as a polygon, you must specify the order of the vertices of each ring such that the interior of the polygon is on your left when you traverse the ring. To define an excluded region, you must specify the vertices of the ring in the opposite order, as Figure 20 on page 136 illustrates. The interior of the polygon is always to the left. Figure 20 on page 136 shows two rings, one inside the other. The larger ring defines the outer boundary of the polygon and is drawn counter-clockwise. The smaller ring defines the inner boundary and is drawn clockwise.

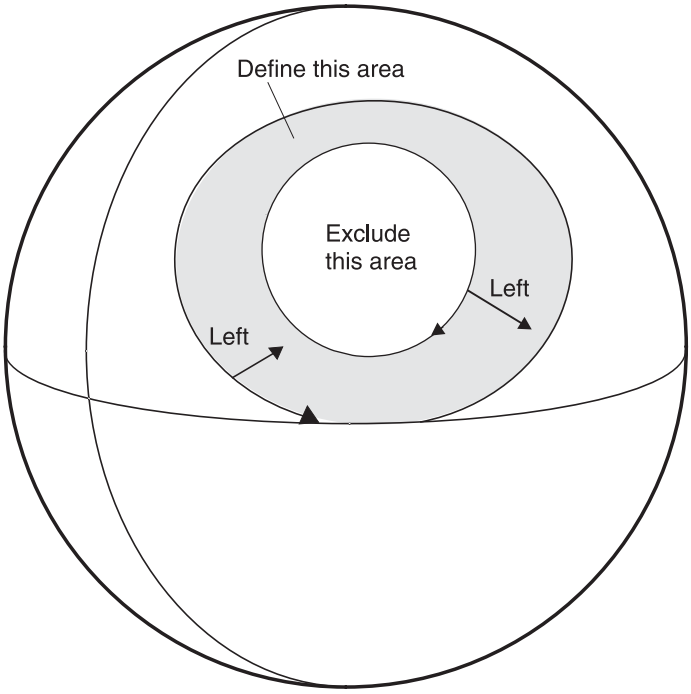

Figure 20. Defining an area with multiple rings

If you create a polygon that is larger than a hemisphere, the following warning message is returned. You might actually want this large polygon, but the warning is for cases where you inadvertently specify the wrong vertex order and a large polygon results when you want a small polygon.

```
GSE3733W "Polygon covers more than half the earth. Verify counter-clockwise
  orientation of the vertex points."
```

Chapter 17. Setting up DB2 Geodetic Data Management Feature

This section provides instructions for setting up DB2 Geodetic Data Management Feature, migrating from Informix Geodetic DataBlade, and populating spatial columns with geodetic data.

Setting up and enabling DB2 Geodetic Data Management Feature

Before you enable DB2 Geodetic Data Management Feature, you must:

- Install and configure DB2 Version 9.1.

  You must install the DB2 database on your system *before* you install DB2 Spatial Extender and DB2 Geodetic Data Management Feature. If you plan to use the DB2 Control Center, create and configure the DB2 Administration Server (DAS). For more information on creating and configuring DAS, see the *IBM DB2 Administration Guide: Implementation*
- Install and configure DB2 Spatial Extender.

  DB2 Geodetic Data Management Feature is integrated into the same library code as DB2 Spatial Extender. Therefore, the installation CD for Spatial Extender includes Geodetic Data Management Feature. The disk space requirements for Spatial Extender include Geodetic Data Management Feature. However, you cannot use Geodetic Data Management Feature until you purchase and enable a Geodetic Data Management Feature license.
- Purchase a license for DB2 Geodetic Data Management Feature.

  When you purchase a DB2 Geodetic Data Management Feature license, you can enable the Geodetic license key. Contact your Sales Representative if you want to purchase DB2 Geodetic Data Management Feature.

Restriction:

- DB2 Geodetic Data Management Feature is licensed only for DB2 Version 9.1 Enterprise Server Edition.
- DB2 Geodetic Data Management Feature treats the Earth as a globe; whereas, Spatial Extender treats the round surface of the Earth as a flat map. If you install the Geodetic Data Management Feature, you can analyze spatial data with more accuracy than a flat map.
- A DB2 Geodetic Data Management Feature system consists of DB2 database system, DB2 Spatial Extender, DB2 Geodetic Data Management Feature, and, for most applications, a geobrowser.

For any additional or changed information to enable DB2 Geodetic Data Management Feature, refer to the *DB2 Release Notes*.

After you enable the DB2 Geodetic Data Management Feature license, you populate spatial columns with geodetic data.

To do this task... :

Enable the DB2 Geodetic Data Management Feature license in one of the following ways:

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- Use the License Center on the DB2 Control Center. See the online help on the DB2 License Center for more information on how to enable the Geodetic license.
- Run the **db2licm** command.

Migrating from Informix Geodetic DataBlade to DB2 Geodetic Data Management Feature

Prerequisites

You must port your Geodetic DataBlade applications to use DB2 Geodetic Data Management Feature data types and functions.

Restrictions

If you currently use the Informix Geodetic DataBlade, you might be able to migrate to DB2 Geodetic Data Management Feature if you meet the following criteria:

- Use only GeoPoint, GeoLineseg, GeoString, GeoRing and GeoPolygon data types.
- Use only Geodetic DataBlade functions that have equivalent or near-equivalent counterparts in DB2 Geodetic Data Management Feature, as the tables below describe.
- Index only the spatial component of GeoObjects; in other words, you do not index time ranges or altitude ranges.

If you use the IBM Informix Geodetic DataBlade to store and manipulate geospatial objects in a database, you can migrate your data and applications to IBM DB2 Geodetic Data Management Feature with some restrictions.

To do this task... :

1. To migrate from IBM Informix Geodetic DataBlade to IBM DB2 Geodetic Data Management Feature:

Table 13. Corresponding data types in Informix Geodetic DataBlade and Geodetic Data Management Feature

Data type in Informix Geodetic DataBlade	Corresponding data type in DB2 Geodetic Data Management Feature	Comments for near-equivalent data types
GeoEllipse		First convert to a GeoPolygon, then migrate to ST_Polygon
GeoLineseg	ST_LineString	
GeoObject	ST_Geometry	ST_Geometry and its subtypes do not support the GeoAltRange and GeoTimeRange data types
GeoPoint	ST_Point	
GeoPolygon	ST_MultiPolygon, ST_Polygon	ST_MultiPolygon requires an explicit closure point for each ring. If a GeoPolygon has one outer ring, it can be mapped to a ST_Polygon.
GeoRing	ST_LineString	
GeoString	ST_LineString	

The following Geodetic DataBlade data types do not have a corresponding data type in Geodetic Data Management Feature:

- GeoAltitude
- GeoAltRange
- GeoAngle
- GeoAzimuth
- GeoCoords
- GeoDistance
- GeoEllipse
- GeoLatitude
- GeoLongitude
- GeoTimeRange
- GeoVoronoi

a. Rewrite your SQL statements to use DB2 Geodetic Data Management Feature data types and functions.
b. Load or import your data into DB2 Geodetic Data Management Feature.
c. Rewrite applications which use Informix ODBC, ESQL/C, and JDBC. Table 23 on page 144 shows the corresponding client connectivity in Geodetic DataBlade and Geodetic Data Management Feature.

Table 14. Corresponding predicate functions in Informix Geodetic DataBlade and Geodetic Data Management Feature

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature
Contains	ST_Contains
Inside	ST_Within
Intersect	ST_Intersects
Outside	ST_Disjoint
Within	ST_Distance

2. The following Geodetic DataBlade predicate functions do not have a corresponding function in Geodetic Data Management Feature:
   - Beyond
   - Equal
   - Nearest

Table 15. Corresponding production functions in Informix Geodetic DataBlade and Geodetic Data Management Feature

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature	Comments for near-equivalent functions
Difference	ST_Difference	ST_Difference supports points in addition to polygons
Generalize	ST_Generalize	
Intersection	ST_Intersection	ST_Intersection(line,line) might result in a multipoint. ST_Intersection (line,poly) might result in a multlinestring. Returns Empty for disjoint objects.

Table 15. Corresponding production functions in Informix Geodetic DataBlade and Geodetic Data Management Feature (continued)

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature	Comments for near-equivalent functions
SymDifference	ST_SymDifference	ST_SymDifference supports points in addition to polygons
Union	ST_Union	ST_Union supports points and lines in addition to polygons

Table 16. Corresponding accessor functions in Informix Geodetic DataBlade and Geodetic Data Management Feature

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature	Comments for near-equivalent functions
Center	ST_MidPoint, ST_PointOnSurface	ST_MidPoint is a near substitute for lines. ST_PointOnSurface is a near substitute for polygons.
Coords	ST_PointN	
Dimension	ST_Dimension	
HasZValue	ST_Is3d	
IsGeoBox	Use IS OF expression or ST_GeometryType	
IsGeoCircle	Use IS OF expression or ST_GeometryType	
IsGeoEllipse	Use IS OF expression or ST_GeometryType	
IsGeoLineseg	Use IS OF expression or ST_GeometryType	
IsGeoPoint	Use IS OF expression or ST_GeometryType	
IsGeoPolygon	Use IS OF expression or ST_GeometryType	
IsGeoRing	Use IS OF expression or ST_GeometryType	
IsGeoString	Use IS OF expression or ST_GeometryType	
Latitude	ST_Y	
Longitude	ST_X	
NPoints	ST_NumPoints	
NRings	ST_NumGeometries, ST_NumInteriorRing	Use ST_NumGeometries to obtain total number of outer rings, and sum ST_NumInteriorRings for each polygon in the multipolygon set

Table 16. Corresponding accessor functions in Informix Geodetic DataBlade and Geodetic Data Management Feature (continued)

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature	Comments for near-equivalent functions
Ring	ST_GeometryN, ST_ExteriorRing, ST_InteriorRingN	Use ST_GeometryN in conjunction with ST_ExteriorRing and ST_InteriorRingN
SRID	ST_SRID	
Zvalue	ST_Z	

3. The following Geodetic DataBlade accessor functions do not have a corresponding function in Geodetic Data Management Feature:
   - IsLarge
   - IsSmallArea

Table 17. Corresponding modifier functions in Informix Geodetic DataBlade and Geodetic Data Management Feature

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature
SetSRID	ST_SRID

4. The following Geodetic DataBlade modifier functions do not have a corresponding function in Geodetic Data Management Feature:
   - SetAltRange
   - SetAltRangeZ
   - SetDist
   - SetTimeRange

Table 18. Corresponding measurement functions in Informix Geodetic DataBlade and Geodetic Data Management Feature

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature
Area	ST_Area
Distance	ST_Distance
Length	ST_Length, ST_Perimeter

5. The VoronoiResolution measurement function does not have a corresponding function in Geodetic Data Management Feature.

Table 19. Corresponding downcast functions in Informix Geodetic DataBlade and Geodetic Data Management Feature

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature
GeoBox	Use SQL TREAT expression
GeoCircle	Use SQL TREAT expression
GeoEllipse	Use SQL TREAT expression
GeoLineseg	Use SQL TREAT expression
GeoPoint	Use SQL TREAT expression

Table 19. Corresponding downcast functions in Informix Geodetic DataBlade and Geodetic Data Management Feature (continued)

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature
GeoPolygon	Use SQL TREAT expression
GeoRing	Use SQL TREAT expression
GeoString	Use SQL TREAT expression

Table 20. Corresponding constructor functions in Informix Geodetic DataBlade and Geodetic Data Management Feature

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature
GeoCoords	ST_Point
GeoPoint	ST_Point

6. The following Geodetic DataBlade constructor functions do not have a corresponding function in Geodetic Data Management Feature:
   - GeoBox
   - GeoCircle
   - GeoEllipse
   - GeoLineseg

Table 21. Corresponding diagnostic functions in Informix Geodetic DataBlade and Geodetic Data Management Feature

Function in Informix Geodetic DataBlade	Corresponding function in DB2 Geodetic Data Management Feature
GeoTraceLevel	DB2 Trace Facility
IsValidGeometry	ST_IsValid

7. The following Geodetic DataBlade diagnostic functions do not have a corresponding function in Geodetic Data Management Feature:
   - GeoInRowSize
   - GeoOutOfRowSize
   - GeoRelease
   - GeoTotalSize
   - GeoTraceLevelSet
   - GeoWarningLevel
   - GeoWarningLevelSet
   - IsValidSDTS

Table 22. Corresponding system catalog tables in Informix Geodetic DataBlade and Geodetic Data Management Feature

System catalog table in Informix Geodetic DataBlade	Corresponding catalog view in DB2 Geodetic Data Management Feature
GeoLenUnit	DB2GSE.ST_UNITS_OF_MEASURE
GeoSpatialRef	DB2GSE.SPATIAL_REF_SYS

8. The following Geodetic DataBlade system catalog tables do not have a corresponding table or view in Geodetic Data Management Feature:

- GeoEllipsoid
- GeoParam
- GeoVoronoi

9. The following Geodetic DataBlade user–settable parameter functions do not have a corresponding function in Geodetic Data Management Feature:
   - GeoParamSessionGet
   - GeoParamSessionSet
10. The following Geodetic DataBlade AltRange functions do not have a corresponding function in Geodetic Data Management Feature:
   - AltRange
   - Bottom
   - Contains
   - Equal
   - Inside
   - Intersect
   - IsAny
   - Outside
   - Top
11. The following Geodetic DataBlade TimeRange functions do not have a corresponding function in Geodetic Data Management Feature:
   - Begin
   - Contains
   - End
   - Equal
   - IsAny
   - Inside
   - Intersect
   - Outside
   - TimeRange
12. The following Geodetic DataBlade ellipse functions do not have a corresponding function in Geodetic Data Management Feature:
   - Azimuth
   - Coords
   - Major
   - Minor
13. The following Geodetic DataBlade circle functions do not have a corresponding function in Geodetic Data Management Feature:
   - Coords
   - Radius
14. The following Geodetic DataBlade angle arithmetic functions do not have a corresponding function in Geodetic Data Management Feature:
   - Divide
   - Minus
   - Negate
   - Plus
   - Times

15. The following Geodetic DataBlade client connectivity do not have a corresponding client connectivity in Geodetic Data Management Feature:
    - Java API
    - LIBMI

Table 23. Corresponding client connectivity products in Geodetic DataBlade and DB2 Geodetic Data Management Feature

Client connectivity in Informix Geodetic DataBlade	Corresponding client connectivity in DB2 Geodetic Data Management Feature
ESQLC	SQC
ODBC	ODBC
JDBC	JDBC

Populating spatial columns with geodetic data

After you create spatial columns and register the columns on which you plan to create a spatial index, you are ready to populate the columns with geodetic data. You can supply geodetic data in the following ways:

- Import the following data formats to a new or existing table:
  - Shape
  - SDE
- Insert or update values in the following data formats:
  - Shape
  - SDE
  - Well-known text (WKT)
  - Well-known binary (WKB)
  - GML (Geography Markup Language)

Restriction:

- For Spatial Extender, you cannot use the geocoder commands or stored procedures to translate data into geodetic data.
- For geodetic behavior, use spatial reference systems that have SRIDs in the range 2,000,000,000 to 2,000,001,000.
- Shape data and SDE transfer data must be in a geographic coordinate system.

The procedure to import geodetic data is the same as with spatial data.

Chapter 18. Geodetic Indexes

You can create geodetic Voronoi indexes that can improve performance when you query geodetic data. This chapter:

- Describes Geodetic Voronoi indexes
- Describes Voronoi cell structures and when you might select an alternate structure.
- Explains how to create a Geodetic Voronoi index.

Geodetic Voronoi indexes

DB2® Geodetic Data Management Feature provides a geodetic Voronoi index that speeds access to geodetic data. This index organizes access to geodetic data by using Voronoi tessellations of the Earth's surface.

Geodetic Data Management Feature calculates the minimum bounding circle (MBC) for each geometry. The MBC is a circle that surrounds a geodetic geometry. The Voronoi index uses this MBC information to organize data in a cell structure. A search using a Voronoi index can quickly descend within the organized data to find objects in the general area of interest and then perform more exact tests on the objects themselves. A Voronoi index can improve performance because it eliminates the need to examine objects outside the area of interest. Without a Voronoi index, a query would need to evaluate every object to find those that match the query criteria.

The optimizer considers a geodetic Voronoi index for use by all queries that contain the following functions in their WHERE clause:

- EnvelopesIntersect
- ST_Contains
- ST_Distance
- ST_EnvIntersects
- ST_Intersects
- ST_MBRIntersects
- ST_Within

When you create a geodetic Voronoi index, you can choose an alternate Voronoi cell structure.

Voronoi cell structures

To perform computations efficiently, DB2® Geodetic Data Management Feature subdivides the surface of the Earth into smaller, more manageable, honeycomb-like cells. This subdivision is known as a *Voronoi tessellation*, and the data structure that describes it is called a *Voronoi cell structure*. A Voronoi tessellation is a cell structure where each cell's interior consists of all points that are closer to a particular lattice point than to any other lattice point. The cells in a Voronoi cell structure are *convex hulls*. A convex hull of a set of points is the smallest convex set that includes the points (or, the smallest polygon that defines the ″outside″ of a group of points).

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Voronoi cell structures tend to be irregularly shaped polygons; the number and location of cells can be tuned to match the density and location of your spatial data.

For example, a Voronoi cell structure can subdivide the Earth into polygons based on human population. Where the population (and the data) is dense, there are small polygons. Where the population is sparse, there are large polygons.

Figure 21 shows the Voronoi structure that is based on world population density. Geodetic Data Management Feature uses this cell structure in its spatial computations.

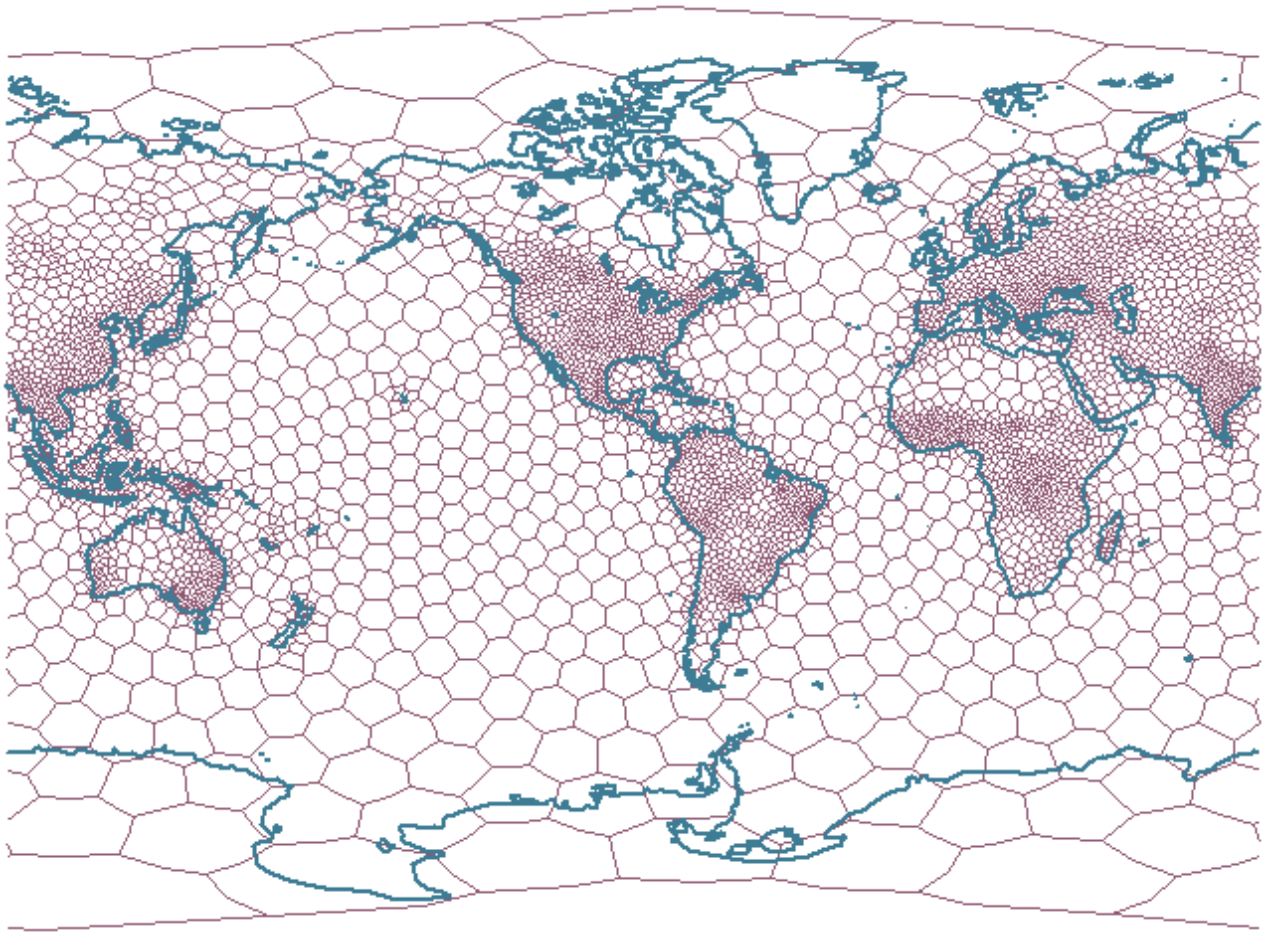


Figure 21. Voronoi structure based on world population density

Considerations for selecting an alternate Voronoi cell structure

All operations on geodetic geometries use a Voronoi ID of 1 that specifies the Voronoi cell structure based on world population density. When you create an index, if your data is clustered in one or more areas of the Earth, such as street data for one or more countries, you can choose an alternate Voronoi cell structure that has smaller cells in the areas where your data is located (because resolution is inversely proportional to cell size). DB2® Geodetic Data Management Feature provides a number of Voronoi cell structures for indexing that might be better suited to your data.

Restriction:
You can choose an alternate Voronoi cell structure only when you create a geodetic Voronoi index.

The dodeca04 structure (Voronoi ID 12) is best suited for data that is uniformly distributed over the entire surface of the Earth, such as satellite imagery. The cells are all roughly uniform in size and the worst-case resolution is approximately 10 centimeters. Consider using a different Voronoi cell structure than the default world population stucture (Voronoi ID 1) or the dodeca04 structure, if any of the following conditions apply to your data or your application:

High resolution
If you need to determine if objects less than 10 centimeters apart intersect, you must use a Voronoi cell structure that has smaller cells in the regions where your data is located. Resolution is inversely proportional to cell size.

Polygons with many vertexes
If your data consist of polygons that have relatively large numbers of vertexes and are relatively small in area, you might want to switch to a Voronoi cell structure that has more cells in your regions of interest. If most of your polygons have 50 or fewer vertexes, you might not need to switch. If the only polygons in your data set that have many vertexes are continent-sized, you also might not need to switch.

If you have many 3000-vertex polygons that are the size of U.S. counties, you might be able to substantially improve query performance by switching to a different Voronoi cell structure, particularly if your application performs a number of polygon-intersect-polygon queries.

Very dense data
If your data is concentrated in very small regions (for example, you have hundreds of objects per square kilometer) you might be able to improve query performance by using a Voronoi cell structure whose cell density matches your data density.

Creating geodetic Voronoi indexes

Prerequisites

Before you create a geodetic Voronoi index, your user ID must hold the same authorizations and privileges as when you create a spatial grid index.

Restriction:
The same restrictions for creating indexes using the CREATE INDEX statement are in effect when you create a geodetic Voronoi index. That is, the column on which you create an index must be a base table column, not a view column or a nickname column. The DB2 database system will resolve aliases in the process.

DB2 Geodetic Data Management Feature provides a new spatial access method that enables you to create indexes on columns containing geodetic data. Queries that use an index can execute more quickly.

You can create a geodetic Voronoi index in one of the following ways:

- Use the Create Index window of the DB2 Control Center.
- Use the SQL CREATE INDEX statement with the db2gse.spatial_index extension in the EXTEND USING clause.

Create a geodetic Voronoi index using the DB2 Control Center or the command line processor.

- To create a geodetic Voronoi index using the Control Center, right-click the table that has the spatial column on which you want to create a geodetic Voronoi index, and click **Spatial Extender → Spatial Indexes** from the menu. The Spatial Indexes window opens. Follow the prompts to complete the task.
- To create a geodetic Voronoi index using the SQL CREATE INDEX statement, issue the CREATE INDEX statement using the EXTEND USING clause and the db2gse.spatial_index grid index extension.

In the following example, CREATE INDEX statement creates the STORESX1 geodetic index on the spatial column LOCATION in the CUSTOMERS table:

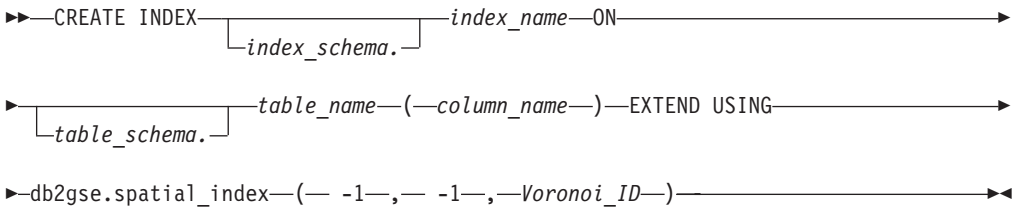
```
CREATE INDEX storesx1
   ON customers (location)
   EXTEND USING db2gse.spatial_index (-1, -1, 1)
```

For a geodetic Voronoi index, you must specify the value –1 in the first two parameters of the USING db2gse.spatial_index clause.

CREATE INDEX statement for a geodetic Voronoi index

Use the CREATE INDEX statement with the EXTEND USING clause to create a geodetic Voronoi index.

Syntax:



Where:

index_schema
Name of the schema to which the index that you are creating is to belong. If you do not specify a name, the DB2 database system uses the schema name that is stored in the CURRENT SCHEMA special register.

index_name
Unqualified name of the geodetic index that you are creating.

table_schema
Name of the schema to which the table that contains *column_name* belongs. If you do not specify a name, the DB2 database system uses the schema name that is stored in the CURRENT SCHEMA special register.

table_name
Unqualified name of the table that contains *column_name*.

column_name
Name of the spatial column on which the geodetic Voronoi index is created.

Voronoi_ID
An integer that identifies the Voronoi cell structure ID. Fourteen Voronoi

cell structures are available. A Voronoi ID of 1 specifies the Voronoi cell structure that is based on world population density that is also used for all spatial operations by DB2 Geodetic Data Management Feature.

Examples

The following example CREATE INDEX statement creates the STORESX1 geodetic index on the spatial column LOCATION in the CUSTOMERS table:

```
CREATE INDEX storesx1
   ON customers (location)
   EXTEND USING db2gse.spatial_index (-1, -1, 1)
```

The optimizer considers a Voronoi index for use by all queries that contain the following functions in their WHERE clause:

- ST_Contains
- ST_Distance
- ST_Intersects
- ST_MBRIntersects
- ST_EnvIntersects
- EnvelopesIntersect
- ST_Within

The following statements demonstrate the use of a Voronoi index. First, insert data into the CUSTOMER table. You can enter values directly, as shown in this first INSERT statement:

```
INSERT INTO customer
(id, last_name, first_name, address, city, state, zip,
location)
VALUES
('123-456789', 'Duck', 'Donald',
'123 Mallard Way', 'Wetland Marsh', 'ND', '55555-5555',
db2gse.ST_GeomFromWKT('POINT(123.123, 45.67)', 2000000000))
```

Alternatively, you can use variables in an application, as the next query shows, to insert values into a table:

```
INSERT INTO customer
(id, last_name, first_name,
address, city, state, zip,
location)
VALUES
(:mid, :mlast, :mfirst,
:maddress, :mcity, :mstate, :mzip,
db2gse.ST_GeomFromWKB(:mlocation))
```

The following UPDATE statement modifies the inserted data. It does not use the STORESX1 index because it does not use the ST_Contains, ST_Distance, ST_Intersects, ST_MBRIntersects, ST_EnvIntersects, EnvelopesIntersect, or ST_Within function in its WHERE clause.

```
UPDATE customer
SET location = db2gse.ST_GeomFromWKT('POINT(123.123, 45.67)',
2000000000)
WHERE id = '123-456789';
```

The following DELETE statements can use the STORESX1 index, if the optimizer determines that the index improves performance because the DELETE statements use the ST_Within function and ST_Intersects functions in their WHERE clauses, respectively:

```
DELETE FROM customers
WHERE db2gse.ST_Within(location, :BayArea) = 1;
DELETE FROM customers
WHERE db2gse.ST_Intersects(c.location, :BayArea) = 1
```

The following two SELECT statements can also use the STORESX1 index:

```
SELECT s.id, AVG(c.location..ST_Distance(s.location))
FROM customers c, stores s
WHERE db2gse.ST_Within(c.location, s.zone) = 1
GROUP BY s.id;
SELECT c.location..ST_AsText()
FROM customers c
WHERE db2gse.ST_Within(c.location, :BayArea) = 1
```

Voronoi cell structures supplied with DB2 Geodetic Data Management Feature

Each Voronoi cell structure covers the entire Earth. In the illustrations that follow, only those portions of the Earth in the area where cells are dense for that Voronoi cell structure are shown. When you select a Voronoi cell structure, keep in mind that the cells outside the illustrated areas will be large, with correspondingly lower resolution. If your data is located in these sparse areas, query performance might be degraded.

The following table lists the Voronoi cell structures that DB2 Geodetic Data Management Feature supplies. These Voronoi cell structures are provided by Geodyssey Ltd.

Table 24. Voronoi cell structures

Description	Voronoi ID	Illustration
World, based on population density	1	Figure 22 on page 151
United States	2	Figure 23 on page 152
Canada	3	Figure 24 on page 153
India	4	Figure 25 on page 154
Japan	5	Figure 26 on page 155
Africa	6	Figure 27 on page 156
Australia	7	Figure 28 on page 157
Europe	8	Figure 29 on page 158
North America	9	Figure 30 on page 159
South America	10	Figure 31 on page 160
Mediterranean	11	Figure 32 on page 161
World, uniform data distribution, medium resolution (dodeca04)	12	Figure 33 on page 162
World, based on industrial output (G7 nations)	13	Figure 34 on page 163
World, uniform data distribution, low resolution (isotype)	14	Figure 35 on page 164

World, based on population density (Voronoi ID: 1)

Voronoi cells subdivide the Earth based on world population density.

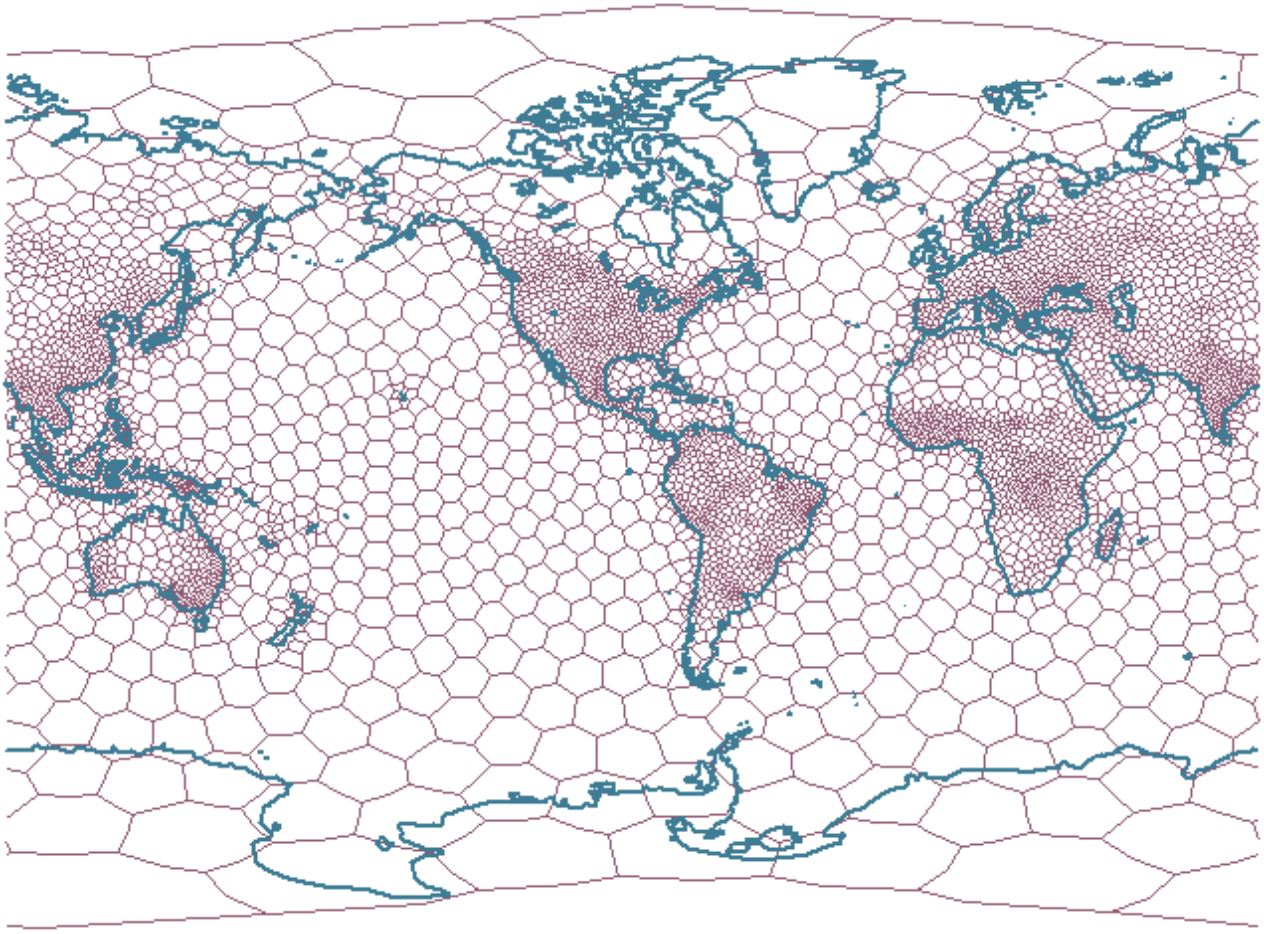


Figure 22. Voronoi cell structure for the world (population)

United States (Voronoi ID: 2)

Voronoi cells subdivide the USA based on population density.

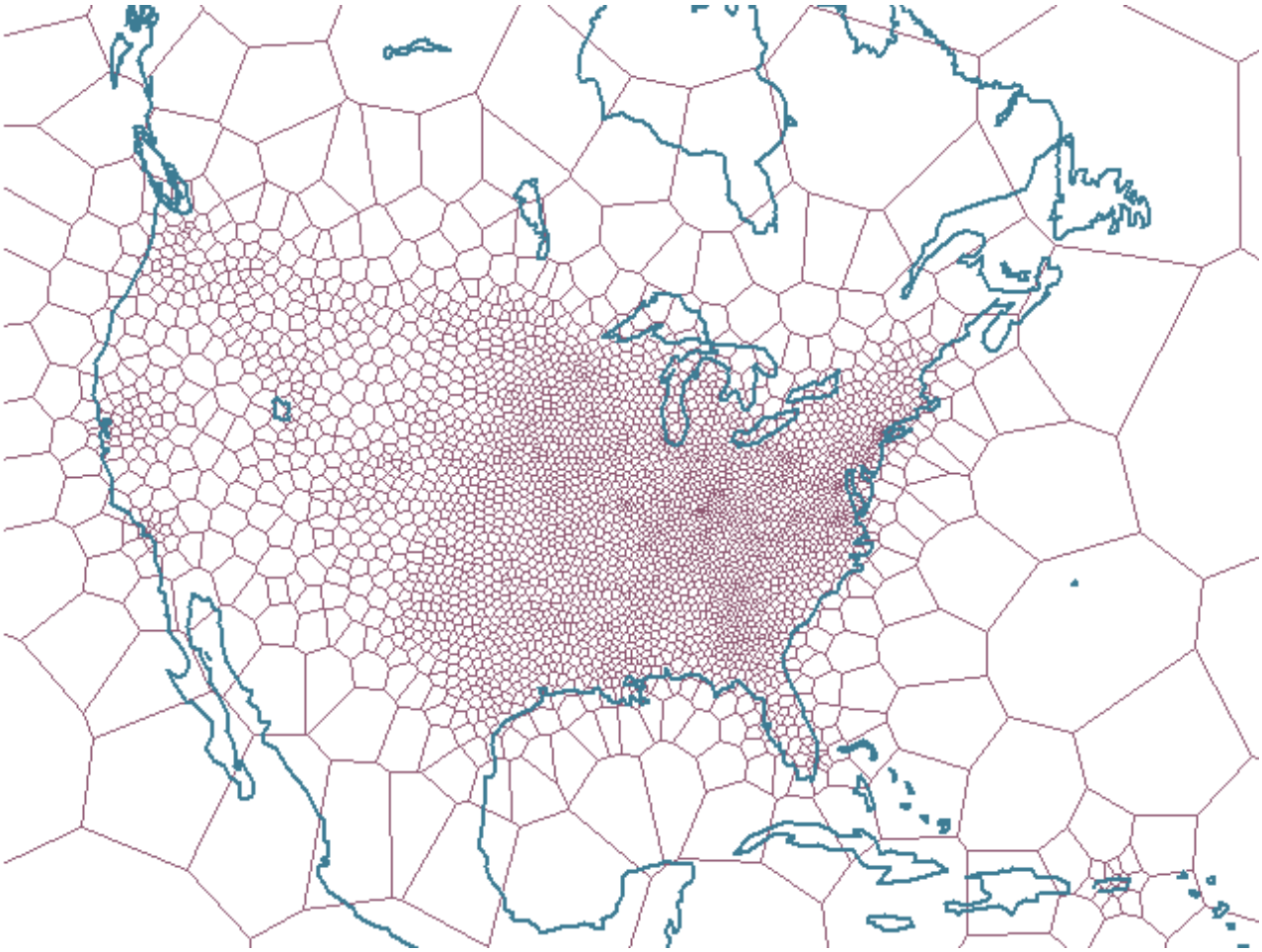


Figure 23. Voronoi cell structure for the USA

Canada (Voronoi ID: 3)

Voronoi cells subdivide Canada based on population density.

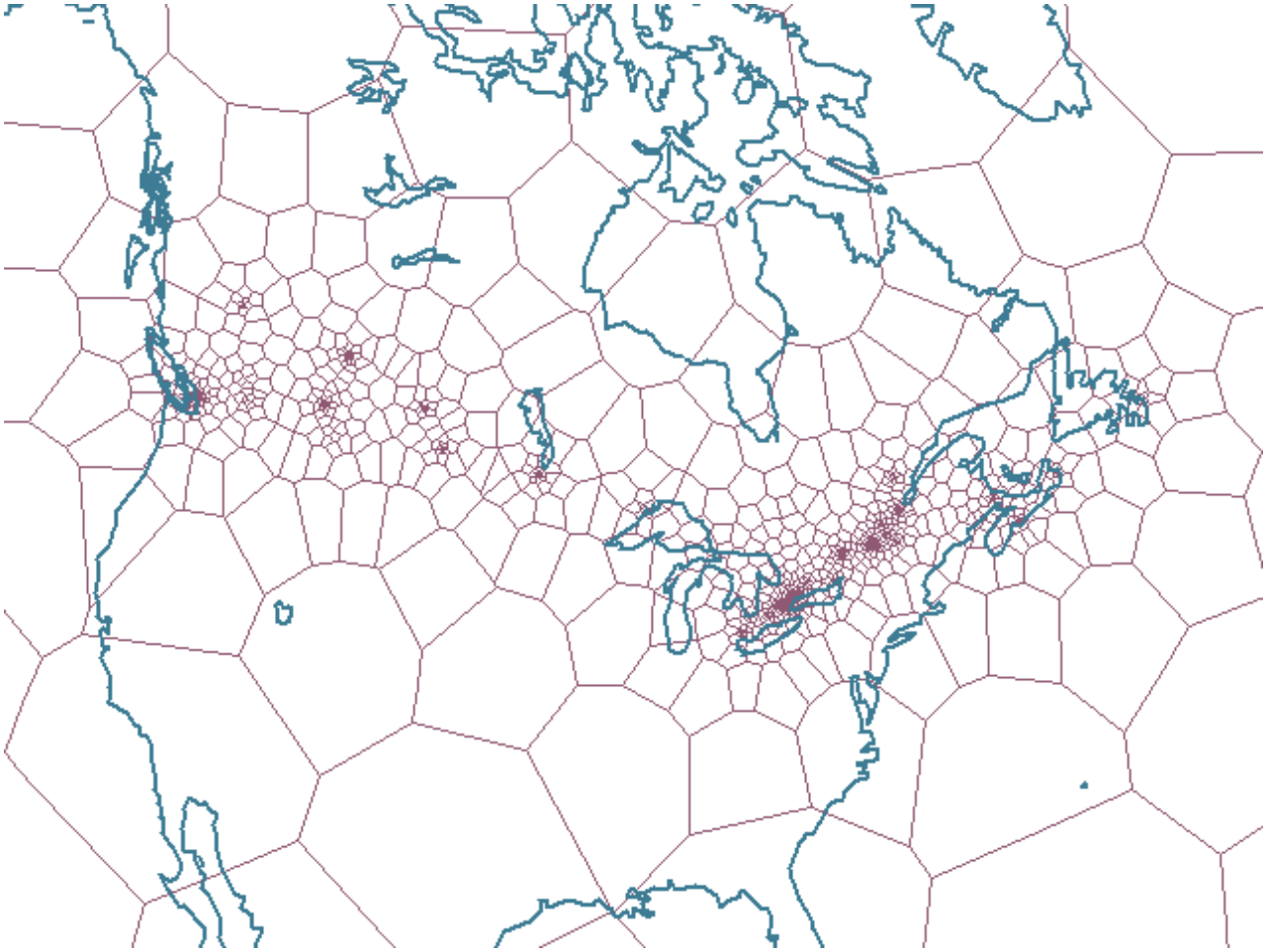


Figure 24. Voronoi cell structure for Canada

India (Voronoi ID: 4)

Voronoi cells subdivide India based on population density.

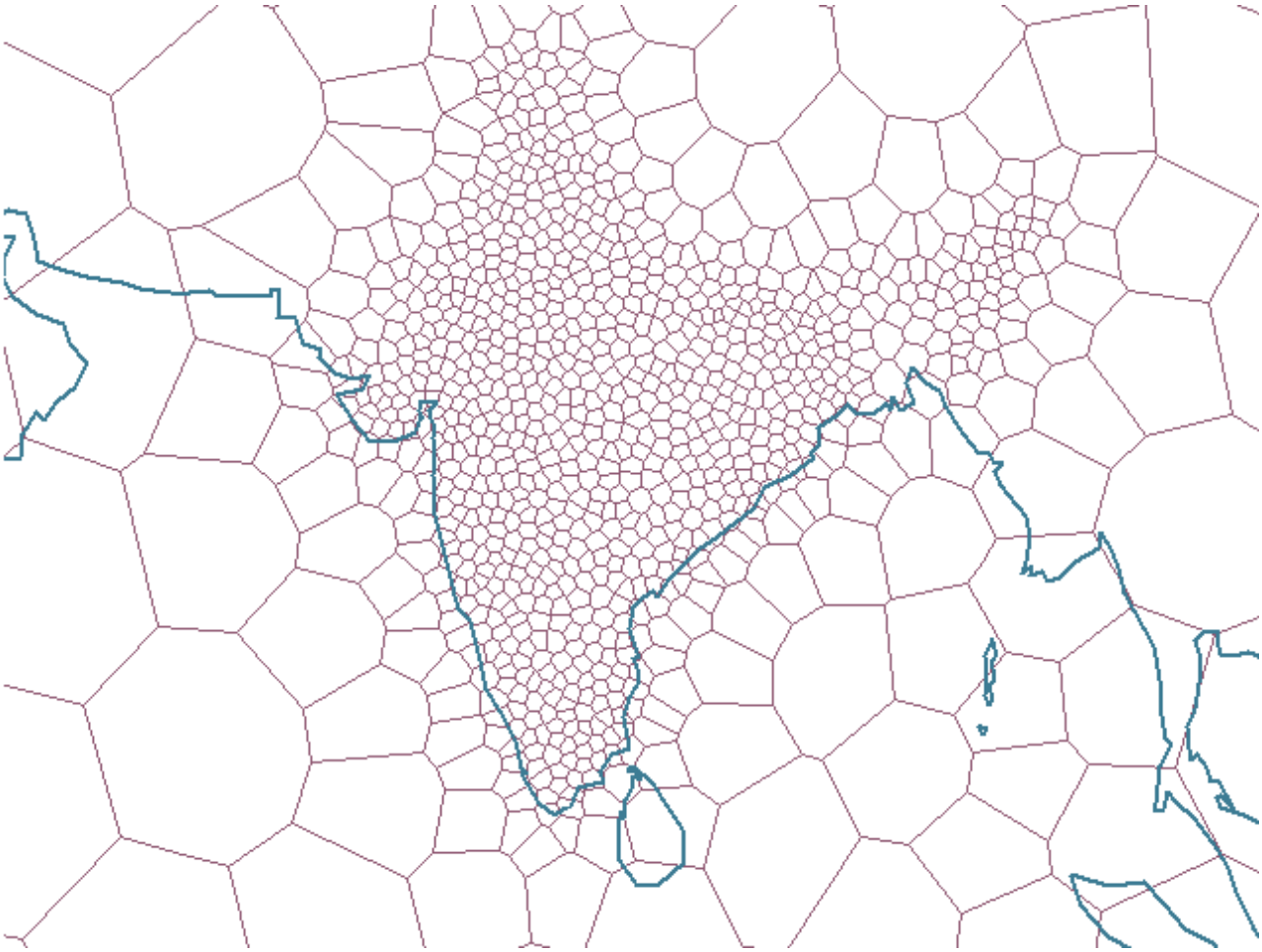


Figure 25. Voronoi cell structure for India

Japan (Voronoi ID: 5)

Voronoi cells subdivide Japan based on population density.

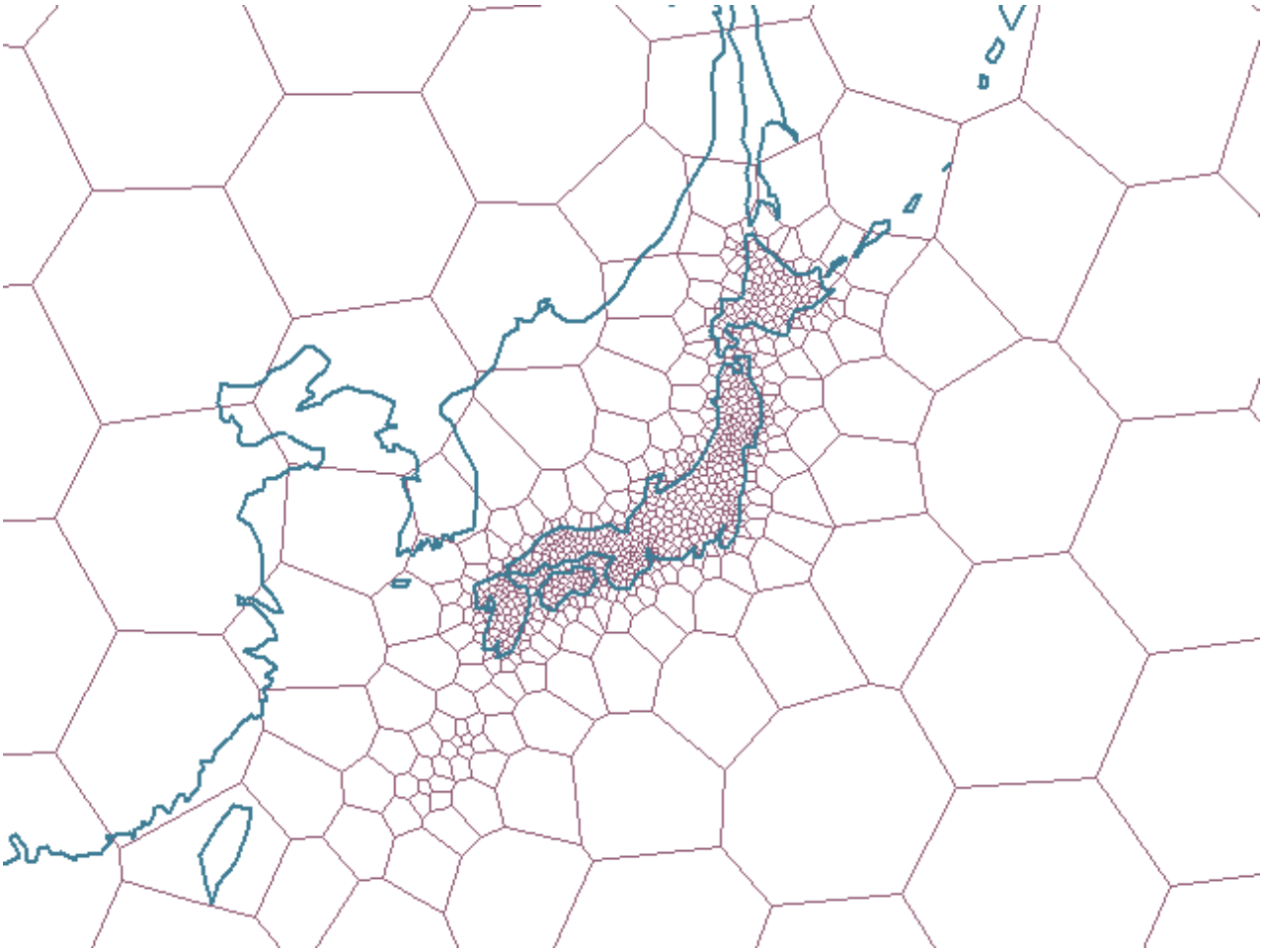


Figure 26. Voronoi cell structure for Japan

Africa (Voronoi ID: 6)

Voronoi cells subdivide Africa based on population density.

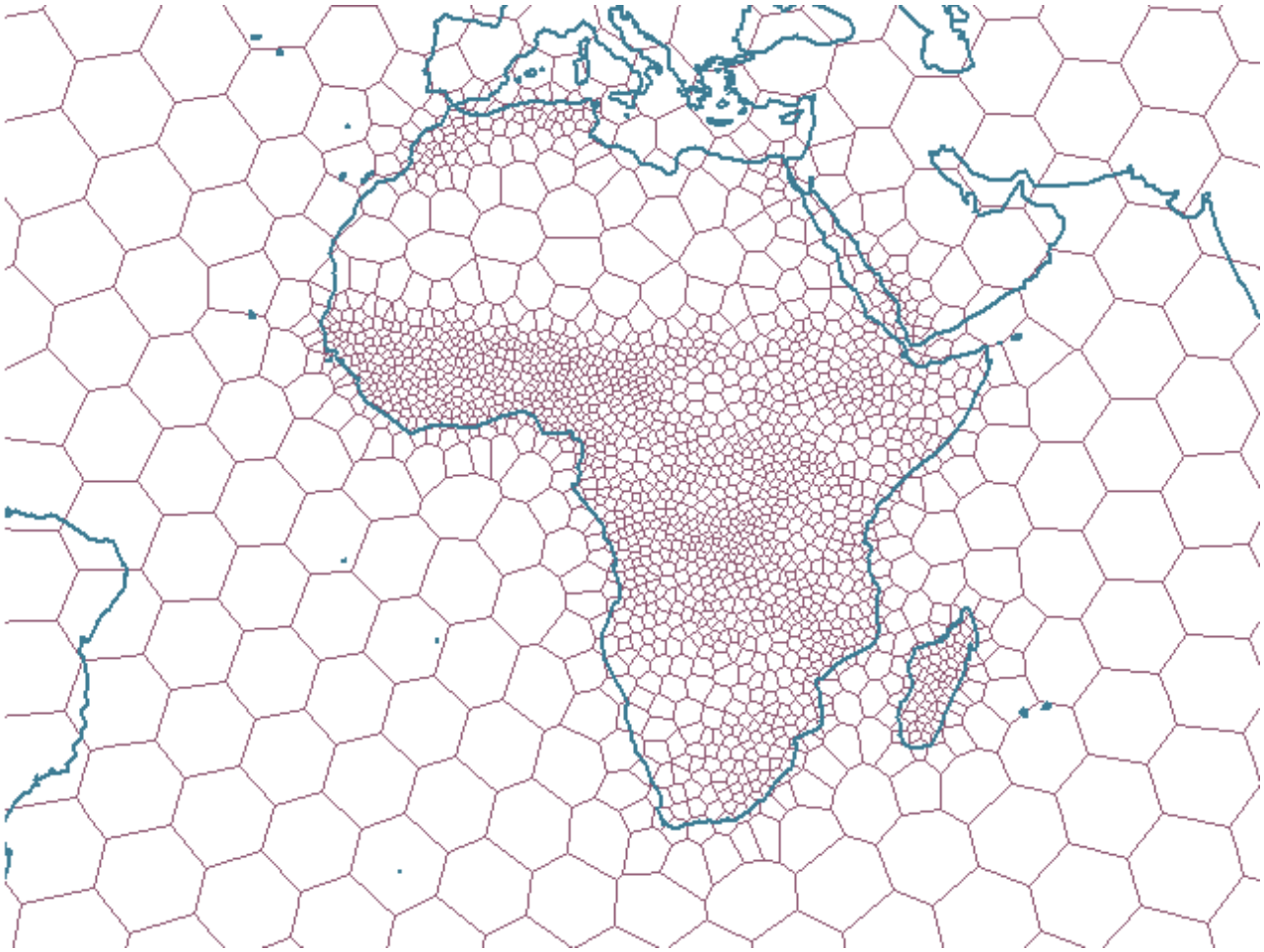


Figure 27. Voronoi cell structure for Africa

Australia (Voronoi ID: 7)

Voronoi cells subdivide Australia based on population density.

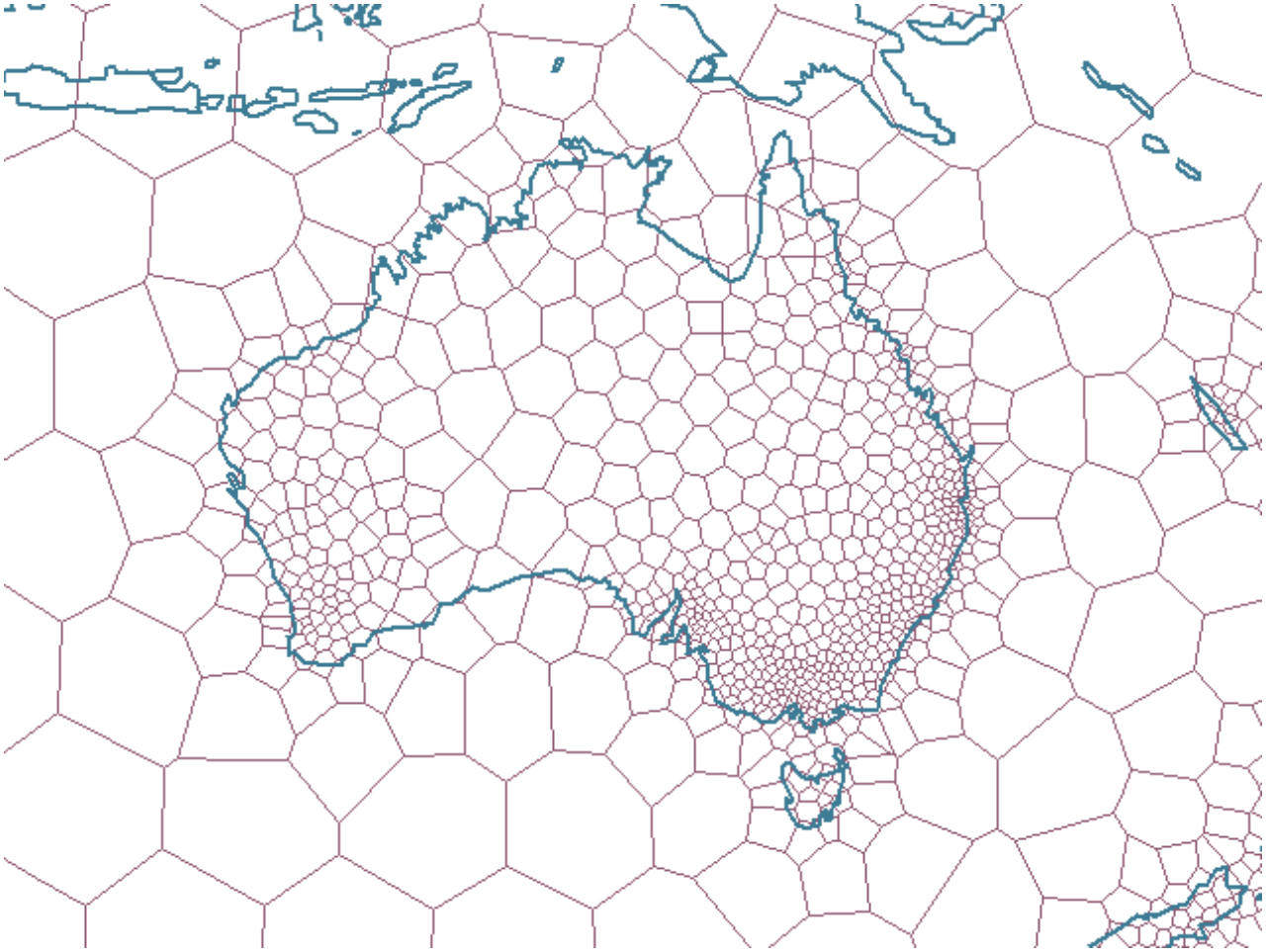


Figure 28. Voronoi cell structure for Australia

Europe (Voronoi ID: 8)

Voronoi cells subdivide Europe based on population density.

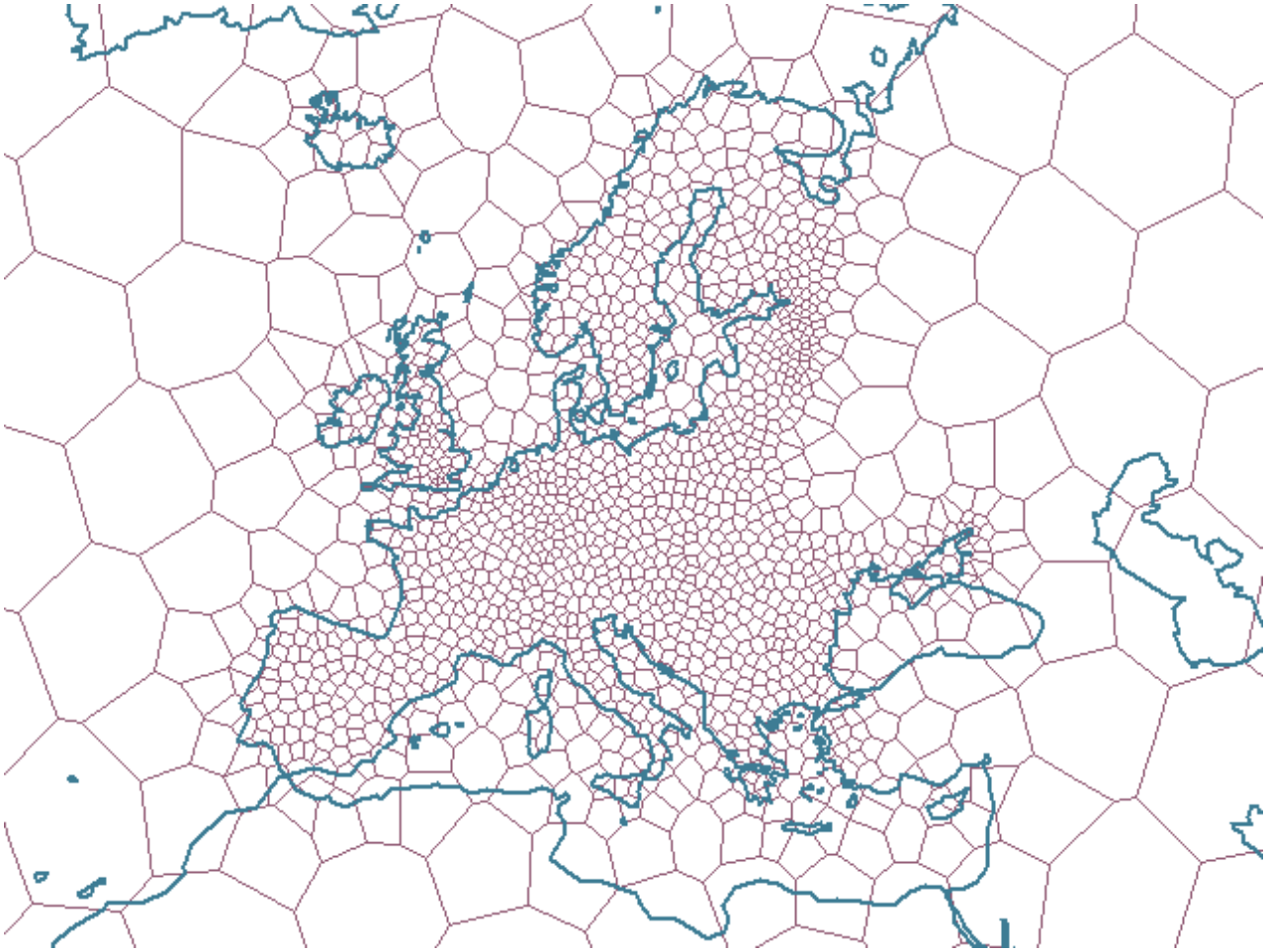


Figure 29. Voronoi cell structure for Europe

North America (Voronoi ID: 9)

Voronoi cells subdivide North America based on population density.

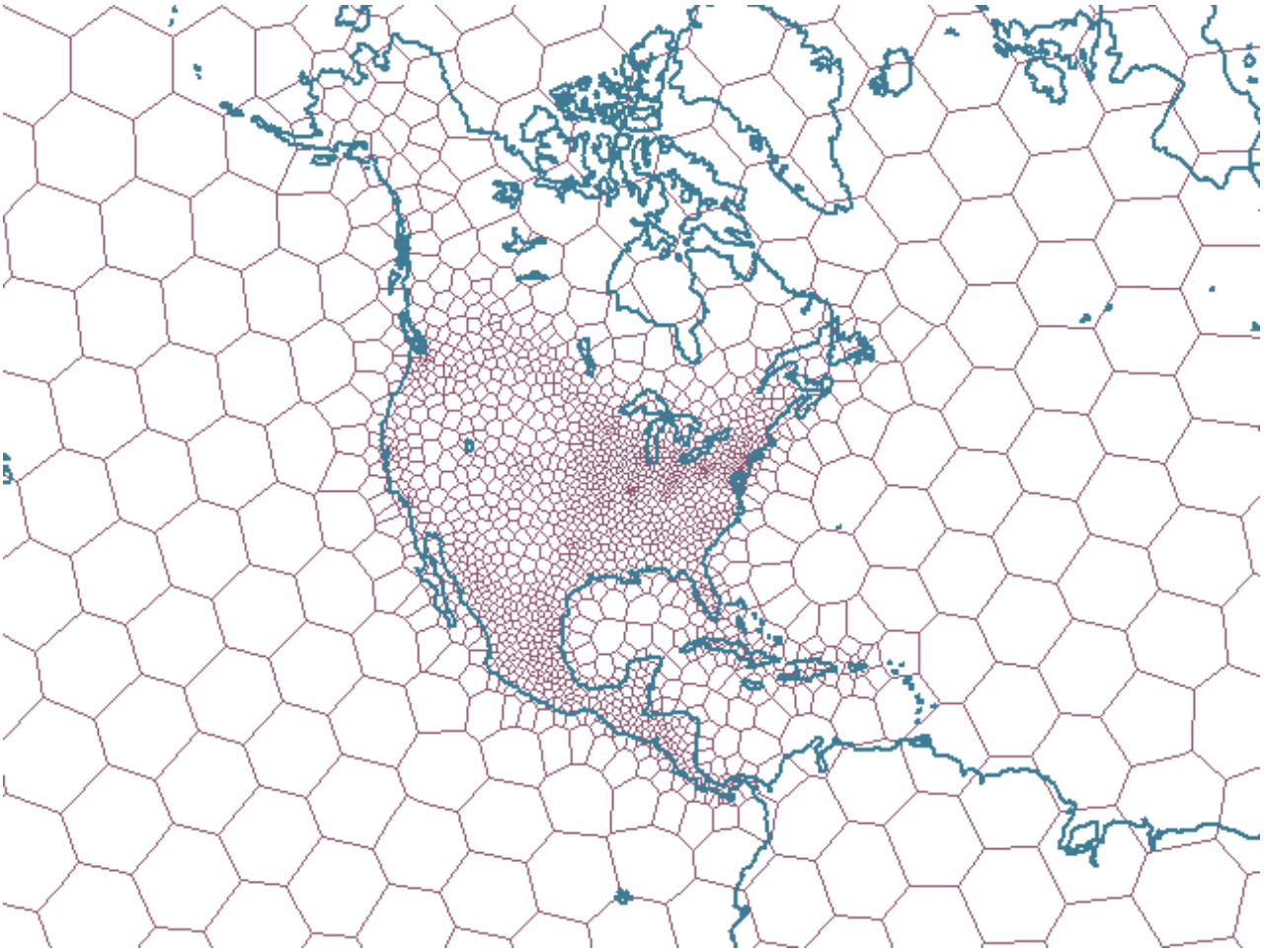


Figure 30. Voronoi cell structure for North America

South America (Voronoi ID: 10)

Voronoi cells subdivide South America based on population density.

Figure 31. Voronoi cell structure for South America

Mediterranean (Voronoi ID: 11)

Voronoi cells subdivide the Mediterranean area based on population density.

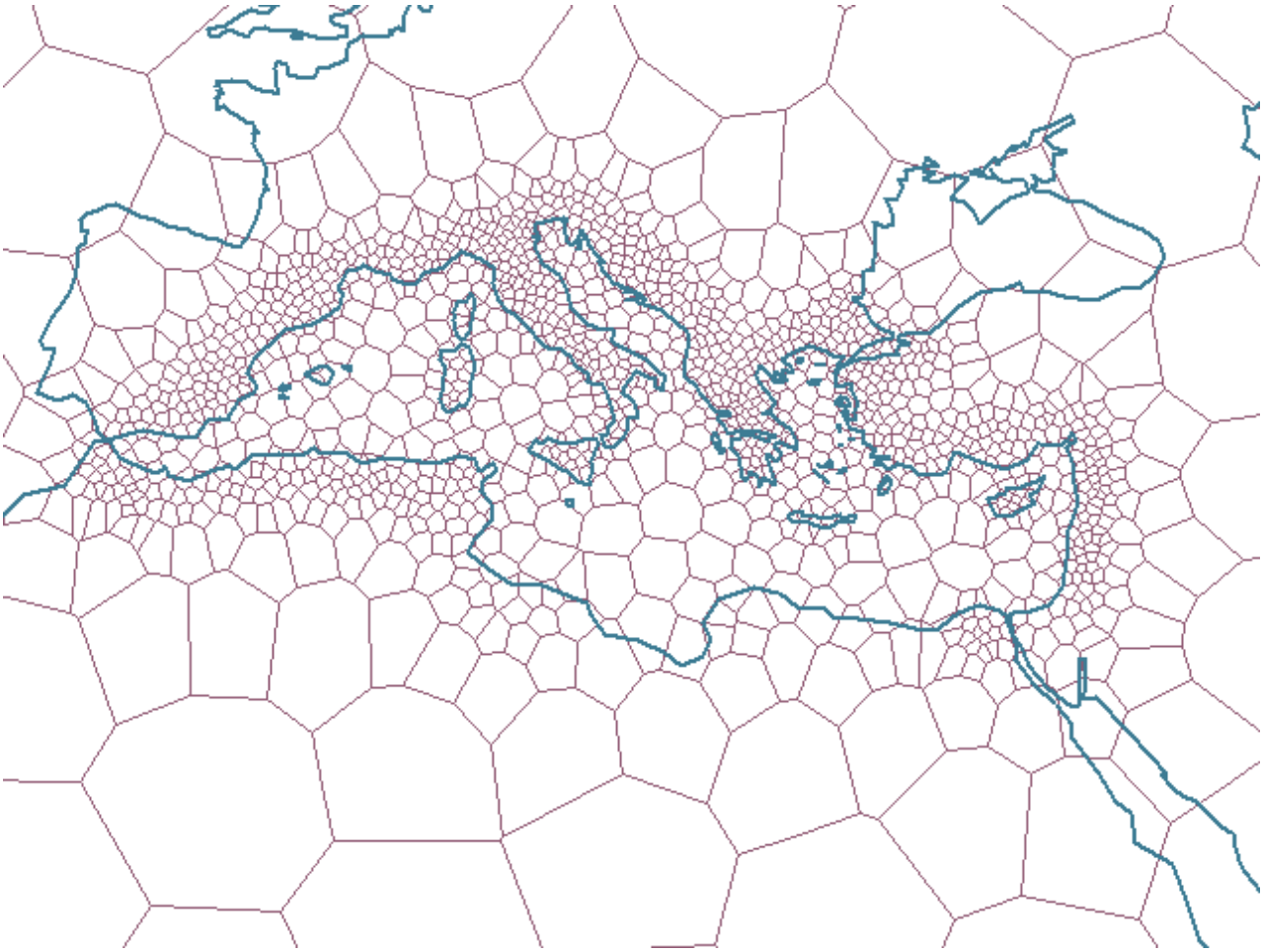


Figure 32. Voronoi cell structure for the Mediterranean area

World, uniform data distribution, medium resolution – dodeca04 (Voronoi ID: 12)

Voronoi cells subdivide the world with uniform data distribution and medium resolution.

Figure 33. Voronoi cell structure for the world (dodeca04)

World, industrial nations – G7 nations (Voronoi ID: 13)

Voronoi cells subdivide the world based on industrial output of the nations.

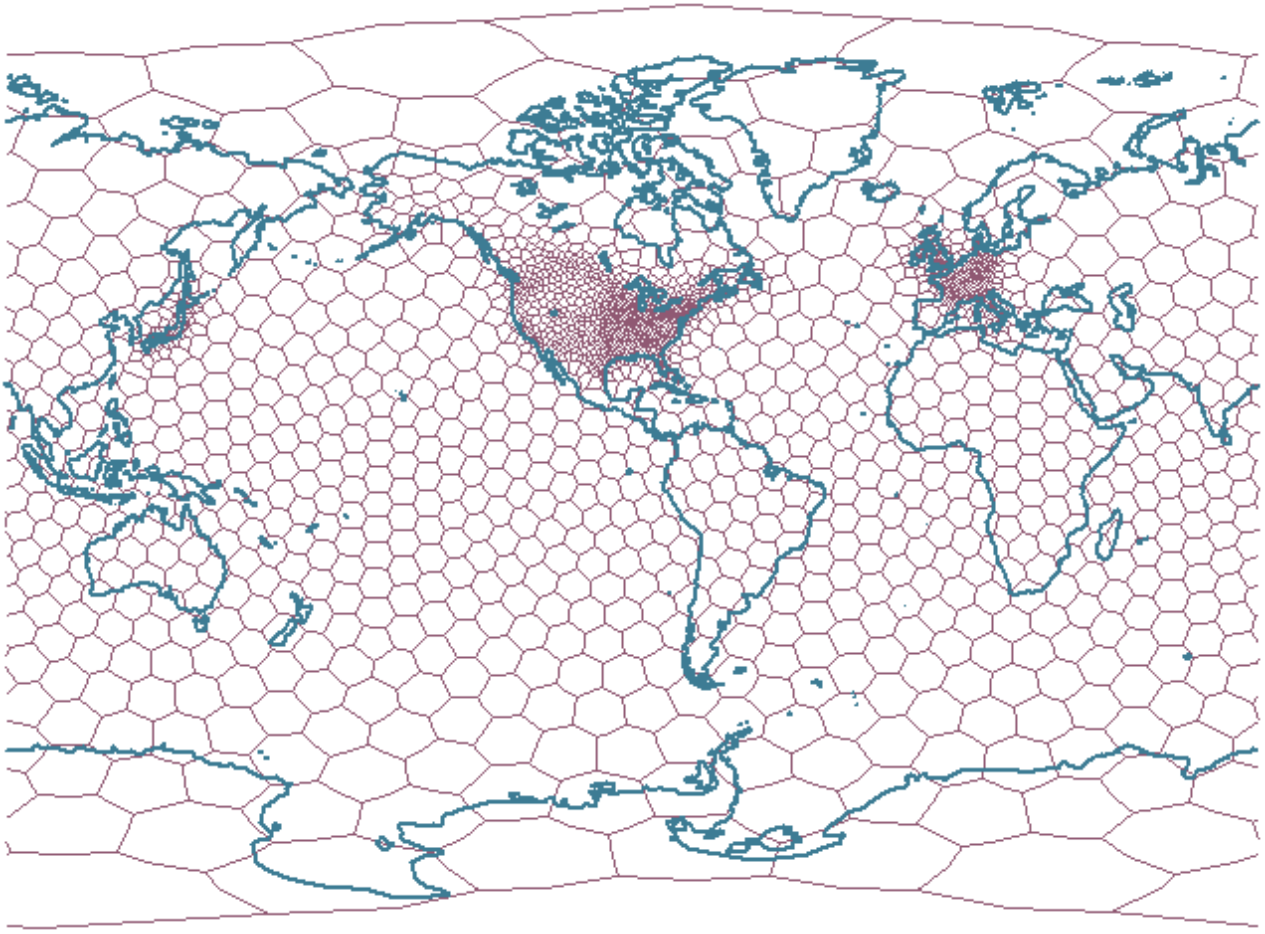


Figure 34. Voronoi cell structure for (g7nations)

World, uniform data distribution, low resolution – isotype (Voronoi ID: 14)

Voronoi cells subdivide the world with uniform data distribution and low resolution.

Figure 35. Voronoi cell structure for the world (isotype)

Chapter 19. Differences in using geodetic and spatial data

This chapter describes the following differences in using geodetic and spatial data:

- Minimum and maximum x and y attributes for ST_Geometry data types
- Differences in working with flat-Earth and round-Earth representations
- Spatial functions supported by DB2 Geodetic Data Management Feature and differences in function behavior
- Stored procedures and catalog views supported by DB2 Geodetic Data Management Feature
- Additional geodetic spatial references systems (datums) and geodetic ellipsoids

Minimum and maximum x and y attributes

DB2® Geodetic Data Management Feature uses a minimum bounding circle (MBC) instead of a minimum bounding rectangle to organize data into cell structures for the geodetic Voronoi index.

For geodetic geometries, the MBC is a circle that surrounds the geometries, and the minimum and maximum x and y have the following internal values:

xmin The *i* term of the direction cosine of the center of the bounding circle.

xmax The *j* term of the direction cosine of the center of the bounding circle.

ymin The *k* term of the direction cosine of the center of the bounding circle.

ymax The *arc_radius* of the bounding circle.

For geodetic geometries, the ST_MinX, ST_MaxX, ST_MinY and ST_MaxY functions display points along the MBC. The results of these functions still produce longitude and latitude values similar to spatial geometries, but the results can differ for geodetic geometries as follows:

- If the MBC crosses the dateline, the ST_MinX value is greater than the ST_MaxX value. For example, if the center of a MBC is at the dateline and has a radius of 5 degrees, then the ST_MinX value is 175, and the ST_MaxX value is –175.
- If the MBC includes the North pole or the South pole, ST_MinX is –180 and ST_MaxX is 180.
- If the MBC includes the North pole, the ST_MaxY value is 90.
- If the MBC includes the South pole, the ST_MinY value is –90.

Differences in working with flat-Earth and round-Earth representations

DB2 Spatial Extender and DB2 Geodetic Data Management Feature use different core technologies:

- Spatial Extender uses a flat (or planar) map, based on projected coordinates. However, no map projection can faithfully represent the entire Earth because every map has edges; whereas, the Earth does not have edges.
- Geodetic Data Management Feature uses an ellipsoid as its model to treat the Earth as a seamless globe that has no distortions at the poles or edges at the 180th meridian.

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In this section, the term ″flat-Earth″ refers to the use of a projection to represent the entire Earth. The term ″round-Earth″ referes to the use of a reference system that uses an ellipsoid as its Earth model.

The different technologies lead to differences in how geometries are handled in certain situations, especially those illustrated in this topic:

- Line segments (and measured distances) that cross the 180th meridian.
- Polygons that straddle the 180th meridian.
- Minimum bounding rectangles that cross the 180th meridian.
- Polygons that enclose a pole.
- Polygons that represent hemispheres, equatorial belts, or the whole Earth.

Geodetic Data Management Feature has particular advantages when you are working with geometries that cross the 180th meridian, or are close to a pole, where the flat-Earth representation used by Spatial Extender encounters limitations.

Line segments that cross the 180th meridian

A round-Earth representation gives a shorter path than a flat-Earth projection.

Figure 36 on page 167 shows the different ways that Spatial Extender and Geodetic Data Management Feature handle a line segment that crosses the 180th meridian. In this example, the line segment is used to measure the distance between Anchorage and Tokyo. Geodetic Data Management Feature measures distance between two points along a geodesic, the shortest path between two points on the ellipsoid. The two points can be located anywhere on the globe, and Geodetic Data Management Feature correctly chooses a line segment that travels west from Anchorage to Tokyo because it uses the round-Earth representation. However, because Spatial Extender uses flat-map projection, Spatial Extender is unaware that a line segment could connect Anchorage and Tokyo that way, and it chooses a much longer line segment that travels eastwards to Tokyo. The flat-map projection has the –180th meridian at the left edge and the 180th meridian at the right edge.

To obtain a correct result using Spatial Extender, you need to take one of the following actions:

- Split the line segment into two line segments, one east of the 180th meridian and the other west of it.
- Reproject the data in such a way that the 180th meridian is not at an edge.

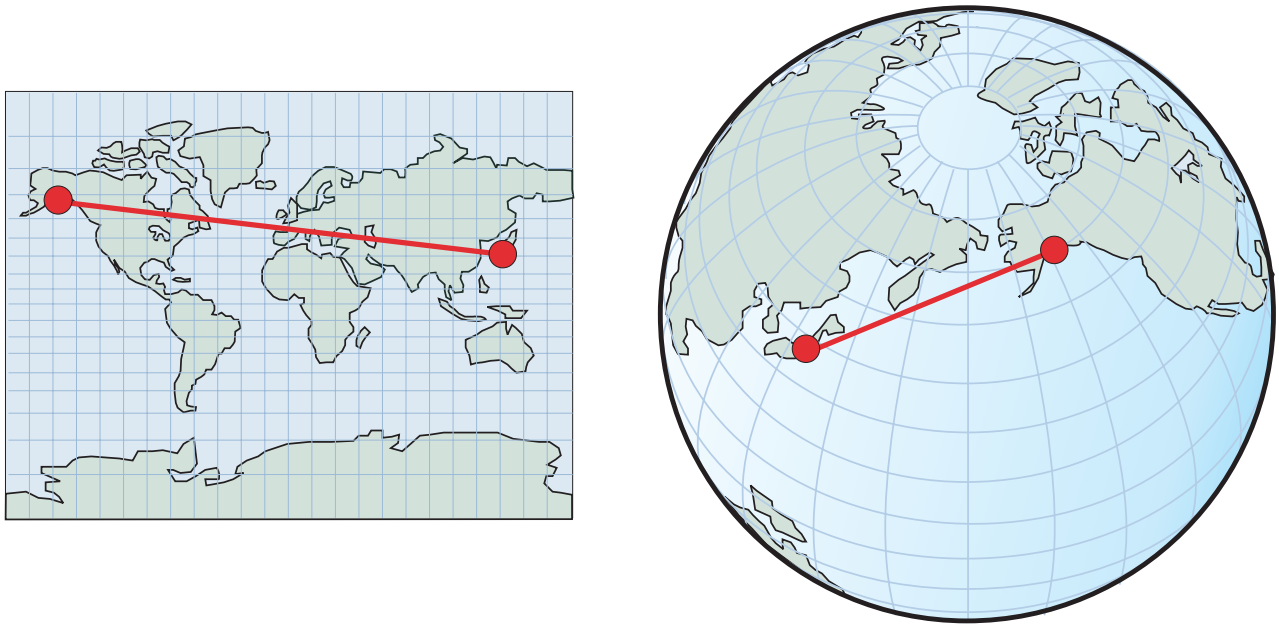


Figure 36. Lines that cross the 180th meridian

Polygons that straddle the 180th meridian

To handle a polygon that straddles the 180th meridian, the flat-Earth representation (Spatial Extender) requires that you split the polygon into two parts.

The following example shows a polygon for the portion to the east of the 180th meridian, and a polygon for the portion to the west of the meridian:

```
  MULTIPOLYGON(
((–180 30, –165 30, –165 40, –180 40, –180 30)),
((180 30, 180 40, 165 40, 165 30, 180 30)))
```

As Figure 37 on page 168 shows, the round-Earth representation (Geodetic Data Management Feature) requires no such split, and you can use a single, unaltered polygon:

```
  POLYGON((165 30, –165 30, –165 40, 165 40, 165 30))
```

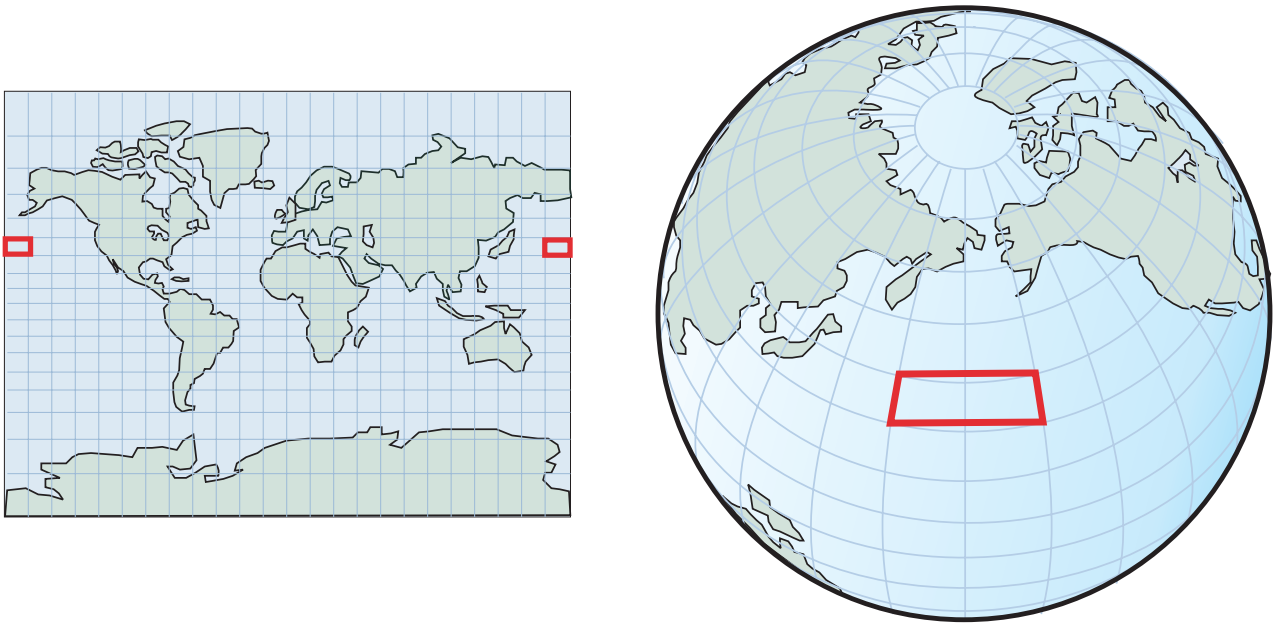


Figure 37. Polygons that straddle the 180th meridian—create two separate polygons

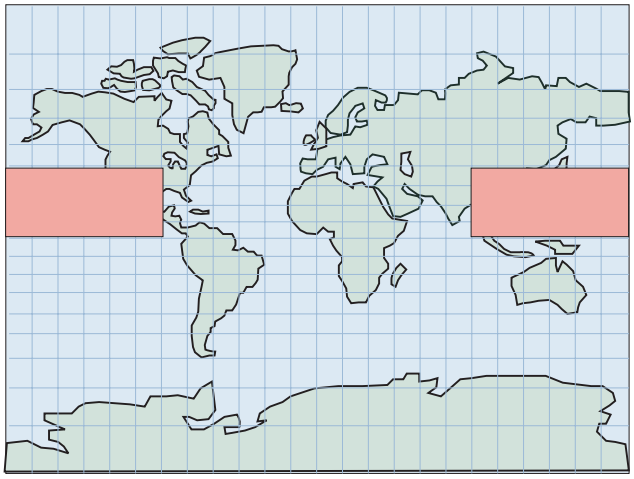
If you did not create two separate polygons while using Spatial Extender, it would actually reorder the vertices of the polygon so that it defined a different area, as Figure 38 on page 169 shows. The top part of Figure 38 on page 169 shows the correct vertices of a polygon straddling the 180th meridian:

```
POLYGON((90 0, -90 0, -90 40, 90 40, 90 0))
```

The bottom part of Figure 38 on page 169 shows the reordered vertices which results in a polygon that no longer straddles the 180th meridian, but now straddles the 0th meridian.

```
POLYGON((-90 0, 90 0, 90 40, -90 40, -90 0))
```

You want a polygon that straddles the 180th meridian:
Polygon ((90 0, -90 0, -90 40, 90 40))



But Spatial Extender reorders the vertices and the resultant polygon defines a different area:
Polygon ((-90 0, 90 0, 90 40, -90 40))

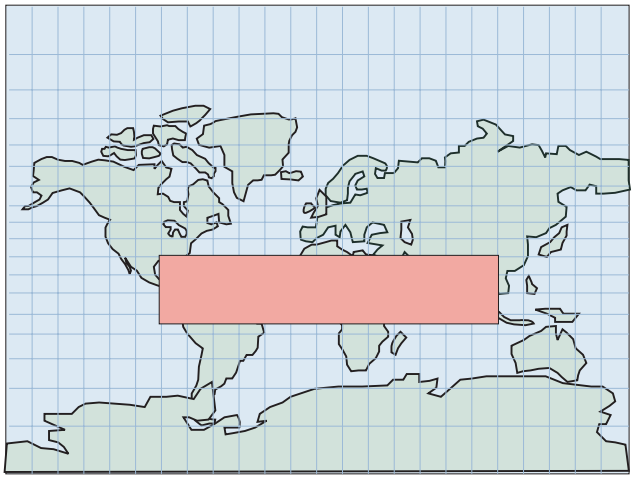


Figure 38. Polygons that straddle the 180th meridian—reordered vertices

The area defined would be the complementary area of the Earth, and not the intended area, as shown in Figure 39 on page 170. Similar to the line segment example above, another way to handle this situation is to reproject the data in such a way that the 180th meridian is not at an edge.

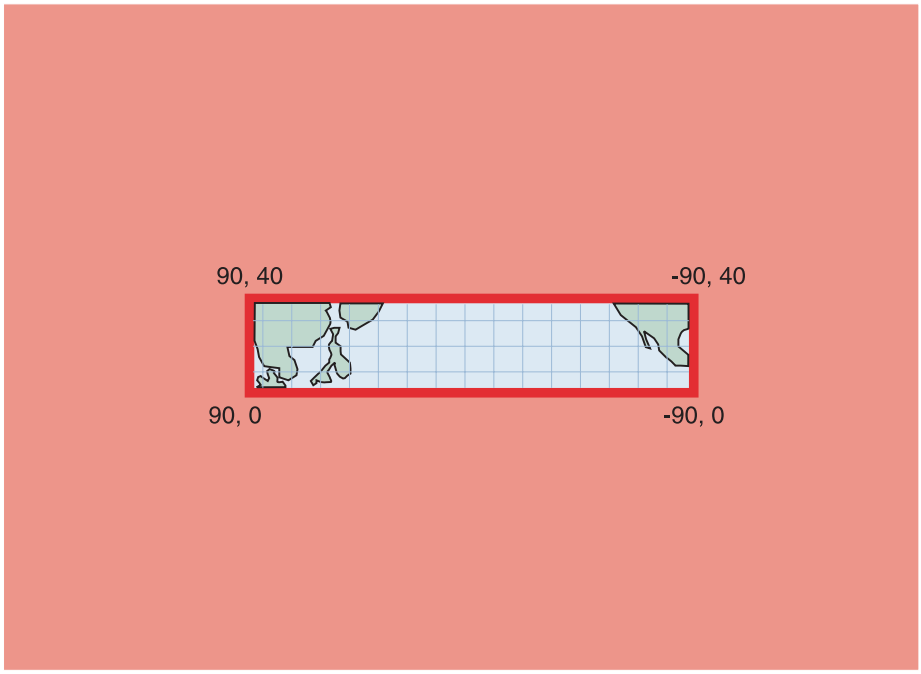


Figure 39. Polygons that straddle the 180th meridian—complementary area

Polygons that enclose a pole

Because you are working right at the edge of the flat-map projection with Spatial Extender, the map's distortion of the Earth's surface requires you to add extra edges and vertices to represent the pole within a polygon.

Figure 40 on page 171 shows how you could work with a polygon that encloses the South pole with Spatial Extender or with Geodetic Data Management Feature:

```
POLYGON((–180 –90, 180 –90, 180 –60, –180 –60, –180 –90))
```

The round-Earth representation (Geodetic Data Management Feature) shows the polygon around the South Pole as a circle that follows the –60° South parallel:

```
POLYGON((0 –60, –1 –60, –2 –60, ..., –179 –60, 180 –60, 179 –60, ..., 1 –60, 0 –60))
```

A better way to represent this circle is to reproject the data in such a way that the entire South Pole and surrounding area are visible on the map.

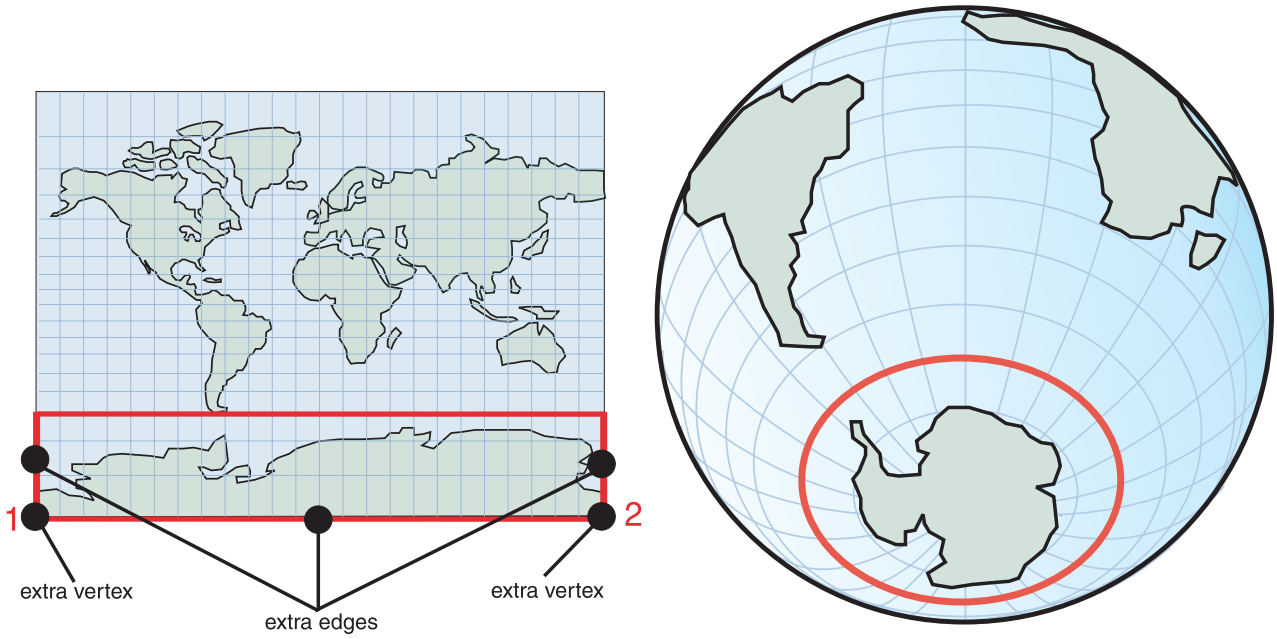


Figure 40. Polygons that enclose a pole

In the examples above, you can obtain accurate results if you choose an appropriate projected spatial reference system. However, no one projection can solve them all simultaneously. For example, a projection that does not have the 180th meridian at the edge puts the edge somewhere else and shifts the problem area.

Polygons that represent hemispheres, equatorial belts, and the whole Earth

A round-Earth representation gives better results for distance and area calculations over a large area of the Earth's surface.

When you must use a polygon to represent large areas of the Earth's surface, such as one of the hemispheres, the equatorial belts, or the whole Earth itself, be aware of the different ways that Spatial Extender and Geodetic Data Management Feature handle these cases. In these situations, a round-Earth representation obtains accurate results for distance and area calculations; whereas, a careful choice of projection cannot.

For example, Figure 41 on page 172, shows the polygons that define the Western hemisphere in a flat-Earth representation (Spatial Extender) and a round-Earth representation (Geodetic Data Management Feature).

- In the flat-Earth representation in the top part of Figure 41 on page 172, four coordinates represent the Western hemisphere in well-known text format as 'POLYGON((0 -90, 0 90, -180 90, 180 -90, 0 -90))'.
- In the round-Earth representation, four coordinates represent the Western hemisphere in well-known text format as 'POLYGON((0 0, 0 90, 180 0, 0 -90, 0 0))'. These four coordinates define a ring around the Earth along the 0th meridian and its antipodal line, the 180th meridian.

When you specify the same four points in the opposite order, you define the Eastern hemisphere:

- In a flat-Earth representation, the Eastern hemisphere is 'POLYGON((0 -90, 180 -90, 180 90, 0 90, 0 -90))'.
- In a round-Earth representation, the Eastern hemisphere is 'POLYGON((0 -90, 180 0, 0 90, 0 0, 0 -90))'.

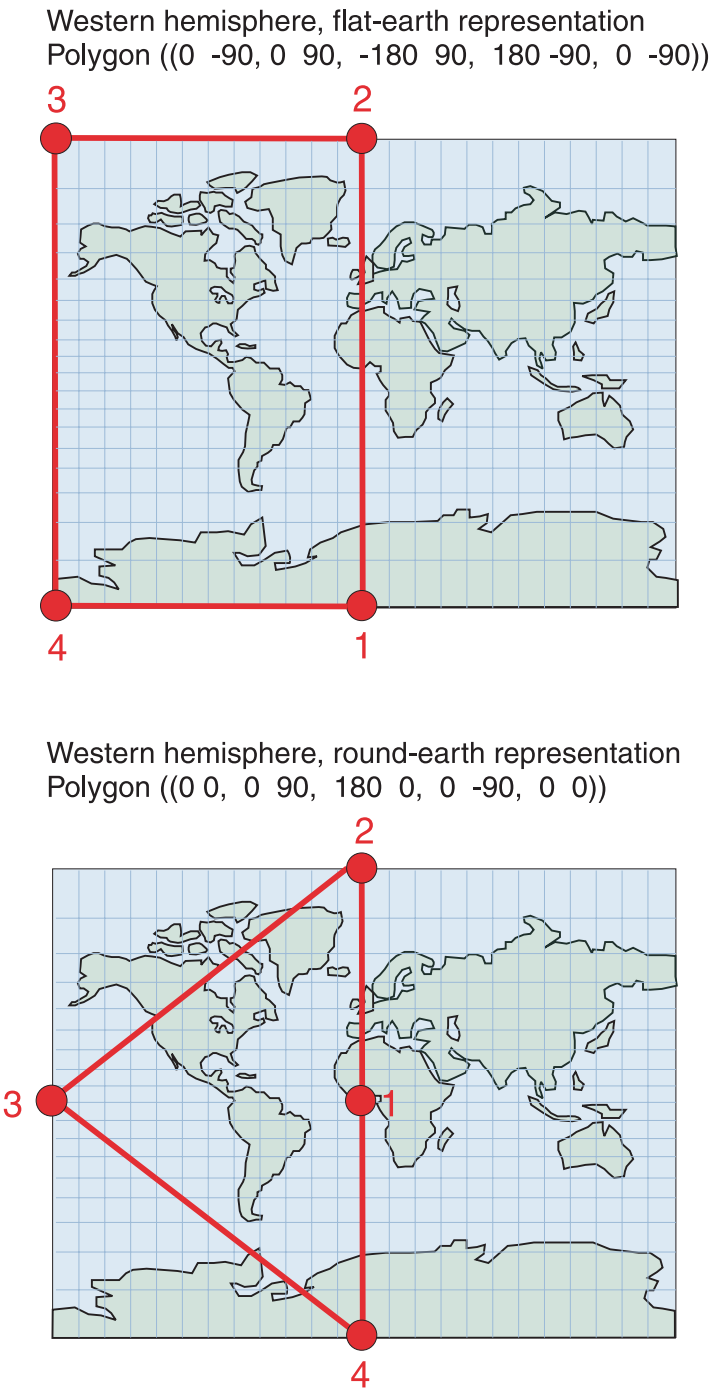


Figure 41. Polygons that represent hemispheres

Figure 42 on page 173, shows the coordinates of polygons that define the equatorial belt in a flat-Earth representation (Spatial Extender) and a round-Earth representation (Geodetic Data Management Feature).

- The top part of Figure 42 shows the flat-earth representation of the equatorial belt with coordinates in well-known text format as 'POLYGON((180 –60, 180 60, –180 60, –180 –60, 180 –60))'.
- In the round-earth representation in the bottom part of Figure 42, you define the exclusion area of two rings to represent the equatorial belt:

```
'MULTIPOLYGON(((0 60, -120 60, 120 60, 0 60)),
   ((0 -60, 120 -60, -120 -60, 0 -60)))'
```

  Only three points in each ring are shown for clarity. In reality, if you want the rings to more closely follow the 60 or –60 latitude line, you need to add more intermediate points. The first ring ((0 60, -120 60, 120 60, 0 60)) specifies the vertices in the order that defines the area south of the 60th latitude line. The second ring ((0 -60, 120 -60, -120 -60, 0 -60)) specifies the area north of the –60 latitude line.

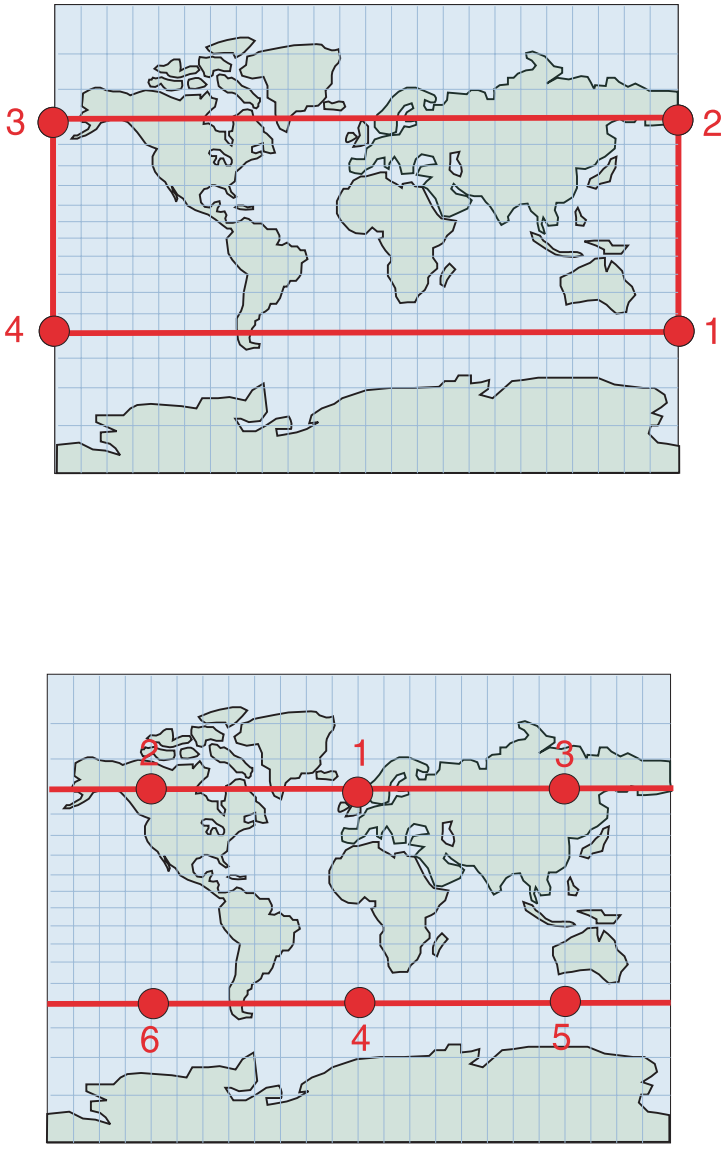


Figure 42. Polygons that represent Equatorial belts

Figure 43, shows polygons that define the whole Earth in a flat-Earth representation (Spatial Extender) and a round-earth representation (Geodetic Data Management Feature). Both representations represent the whole Earth with the same polygon in well-known text format as 'POLYGON((-180 -90, 180 -90, 180 90, -180 90, -180 -90))'.

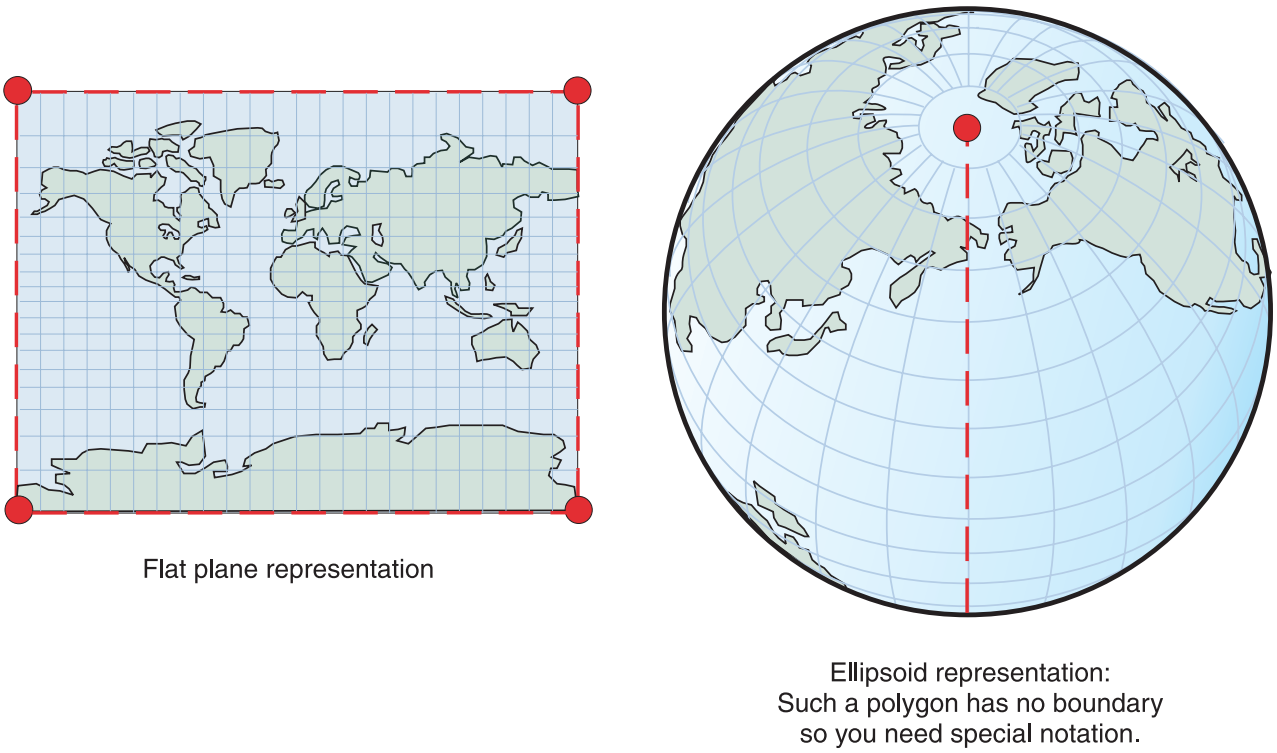


Figure 43. Polygons that represent the whole Earth

Spatial functions supported by DB2 Geodetic Data Management Feature

DB2 Spatial Extender is built on the function library provided by ESRI, and DB2 Geodetic Data Management Feature is built on the Hipparchus function library. Differences between functionality in the ESRI and Hipparchus libraries lead to minor differences in how some functions behave. The following table shows Spatial Extender functions that Geodetic Data Management Feature supports and it notes any differences in behavior. For information about the usage and syntax of spatial functions, see the appropriate spatial function topic.

Table 25. Function support for Geodetic Data Management Feature

Function	Supported by DB2 Geodetic Data Management Feature?	Difference in behavior for DB2 Geodetic Data Management Feature
EnvelopesIntersect	Yes	None
MBR Aggregate	No	Not applicable
ST_AppendPoint	No	Not applicable
ST_Area	Yes	Default unit of measure is meters.
ST_AsBinary	Yes	None

Table 25. Function support for Geodetic Data Management Feature (continued)

Function	Supported by DB2 Geodetic Data Management Feature?	Difference in behavior for DB2 Geodetic Data Management Feature
ST_AsGML	Yes	None
ST_AsShape	Yes	None
ST_AsText	Yes	None
ST_Boundary	No	Not applicable
ST_Buffer	Yes	Supported with points and multipoints only. Distance can be a negative value. Default unit of measure is meters.
ST_Centroid	No	Not applicable
ST_ChangePoint	No	Not applicable
ST_Contains	Yes	Both geometries must be in the same geodetic spatial reference system (SRS).
ST_ConvexHull	No	Not applicable
ST_CoordDim	Yes	None
ST_Crosses	No	Not applicable
ST_Difference	Yes	Not supported with linestrings and multilinestrings. Both geometries must be in the same geodetic SRS. Dimension of returned geometry is the same as that of the input geometries.
ST_Dimension	Yes	None
ST_Disjoint	Yes	None
ST_Distance	Yes	Returns the *geodesic distance*. Both geometries must be in the same geodetic SRS. Default unit of measure is meters.
ST_Edge_GC_USA	Yes	None
ST_Endpoint	Yes	None
ST_Envelope	Yes	Envelope is a polygon that encloses the minimum bounding circle (MBC) of the geometry.
ST_EnvIntersects	Yes	None
ST_EqualCoordsys	Yes	None
ST_Equals	No	Not applicable
ST_EqualSRS	Yes	None
ST_ExteriorRing	Yes	None
ST_FindMeasure or ST_LocateAlong	No	Not applicable
ST_Generalize	Yes	Unit for threshold is meters.
ST_GeomCollection	No	Not applicable
ST_GeomCollFromTxt	No	Not applicable
ST_GeomCollFromWKB	No	Not applicable
ST_Geometry	Yes	None
ST_GeometryN	Yes	None

Table 25. Function support for Geodetic Data Management Feature (continued)

Function	Supported by DB2 Geodetic Data Management Feature?	Difference in behavior for DB2 Geodetic Data Management Feature
ST_GeometryType	Yes	None
ST_GeomFromText	Yes	None
ST_GeomFromWKB	Yes	None
ST_GetIndexParms	No	Not applicable
ST_InteriorRingN	Yes	None
ST_Intersection	Yes	Dimension of returned geometry is that of the input with the lower dimension, except the dimension of the intersection of two linestrings is 0.
ST_Intersects	Yes	Both geometries must be in the same geodetic SRS.
ST_Is3d	Yes	None
ST_IsClosed	Yes	None
ST_IsEmpty	Yes	None
ST_IsMeasured	Yes	None
ST_IsRing	No	Not applicable
ST_IsSimple	No	Not applicable
ST_IsValid	Yes	None
ST_Length	Yes	Default unit of measure is meters.
ST_LineFromText	Yes	None
ST_LineFromWKB	Yes	None
ST_LineString	Yes	None
ST_LineStringN	Yes	None
ST_M	Yes	None
ST_MaxM	Yes	None
ST_MaxX	Yes	Returns the maximum X value of the minimum bounding circle (MBC). **Note:** If the MBC crosses the dateline, the ST_MaxX value is less than the ST_MinX. If the MBC includes the North pole, or the South pole, ST_MinX is –180 and ST_MaxX is 180.
ST_MaxY	Yes	Returns the maximum Y value of the MBC. **Note:** If the MBC includes the North pole, the ST_MaxY value is 90.
ST_MaxZ	Yes	None
ST_MBR	Yes	MBR is a geometry that encloses the MBC of the geometry.
ST_MBRIntersects	Yes	None
ST_MeasureBetween or ST_LocateBetween	No	Not applicable
ST_MidPoint	Yes	None
ST_MinM	Yes	None

Table 25. Function support for Geodetic Data Management Feature (continued)

Function	Supported by DB2 Geodetic Data Management Feature?	Difference in behavior for DB2 Geodetic Data Management Feature
ST_MinX	Yes	Returns the minimum X value of the MBC. **Note:** If the MBC crosses the dateline, the ST_MinX value is greater than the ST_MaxX value. If the MBC includes the North pole, or the South pole, ST_MinX is –180 and ST_MaxX is 180.
ST_MinY	Yes	Returns the minimum Y value of the MBC. **Note:** If the MBC includes the South pole, the ST_MinY value is –90.
ST_MinZ	Yes	None
ST_MLineFromText	Yes	None
ST_MLineFromWKB	Yes	None
ST_MPointFromText	Yes	None
ST_MPointFromWKB	Yes	None
ST_MPolyFromText	Yes	None
ST_MPolyFromWKB	Yes	None
ST_MultiLineString	Yes	None
ST_MultiPoint	Yes	None
ST_MultiPolygon	Yes	None
ST_NumGeometries	Yes	None
ST_NumInteriorRing	Yes	None
ST_NumLineStrings	Yes	None
ST_NumPoints	Yes	None
ST_NumPolygons	Yes	None
ST_Overlaps	No	Not applicable
ST_Perimeter	Yes	Default unit of measure is meters.
ST_PerpPoints	No	Not applicable
ST_Point	Yes	None
ST_PointFromText	Yes	None
ST_PointFromWKB	Yes	None
ST_PointN	Yes	None
ST_PolyFromText	Yes	None
ST_PolyFromWKB	Yes	None
ST_PointOnSurface	Yes	None
ST_Polygon	Yes	None
ST_PolygonN	Yes	None
ST_Relate	No	Not applicable
ST_RemovePoint	No	Not applicable
ST_SrsId or ST_SRID	Yes	None
ST_SrsName	Yes	None

Table 25. Function support for Geodetic Data Management Feature (continued)

Function	Supported by DB2 Geodetic Data Management Feature?	Difference in behavior for DB2 Geodetic Data Management Feature
ST_StartPoint	Yes	None
ST_SymDifference	Yes	Not supported with linestrings and multi-linestrings. Dimension of returned geometry is same as that of input geometries. Both geometries must be in the same geodetic SRS.
ST_ToGeomColl	No	Not applicable
ST_ToLineString	Yes	None
ST_ToMultiLine	Yes	None
ST_ToMultiPoint	Yes	None
ST_ToPoint	Yes	None
ST_ToPolygon	Yes	None
ST_Touches	No	Not applicable
ST_Transform	Yes	None. **Note:** Coordinate transformations are done point-by-point. When transforming between geodetic coordinate systems and non-projected planar coordinate systems, check carefully any polygons and linestrings that straddle the 180th meridian or enclose one or both poles. Because Spatial Extender and Geodetic Data Management Feature handle these cases differently, it is possible that geometries that are valid in a flat-Earth coordinate system will not be valid in a round-Earth system and vice-versa. For more information, see "Differences in working with flat-Earth and round-Earth representations" on page 165.
ST_Union	Yes	Both geometries must be in the same geodetic SRS.
ST_Within	Yes	Both geometries must be in the same geodetic SRS.
ST_WKBToSQL	Yes	None
ST_WKTToSQL	Yes	None
ST_X	Yes	None
ST_Y	Yes	None
ST_Z	Yes	None
Union Aggregate	No	Not applicable

DB2 Geodetic Data Management Feature stored procedures and catalog views

DB2 Geodetic Data Management Feature supports the same catalog views as DB2 Spatial Extender and supports a subset of the spatial stored procedures.

Geodetic Data Management Feature does not support the following stored procedures:

- ST_disable_autogeocoding
- ST_enable_autogeocoding
- ST_register_geocoder
- ST_remove_geocoding_setup
- ST_run_geocoding
- ST_setup_geocoding
- ST_unregister_geocoder

Geodetic Data Management Feature provides 318 predefined geodetic spatial reference systems that appear in the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view. See for a complete list.

Datums supported by DB2 Geodetic Data Management Feature

As describes, a *datum* is a set of values that defines the position of an ellipsoid relative to the center of the earth. A spatial reference system (SRS) is a set of parameters that associate a datum with an ellipsoid and is identified with a spatial reference system identifier (SRID). Table 27 on page 180 lists the predefined datums that DB2 Geodetic Data Management Feature provides. The offset values and scale factors for all of the predefined geodetic SRSs are the same, and the following table shows their values.

Table 26. Offset and scale values for predefined geodetic SRSs

SRS Parameter	Value
xOffset	–180
yOffset	–90
zOffset	–50000
mOffset	–1000
xScale	5965232
yScale	5965232
zScale	1000
mScale	1000

The yScale is always the same as the xScale.

You can choose any datum listed in Table 27 on page 180 for your spatial reference system. Ideally, choose the one that best suits your data. For example, one of the most commonly used datums, World Geodetic System 1984 (WGS 1984), takes the center of the Earth as its point of origin and maps the whole of the globe; it is an Earth-centered datum. In contrast, a regional datum, such as the North American 1927 datum, maps North America starting from a point on the ground. A regional datum is accurate for the region it aims to model, but an Earth-centered geodetic datum is necessary to handle locations over the entire globe.

Table 27. SRIDs with associated datum and ellipsoid

SRID	Datum name	Reference ellipsoid
2000000000	WGS 1984	WGS 1984
2000000001	Abidjan 1987	Clarke 1880 (RGS)
2000000002	Accra	War Office
2000000003	Adindan	Clarke 1880 (RGS)
2000000004	Afgooye	Krasovsky 1940
2000000005	Agadez	Clarke 1880 (IGN)
2000000006	Australian Geodetic Datum 1966	Australian
2000000007	Australian Geodetic Datum 1984	Australian
2000000008	Ain el Abd 1970	International 1924
2000000009	Airy 1830	Airy 1830
2000000010	Airy Modified	Airy Modified
2000000011	Alaskan Islands	Clarke 1866
2000000012	Amersfoort	Bessel 1841
2000000013	Anguilla 1957	Clarke 1880 (RGS)
2000000014	Anna 1 Astro 1965	Australian
2000000015	Antigua Astro 1943	Clarke 1880 (RGS)
2000000016	Aratu	International 1924
2000000017	Arc 1950	Clarke 1880 (Arc)
2000000018	Arc 1960	Clarke 1880 (RGS)
2000000019	Ascension Island 1958	International 1924
2000000020	Assumed Geographic (NAD27 for shapefiles without a PRJ)	Clarke 1866
2000000021	Astronomical Station 1952	International 1924
2000000022	ATF (Paris)	Plessis 1817
2000000023	Average Terrestrial System 1977	ATS 1977
2000000024	Australian National	Australian
2000000025	Ayabelle Lighthouse	Clarke 1880 (RGS)
2000000026	Bab South Astro (Bablethuap Is, Republic of Palau)	Clarke 1866
2000000027	Barbados 1938	Clarke 1880 (RGS)
2000000028	Batavia	Bessel 1841
2000000029	Batavia (Jakarta)	Bessel 1841
2000000030	Astro Beacon E 1945	International 1924
2000000031	Beduaram	Clarke 1880 (IGN)
2000000032	Beijing 1954	Krasovsky 1940
2000000033	Reseau National Belge 1950	International 1924
2000000034	Belge 1950 (Brussels)	International 1924
2000000035	Reseau National Belge 1972	International 1924
2000000036	Bellevue (IGN)	International 1924
2000000037	Bermuda 1957	Clarke 1866
2000000038	Bern 1898	Bessel 1841
2000000039	Bern 1898 (Bern)	Bessel 1841
2000000040	Bern 1938	Bessel 1841
2000000041	Bessel 1841	Bessel 1841
2000000042	Bessel Modified	Bessel Modified
2000000043	Bessel Namibia	Bessel Namibia
2000000044	Bissau	International 1924
2000000045	Bogota	International 1924
2000000046	Bogota (Bogota)	International 1924
2000000047	Bukit Rimpah	Bessel 1841
2000000048	Camacupa	Clarke 1880 (RGS)
2000000049	Campo Inchauspe	International 1924
2000000050	Camp Area Astro	International 1924

Table 27. SRIDs with associated datum and ellipsoid (continued)

SRID	Datum name	Reference ellipsoid
2000000051	Canton Astro 1966	International 1924
2000000052	Cape	Clarke 1880 (Arc)
2000000053	Cape Canaveral	Clarke 1866
2000000054	Carthage	Clarke 1880 (IGN)
2000000055	Carthage (degrees)	Clarke 1880 (IGN)
2000000056	Carthage (Paris)	Clarke 1880 (IGN)
2000000057	CH 1903	Bessel 1841
2000000058	CH 1903+	Bessel 1841
2000000059	Chatham Island Astro 1971	International 1924
2000000060	Chos Malal 1914	International 1924
2000000061	Swiss Terrestrial Ref. Frame 1995	GRS 1980
2000000062	Chua	International 1924
2000000063	Clarke 1858	Clarke 1858
2000000064	Clarke 1866	Clarke 1866
2000000065	Clarke 1866 (Michigan)	Clarke 1866 (Michigan)
2000000066	Clarke 1880	Clarke 1880
2000000067	Clarke 1880 (Arc)	Clarke 1880 (Arc)
2000000068	Clarke 1880 (Benoit)	Clarke 1880 (Benoit)
2000000069	Clarke 1880 (IGN)	Clarke 1880 (IGN)
2000000070	Clarke 1880 (RGS)	Clarke 1880 (RGS)
2000000071	Clarke 1880 (SGA)	Clarke 1880 (SGA)
2000000072	Conakry 1905	Clarke 1880 (IGN)
2000000073	Corrego Alegre	International 1924
2000000074	Cote d'Ivoire	Clarke 1880 (IGN)
2000000075	Dabola 1981	Clarke 1880 (RGS)
2000000076	Datum 73	International 1924
2000000077	Dealul Piscului 1933 (Romania)	International 1924
2000000078	Dealul Piscului 1970 (Romania)	Krasovsky 1940
2000000079	Deception Island	Clarke 1880 (RGS)
2000000080	Deir ez Zor	Clarke 1880 (IGN)
2000000081	Deutsche Hauptdreiecksnetz	Bessel 1841
2000000082	Dominica 1945	Clarke 1880 (RGS)
2000000083	DOS 1968	International 1924
2000000084	Astro DOS 71/4	International 1924
2000000085	Douala	Clarke 1880 (IGN)
2000000086	Easter Island 1967	International 1924
2000000087	European Datum 1950	International 1924
2000000088	European Datum 1950 (ED77)	International 1924
2000000089	European Datum 1987	International 1924
2000000090	Egypt 1907	Helmert 1906
2000000091	Estonia 1937	Bessel 1841
2000000092	Estonia 1992	GRS 1980
2000000093	European Terrestrial Ref. Frame 1989	WGS 1984
2000000094	European 1979	International 1924
2000000095	European Libyan Datum 1979	International 1924
2000000096	Everest 1830	Everest 1830
2000000097	Everest (Bangladesh)	Everest Adjustment 1937
2000000098	Everest (Definition 1962)	Everest (Definition 1962)
2000000099	Everest (Definition 1967)	Everest (Definition 1967)

Table 27. SRIDs with associated datum and ellipsoid (continued)

SRID	Datum name	Reference ellipsoid
2000000100	Everest (Definition 1975)	Everest (Definition 1975)
2000000101	Everest (India and Nepal)	Everest (Definition 1962)
2000000102	Everest 1830 Modified	Everest 1830 Modified
2000000103	Everest Modified 1969	Everest Modified 1969
2000000104	Fahud	Clarke 1880 (RGS)
2000000105	Final Datum 1958	Clarke 1880 (RGS)
2000000106	Fischer 1960	Fischer 1960
2000000107	Fischer 1968	Fischer 1968
2000000108	Fischer Modified	Fischer Modified
2000000109	Fort Thomas 1955	Clarke 1880 (RGS)
2000000110	Gandajika 1970	International 1924
2000000111	Gan 1970	International 1924
2000000112	Garoua	Clarke 1880 (IGN)
2000000113	Geocentric Datum of Australia 1994	GRS 1980
2000000114	GEM 10C Gravity Potential Model	GEM 10C
2000000115	Greek Geodetic Ref. System 1987	GRS 1980
2000000116	Graciosa Base SW 1948	International 1924
2000000117	Greek	Bessel 1841
2000000118	Greek (Athens)	Bessel 1841
2000000119	Grenada 1953	Clarke 1880 (RGS)
2000000120	GRS 1967	GRS 1967
2000000121	GRS 1980	GRS 1980
2000000122	Guam 1963	Clarke 1866
2000000123	Gunung Segara	Bessel 1841
2000000124	GUX 1 Astro	International 1924
2000000125	Guyane Francaise	International 1924
2000000126	Hanoi 1972	Krasovsky 1940
2000000127	Hartebeesthoek 1994	WGS 1984
2000000128	Helmert 1906	Helmert 1906
2000000129	Herat North	International 1924
2000000130	Hermannskogel	Bessel 1841
2000000131	Hito XVIII 1963	International 1924
2000000132	Hjorsey 1955	International 1924
2000000133	Hong Kong 1963	International 1924
2000000134	Hong Kong 1980	International 1924
2000000135	Hough 1960	Hough 1960
2000000136	Hungarian Datum 1972	GRS 1967
2000000137	Hu Tzu Shan	International 1924
2000000138	Indian 1954	Everest Adjustment 1937
2000000139	Indian 1960	Everest Adjustment 1937
2000000140	Indian 1975	Everest Adjustment 1937
2000000141	Indonesian National	Indonesian National
2000000142	Indonesian Datum 1974	Indonesian
2000000143	International 1927	International 1924
2000000144	International 1967	International 1967
2000000145	IRENET95	GRS 1980
2000000146	Israel	GRS 1980
2000000147	ISTS 061 Astro 1968	International 1924

Table 27. SRIDs with associated datum and ellipsoid (continued)

SRID	Datum name	Reference ellipsoid
2000000148	ISTS 073 Astro 1969	International 1924
2000000149	Jamaica 1875	Clarke 1880
2000000150	Jamaica 1969	Clarke 1866
2000000151	Japan Geodetic Datum 2000	GRS 1980
2000000152	Johnston Island 1961	International 1924
2000000153	Kalianpur 1880	Everest 1830
2000000154	Kalianpur 1937	Everest Adjustment 1937
2000000155	Kalianpur 1962	Everest (Definition 1962)
2000000156	Kalianpur 1975	Everest (Definition 1975)
2000000157	Kandawala	Everest Adjustment 1937
2000000158	Kerguelen Island 1949	International 1924
2000000159	Kertau	Everest 1830 Modified
2000000160	Kartastokoordinaattijarjestelma	International 1924
2000000161	Kuwait Oil Company	Clarke 1880 (RGS)
2000000162	Korean Datum 1985	Bessel 1841
2000000163	Korean Datum 1995	WGS 1984
2000000164	Krasovsky 1940	Krasovsky 1940
2000000165	Kuwait Utility	GRS 1980
2000000166	Kusaie Astro 1951	International 1924
2000000167	Lake	International 1924
2000000168	La Canoa	International 1924
2000000169	L.C. 5 Astro 1961	Clarke 1866
2000000170	Leigon	Clarke 1880 (RGS)
2000000171	Liberia 1964	Clarke 1880 (RGS)
2000000172	Datum Lisboa Bessel	Bessel 1841
2000000173	Datum Lisboa Hayford	International 1924
2000000174	Lisbon	International 1924
2000000175	Lisbon (Lisbon)	International 1924
2000000176	LKS 1994	GRS 1980
2000000177	Locodjo 1965	Clarke 1880 (RGS)
2000000178	Loma Quintana	International 1924
2000000179	Lome	Clarke 1880 (IGN)
2000000180	Luzon 1911	Clarke 1866
2000000181	Madrid 1870 (Madrid Prime Merid.)	Struve 1860
2000000182	Madzansua	Clarke 1866
2000000183	Mahe 1971	Clarke 1880 (RGS)
2000000184	Majuro (Republic of Marshall Is.)	Clarke 1866
2000000185	Makassar	Bessel 1841
2000000186	Makassar (Jakarta)	Bessel 1841
2000000187	Malongo 1987	International 1924
2000000188	Manoca	Clarke 1880 (RGS)
2000000189	Massawa	Bessel 1841
2000000190	Merchich	Clarke 1880 (IGN)
2000000191	Merchich (degrees)	Clarke 1880 (IGN)
2000000192	Militar-Geographische Institut	Bessel 1841
2000000193	MGI (Ferro)	Bessel 1841
2000000194	Mhast	International 1924
2000000195	Midway Astro 1961	International 1924
2000000196	Minna	Clarke 1880 (RGS)

Table 27. SRIDs with associated datum and ellipsoid (continued)

SRID	Datum name	Reference ellipsoid
2000000197	Monte Mario	International 1924
2000000198	Monte Mario (Rome)	International 1924
2000000199	Montserrat Astro 1958	Clarke 1880 (RGS)
2000000200	Mount Dillon	Clarke 1858
2000000201	Moznet	WGS 1984
2000000202	M'poraloko	Clarke 1880 (IGN)
2000000203	North American Datum 1927	Clarke 1866
2000000204	NAD 1927 CGQ77	Clarke 1866
2000000205	NAD 1927 (1976)	Clarke 1866
2000000206	North American Datum 1983	GRS 1980
2000000207	NAD 1983 (Canadian Spatial Ref. System)	GRS 1980
2000000208	North American Datum 1983 (HARN)	GRS 1980
2000000209	NAD Michigan	Clarke 1866 (Michigan)
2000000210	Nahrwan 1967	Clarke 1880 (RGS)
2000000211	Naparima 1955	International 1924
2000000212	Naparima 1972	International 1924
2000000213	Nord de Guerre (Paris)	Plessis 1817
2000000214	National Geodetic Network (Kuwait)	WGS 1984
2000000215	NGO 1948	Bessel Modified
2000000216	NGO 1948 (Oslo)	Bessel Modified
2000000217	Nord Sahara 1959	Clarke 1880 (RGS)
2000000218	NSWC 9Z-2	NWL 9D
2000000219	Nouvelle Triangulation Francaise (degrees)	Clarke 1880 (IGN)
2000000220	NTF (Paris) (grads)	Clarke 1880 (IGN)
2000000221	NWL 9D Transit Precise Ephemeris	NWL 9D
2000000222	New Zealand Geodetic Datum 1949	International 1924
2000000223	New Zealand Geodetic Datum 2000	GRS 1980
2000000224	Observatario	Clarke 1866
2000000225	Observ. Meteorologico 1939	International 1924
2000000226	Old Hawaiian	Clarke 1866
2000000227	Oman	Clarke 1880 (RGS)
2000000228	OSGB 1936	Airy 1830
2000000229	OSGB 1970 (SN)	Airy 1830
2000000230	OSU 1986 Geoidal Model	OSU 86F
2000000231	OSU 1991 Geoidal Model	OSU 91A
2000000232	OS (SN) 1980	Airy 1830
2000000233	Padang 1884	Bessel 1841
2000000234	Padang 1884 (Jakarta)	Bessel 1841
2000000235	Palestine 1923	Clarke 1880 (Benoit)
2000000236	Pampa del Castillo	International 1924
2000000237	PDO Survey Datum 1993	Clarke 1880 (RGS)
2000000238	Pico de Las Nieves	International 1924
2000000239	Pitcairn Astro 1967	International 1924
2000000240	Plessis 1817	Plessis 1817
2000000241	Pohnpei (Fed. States of Micronesia)	Clarke 1866
2000000242	Point 58	Clarke 1880 (RGS)
2000000243	Pointe Noire	Clarke 1880 (IGN)
2000000244	Porto Santo 1936	International 1924
2000000245	POSGAR	GRS 1980
2000000246	Provisional South Amer. Datum 1956	International 1924
2000000247	Puerto Rico	Clarke 1866
2000000248	Pulkovo 1942	Krasovsky 1940

Table 27. SRIDs with associated datum and ellipsoid (continued)

SRID	Datum name	Reference ellipsoid
2000000249	Pulkovo 1995	Krasovsky 1940
2000000250	Qatar 1974	International 1924
2000000251	Qatar 1948	Helmert 1906
2000000252	Qornoq	International 1924
2000000253	Rassadiran	International 1924
2000000254	REGVEN	GRS 1980
2000000255	Reunion	International 1924
2000000256	Reseau Geodesique Francais 1993	GRS 1980
2000000257	RT38	Bessel 1841
2000000258	RT38 (Stockholm)	Bessel 1841
2000000259	RT 1990	Bessel 1841
2000000260	S-42 Hungary	Krasovsky 1940
2000000261	South American Datum 1969	GRS 1967 Truncated
2000000262	Samboja	Bessel 1841
2000000263	American Samoa 1962	Clarke 1866
2000000264	Santo DOS 1965	International 1924
2000000265	Sao Braz	International 1924
2000000266	Sapper Hill 1943	International 1924
2000000267	Schwarzeck	Bessel Namibia
2000000268	Segora	Bessel 1841
2000000269	Selvagem Grande 1938	International 1924
2000000270	Serindung	Bessel 1841
2000000271	Sierra Leone 1924	War Office
2000000272	Sierra Leone 1960	Clarke 1880 (RGS)
2000000273	Sierra Leone 1968	Clarke 1880 (RGS)
2000000274	SIRGAS	GRS 1980
2000000275	South Yemen	Krasovsky 1940
2000000276	Authalic sphere	Sphere
2000000277	Authalic sphere (ARC/INFO)	Sphere ARC INFO
2000000278	Struve 1860	Struve 1860
2000000279	St. George Island (Alaska)	Clarke 1866
2000000280	St. Kitts 1955	Clarke 1880 (RGS)
2000000281	St. Lawrence Island (Alaska)	Clarke 1866
2000000282	St. Lucia 1955	Clarke 1880 (RGS)
2000000283	St. Paul Island (Alaska)	Clarke 1866
2000000284	St. Vincent 1945	Clarke 1880 (RGS)
2000000285	Sudan	Clarke 1880 (IGN)
2000000286	South Asia Singapore	Fischer Modified
2000000287	S-JTSK	Bessel 1841
2000000288	S-JTSK (Ferro)	Bessel 1841
2000000289	Tananarive 1925	International 1924
2000000290	Tananarive 1925 (Paris)	International 1924
2000000291	Tern Island Astro 1961	International 1924
2000000292	Tete	Clarke 1866
2000000293	Timbalai 1948	Everest (Definition 1967)
2000000294	TM65	Airy Modified
2000000295	TM75	Airy Modified
2000000296	Tokyo	Bessel 1841
2000000297	Trinidad 1903	Clarke 1858
2000000298	Tristan Astro 1968	International 1924
2000000299	Trucial Coast 1948	Helmert 1906
2000000300	Viti Levu 1916	Clarke 1880 (RGS)

Table 27. SRIDs with associated datum and ellipsoid (continued)

SRID	Datum name	Reference ellipsoid
2000000301	Voirol 1875	Clarke 1880 (IGN)
2000000302	Voirol 1875 (degrees)	Clarke 1880 (IGN)
2000000303	Voirol 1875 (Paris)	Clarke 1880 (IGN)
2000000304	Voirol Unifie 1960	Clarke 1880 (RGS)
2000000305	Voirol Unifie 1960 (degrees)	Clarke 1880 (RGS)
2000000306	Voirol Unifie 1960 (Paris)	Clarke 1880 (RGS)
2000000307	Wake-Eniwetok 1960	Hough 1960
2000000308	Wake Island Astro 1952	International 1924
2000000309	Walbeck	Walbeck
2000000310	War Office	War Office
2000000311	WGS 1966	WGS 1966
2000000312	WGS 1972	WGS 1972
2000000313	WGS 1972 Transit Broadcast Ephemeris	WGS 1972
2000000314	Yacare	International 1924
2000000315	Yemen Nat'l Geodetic Network 1996	WGS 1984
2000000316	Yoff	Clarke 1880 (IGN)
2000000317	Zanderij	International 1924

Geodetic spheroids

A spheroid (also known as an ellipsoid) is the part of a geographic coordinate system that defines the shape of the Earth's surface at a specific location.

The definition of a coordinate system includes the definition of an ellipsoid in the SPHEROID definition which is part of the DATUM definition, as the following example shows:

```
GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",
SPHEROID["GRS_1980",6378137,298.257222101]],
PRIMEM["Greenwich",0],UNIT["Degree",0.0174532925199432955]]
```

You can use the DB2GSE.ST_COORDINATE_SYSTEMS catalog view to retrieve this information. The **DEFINITION** column in the DB2GSE.ST_COORDINATE_SYSTEMS catalog view contains the values in the **Name**, **Semi-major axis**, and **Flattening** columns in the table.

Chapter 20. Stored procedures

This section provides reference information about the stored procedures that you can use to set up DB2 Spatial Extender and create projects that use spatial data.

When you set up DB2 Spatial Extender or create projects from the DB2 Control Center or the DB2 command line processor, you invoke these stored procedures implicitly. For example, when you click **OK** from a DB2 Spatial Extender window in the DB2 Control Center, DB2 calls the stored procedure that is associated with that window.

Alternatively, you can invoke the stored procedures explicitly in an application program.

Before invoking most DB2 Spatial Extender stored procedures on a database, you must enable that database for spatial operations by invoking the ST_enable_db stored procedure, either directly or by using the DB2 Control Center. (You can read about invoking this stored procedure in the topic about ST_enable_db, later in this section.)

After a database is enabled for spatial operations, you can invoke any DB2 Spatial Extender stored procedure, either implicitly or explicitly, on that database if you are connected to that database.

This chapter provides topics for all the DB2 Spatial Extender stored procedures, as follows:

- "GSE_export_sde" on page 188
- "GSE_import_sde" on page 189
- "ST_alter_coordsys" on page 192
- "ST_alter_srs" on page 193
- "ST_create_coordsys" on page 197
- "ST_create_srs" on page 199
- "ST_disable_autogeocoding" on page 205
- "ST_disable_db" on page 207
- "ST_drop_coordsys" on page 208
- "ST_drop_srs" on page 209
- "ST_enable_autogeocoding" on page 211
- "ST_enable_db" on page 213
- "ST_export_shape" on page 214
- "ST_import_shape" on page 218
- "ST_register_geocoder" on page 225
- "ST_register_spatial_column" on page 229
- "ST_remove_geocoding_setup" on page 231
- "ST_run_geocoding" on page 233
- "ST_setup_geocoding" on page 236
- "ST_unregister_geocoder" on page 239
- "ST_unregister_spatial_column" on page 240

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The implementations of the stored procedures are archived in the db2gse library on the DB2 Spatial Extender server.

GSE_export_sde

Use this stored procedure to export a spatial column and its associated table to an SDE transfer file.

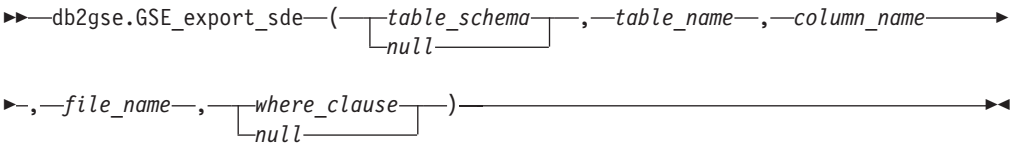
Restriction:

- Exactly one spatial column must exist in the table or view.
- The spatial column must be registered.
- You cannot append to existing SDE files.

Authorization

The user ID under which the stored procedure is invoked must have either SYSADM or DBADM authority. In addition, this user ID under must hold the SELECT privilege on the table that is to be exported.

Syntax



Parameter descriptions

table_schema
Names the schema to which the table that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table or view.

The *table_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name
Specifies the unqualified name of the table that you are exporting. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

column_name
Names the registered spatial column that you are exporting. You must specify a non-null value for this parameter.

The *column_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

file_name
Names the SDE transfer file to which the specified spatial column and its associated table are to be exported. You must specify a non-null value for this parameter.

The data type of this parameter is VARCHAR(256).

where_clause
Specifies the body of the SQL WHERE clause, which defines a restriction on the set of records that are to be exported. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no restrictions are defined in the WHERE clause.

If this parameter is specified, the value can reference any attribute column in the table that you are exporting.

The data type of this parameter is VARCHAR(1024).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the GSE_export_sde stored procedure. This example uses a DB2 CALL command to export data from a table named CUSTOMERS to SDE files:

```
call db2gse.GSE_export_sde(NULL,'CUSTOMERS','LOCATION','/tmp/export_sde_file',
        NULL,?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

GSE_import_sde

Use this stored procedure to import an SDE transfer file to a database that is enabled for spatial operations.

The stored procedure can operate in either of two ways:

- If the SDE transfer file is targeted for an existing table that has a registered spatial column, DB2 Spatial Extender loads the table with the file's data.
- Otherwise, DB2 Spatial Extender creates a table that has a spatial column, registers this column, and loads the spatial column and the table's other columns with the file's data.

The spatial reference system that is specified in the SDE transfer file is compared with the spatial reference systems that are registered to DB2 Spatial Extender. If the specified system matches a registered system, all data values in the transfer data, when loaded, are modified in the way that the registered system specifies. If the specified system matches none of the registered systems, DB2 Spatial Extender creates a new spatial reference system to specify the modifications.

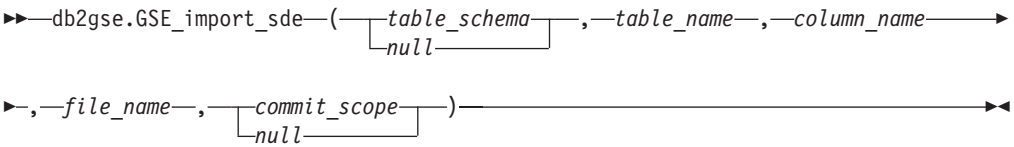
Authorization

When you import data to an existing table, the user ID under which this stored procedure is invoked must hold one of the following authorities or privileges:

- SYSADM or DBADM authority on the database that contains the table to which data is to be imported
- CONTROL privilege on this table

When the table to which you want to import data must be created, the user ID under which this stored procedure is invoked must hold either SYSADM or DBADM authority on the database that contains the table that is to be created.

Syntax



Parameter descriptions

table_schema

Names the schema to which the table or view that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table or view.

The *table_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name

Specifies the unqualified name of the table into which the SDE transfer data is to be loaded. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

column_name
Names the registered column into which the SDE transfer file's spatial data is to be loaded. You must specify a non-null value for this parameter.

The *column_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

file_name
Names the SDE transfer file that is to be imported. You must specify a non-null value for this parameter.

The data type of this parameter is VARCHAR(256).

commit_scope
Specifies the number of records that are to be imported before a COMMIT is issued. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of 0 (zero) is used and no records are committed.

The data type of this parameter is INTEGER.

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the GSE_import_sde stored procedure. This example uses a DB2 CALL command to import an SDE file named `tmp/customerSDE` into a table named CUSTOMERS. This CALL command specifies that a COMMIT is to be performed after every 5 records are imported:

```
call db2gse.GSE_import_sde(NULL,'CUSTOMERS','LOCATION',
     '/tmp/customerSde', 5, ?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_alter_coordsys

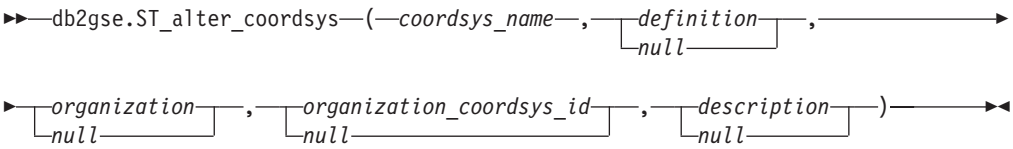
Use this stored procedure to update a coordinate system definition in the database. When this stored procedure is processed, information about the coordinate system is updated in the DB2GSE.ST_COORDINATE_SYSTEMS catalog view.

Attention: Use care with this stored procedure. If you use this stored procedure to change the definition of the coordinate system and you have existing spatial data that is associated with a spatial reference system that is based on this coordinate system, you might inadvertently change the spatial data. If spatial data is affected, you are responsible for ensuring that the changed spatial data is still accurate and valid.

Authorization

The user ID under which the stored procedure is invoked must have either SYSADM or DBADM authority.

Syntax



Parameter descriptions

coordsys_name
Uniquely identifies the coordinate system. You must specify a non-null value for this parameter.

The *coordsys_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

definition
Defines the coordinate system. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the definition of the coordinate system is not changed.

The data type of this parameter is VARCHAR(2048).

organization
Names the organization that defined the coordinate system and provided the definition for it; for example, "European Petroleum Survey Group (EPSG)." Although you must specify a value for this parameter, the value can be null.

If this parameter is null, the organization of the coordinate system is not changed. If this parameter is not null, the *organization_coordsys_id* parameter cannot be null; in this case, the combination of the *organization* and *organization_coordsys_id* parameters uniquely identifies the coordinate system.

The data type of this parameter is VARCHAR(128).

organization_coordsys_id
Specifies a numeric identifier that is assigned to this coordinate system by the

entity listed in the *organization* parameter. Although you must specify a value for this parameter, the value can be null.

If this parameter is null, the *organization* parameter must also be null; in this case, the organization's coordinate system identifier is not changed. If this parameter is not null, the *organization* parameter cannot be null; in this case, the combination of the *organization* and *organization_coordsys_id* parameters uniquely identifies the coordinate system.

The data type of this parameter is INTEGER.

description
Describes the coordinate system by explaining its application. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the description information about the coordinate system is not changed.

The data type of this parameter is VARCHAR(256).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_alter_coordsys stored procedure. This example uses a DB2 CALL command to update a coordinate system named NORTH_AMERICAN_TEST. This CALL command assigns a value of 1002 to the *coordsys_id* parameter:

```
call db2gse.ST_alter_coordsys('NORTH_AMERICAN_TEST',NULL,NULL,1002,NULL,?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_alter_srs

Use this stored procedure to update a spatial reference system definition in the database. When this stored procedure is processed, information about the spatial reference system is updated in the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view.

Internally, DB2 Spatial Extender stores the coordinate values as positive integers. Thus during computation, the impact of rounding errors (which are heavily

dependent on the actual value for floating-point operations) can be reduced. Performance of the spatial operations can also improve significantly.

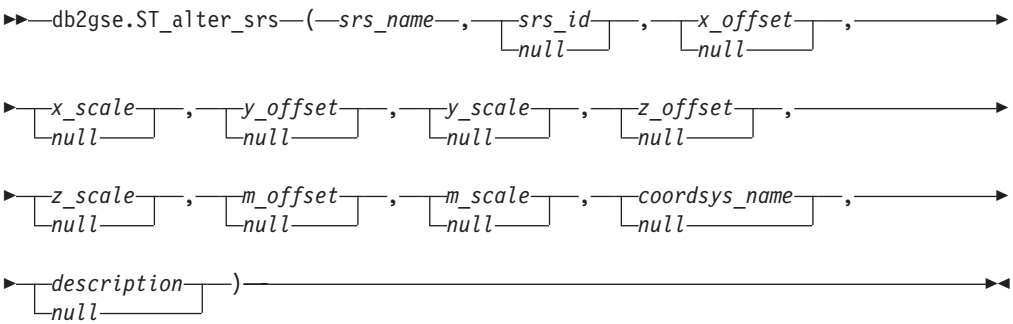
Restriction: You cannot alter a spatial reference system if a registered spatial column uses that spatial reference system.

Attention: Use care with this stored procedure. If you use this stored procedure to change offset, scale, or *coordsys_name* parameters of the spatial reference system, and if you have existing spatial data that is associated with the spatial reference system, you might inadvertently change the spatial data. If spatial data is affected, you are responsible for ensuring that the changed spatial data is still accurate and valid.

Authorization

The user ID under which the stored procedure is invoked must have either SYSADM or DBADM authority.

Syntax



Parameter descriptions

srs_name
Identifies the spatial reference system. You must specify a non-null value for this parameter.

The *srs_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

srs_id
Uniquely identifies the spatial reference system. This identifier is used as an input parameter for various spatial functions. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the numeric identifier of the spatial reference system is not changed.

The data type of this parameter is INTEGER.

x_offset
Specifies the offset for all X coordinates of geometries that are represented in this spatial reference system. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value for this parameter in the definition of the spatial reference system is not changed.

The offset is subtracted before the scale factor *x_scale* is applied when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. (*WKT* is well-known text, and *WKB* is well-known binary.)

The data type of this parameter is DOUBLE.

x_scale
Specifies the scale factor for all X coordinates of geometries that are represented in this spatial reference system. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value for this parameter in the definition of the spatial reference system is not changed.

The scale factor is applied (multiplication) after the offset *x_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation.

The data type of this parameter is DOUBLE.

y_offset
Specifies the offset for all Y coordinates of geometries that are represented in this spatial reference system. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value for this parameter in the definition of the spatial reference system is not changed.

The offset is subtracted before the scale factor *y_scale* is applied when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation.

The data type of this parameter is DOUBLE.

y_scale
Specifies the scale factor for all Y coordinates of geometries that are represented in this spatial reference system. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value for this parameter in the definition of the spatial reference system is not changed.

The scale factor is applied (multiplication) after the offset *y_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. This scale factor must be the same as *x_scale*.

The data type of this parameter is DOUBLE.

z_offset
Specifies the offset for all Z coordinates of geometries that are represented in this spatial reference system. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value for this parameter in the definition of the spatial reference system is not changed.

The offset is subtracted before the scale factor *z_scale* is applied when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation.

The data type of this parameter is DOUBLE.

z_scale
Specifies the scale factor for all Z coordinates of geometries that are represented in this spatial reference system. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value for this parameter in the definition of the spatial reference system is not changed.

The scale factor is applied (multiplication) after the offset *z_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation.

The data type of this parameter is DOUBLE.

m_offset
Specifies the offset for all M coordinates of geometries that are represented in this spatial reference system. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value for this parameter in the definition of the spatial reference system is not changed.

The offset is subtracted before the scale factor *m_scale* is applied when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation.

The data type of this parameter is DOUBLE.

m_scale
Specifies the scale factor for all M coordinates of geometries that are represented in this spatial reference system. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value for this parameter in the definition of the spatial reference system is not changed.

The scale factor is applied (multiplication) after the offset *m_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation.

The data type of this parameter is DOUBLE.

coordsys_name
Uniquely identifies the coordinate system on which this spatial reference system is based. The coordinate system must be listed in the view ST_COORDINATE_SYSTEMS. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the coordinate system that is used for this spatial reference system is not changed.

The *coordsys_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

description
Describes the spatial reference system by explaining its application. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the description information about the spatial reference system is not changed.

The data type of this parameter is VARCHAR(256).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_alter_srs stored procedure. This example uses a DB2 CALL command to change the *description* parameter value of a spatial reference system named SRSDEMO:

```
call db2gse.ST_alter_srs('SRSDEMO',NULL,NULL,NULL,NULL,NULL,NULL,NULL,NULL,
     NULL,NULL,'SRS for GSE Demo Program: offices table',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

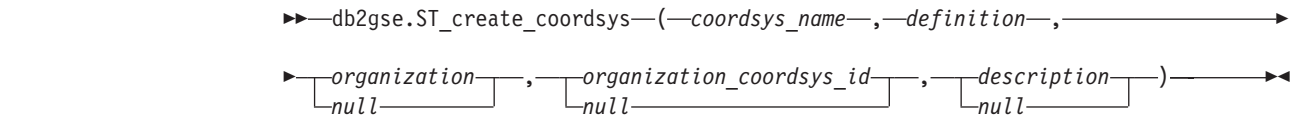
ST_create_coordsys

Use this stored procedure to store information in the database about a new coordinate system. When this stored procedure is processed, information about the coordinate system is added to the DB2GSE.ST_COORDINATE_SYSTEMS catalog view.

Authorization

The user ID under which the stored procedure is invoked must have either SYSADM or DBADM authority.

Syntax



Parameter descriptions

coordsys_name
Uniquely identifies the coordinate system. You must specify a non-null value for this parameter.

The *coordsys_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

definition
Defines the coordinate system. You must specify a non-null value for this parameter. The vendor that supplies the coordinate system usually provides the information for this parameter.

The data type of this parameter is VARCHAR(2048).

organization
Names the organization that defined the coordinate system and provided the definition for it; for example, "European Petroleum Survey Group (EPSG)." Although you must specify a value for this parameter, the value can be null.

If this parameter is null, the *organization_coordsys_id* parameter must also be null. If this parameter is not null, the *organization_coordsys_id* parameter cannot be null; in this case, the combination of the *organization* and *organization_coordsys_id* parameters uniquely identifies the coordinate system.

The data type of this parameter is VARCHAR(128).

organization_coordsys_id
Specifies a numeric identifier. The entity that is specified in the *organization* parameter assigns this value. This value is not necessarily unique across all coordinate systems. Although you must specify a value for this parameter, the value can be null.

If this parameter is null, the *organization* parameter must also be null. If this parameter is not null, the *organization* parameter cannot be null; in this case, the combination of the *organization* and *organization_coordsys_id* parameters uniquely identifies the coordinate system.

The data type of this parameter is INTEGER.

description
Describes the coordinate system by explaining its application. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no description information about the coordinate system is recorded.

The data type of this parameter is VARCHAR(256).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_create_coordsys stored procedure. This example uses a DB2 CALL command to create a coordinate system with the following parameter values:

- *coordsys_name* parameter: NORTH_AMERICAN_TEST
- *definition* parameter:

```
  GEOGCS["GCS_North_American_1983",
  DATUM["D_North_American_1983",
  SPHEROID["GRS_1980",6378137.0,298.257222101]],
  PRIMEM["Greenwich",0.0],
  UNIT["Degree",0.0174532925199433]]
```

- *organization* parameter: EPSG
- *organization_coordsys_id* parameter: 1001
- *description* parameter: Test Coordinate Systems

```
call db2gse.ST_create_coordsys('NORTH_AMERICAN_TEST',
     'GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",
     SPHEROID["GRS_1980",6378137.0,298.257222101]],
     PRIMEM["Greenwich",0.0],UNIT["Degree",
     0.0174532925199433]]','EPSG',1001,'Test Coordinate Systems',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_create_srs

Use the stored procedures to create a spatial reference system.

A spatial reference system is defined by the coordinate system, the precision, and the extents of coordinates that are represented in this spatial reference system. The extents are the minimum and maximum possible coordinate values for the X, Y, Z, and M coordinates.

Internally, DB2 Spatial Extender stores the coordinate values as positive integers. Thus during computation, the impact of rounding errors (which are heavily dependent on the actual value for floating-point operations) can be reduced. Performance of the spatial operations can also improve significantly.

This stored procedure has two variations:

- The first variation takes the conversion factors (offsets and scale factors) as input parameters.
- The second variation takes the extents and the precision as input parameters and calculates the conversion factors internally.

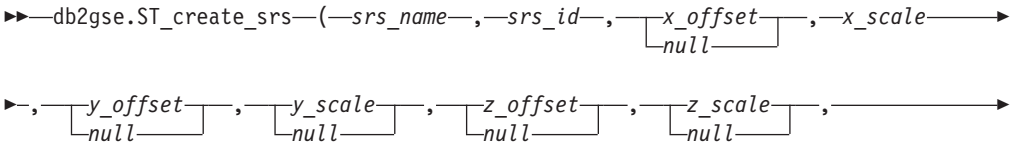
This stored procedure replaces db2gse.gse_enable_sref.

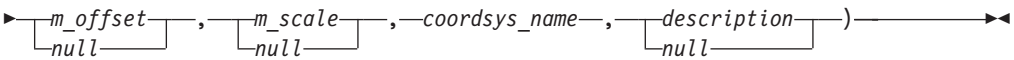
Authorization

None required.

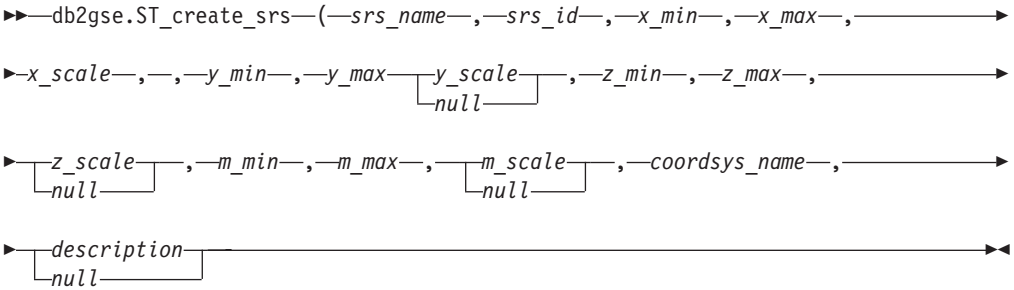
Syntax

With conversion factors (version 1)





With maximum possible extend (version 2)



Parameter descriptions

With conversion factors (version 1)

srs_name
Identifies the spatial reference system. You must specify a non-null value for this parameter.

The *srs_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

srs_id
Uniquely identifies the spatial reference system. This numeric identifier is used as an input parameter for various spatial functions. You must specify a non-null value for this parameter.

For a geodetic spatial reference system, the *srs_id* value must be in the range 2000000318 to 2000001000. DB2 Geodetic Data Management Feature provides predefined geodetic spatial reference systems with *srs_id* values 2000000000 to 2000000317.

The data type of this parameter is INTEGER.

x_offset
Specifies the offset for all X coordinates of geometries that are represented in this spatial reference system. The offset is subtracted before the scale factor *x_scale* is applied when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. (*WKT* is well-known text, and *WKB* is well-known binary.) Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of 0 (zero) is used.

The data type of this parameter is DOUBLE.

x_scale
Specifies the scale factor for all X coordinates of geometries that are represented in this spatial reference system. The scale factor is applied (multiplication) after the offset *x_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial

Extender internal representation. Either the *x_offset* value is specified explicitly, or a default *x_offset* value of 0 is used. You must specify a non-null value for this parameter.

The data type of this parameter is DOUBLE.

y_offset
Specifies the offset for all Y coordinates of geometries that are represented in this spatial reference system. The offset is subtracted before the scale factor *y_scale* is applied when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. Although you must specify a value for this parameter, the value can be null. If this parameter is the null value, a value of 0 (zero) is used.

The data type of this parameter is DOUBLE.

y_scale
Specifies the scale factor for all Y coordinates of geometries that are represented in this spatial reference system. The scale factor is applied (multiplication) after the offset *y_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. Either the *y_offset* value is specified explicitly, or a default *y_offset* value of 0 is used. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value of the *x_scale* parameter is used. If you specify a value other than null for this parameter, the value that you specify must match the value of the *x_scale* parameter.

The data type of this parameter is DOUBLE.

z_offset
Specifies the offset for all Z coordinates of geometries that are represented in this spatial reference system. The offset is subtracted before the scale factor *z_scale* is applied when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of 0 (zero) is used.

The data type of this parameter is DOUBLE.

z_scale
Specifies the scale factor for all Z coordinates of geometries that are represented in this spatial reference system. The scale factor is applied (multiplication) after the offset *z_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. Either the *z_offset* value is specified explicitly, or a default *z_offset* value of 0 is used. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of 1 is used.

The data type of this parameter is DOUBLE.

m_offset
Specifies the offset for all M coordinates of geometries that are represented in this spatial reference system. The offset is subtracted before the scale factor *m_scale* is applied when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of 0 (zero) is used.

The data type of this parameter is DOUBLE.

m_scale
Specifies the scale factor for all M coordinates of geometries that are represented in this spatial reference system. The scale factor is applied (multiplication) after the offset *m_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. Either the *m_offset* value is specified explicitly, or a default *m_offset* value of 0 is used. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of 1 is used.

The data type of this parameter is DOUBLE.

coordsys_name
Uniquely identifies the coordinate system on which this spatial reference system is based. The coordinate system must be listed in the view ST_COORDINATE_SYSTEMS. You must supply a non-null value for this parameter.

The *coordsys_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

description
Describes the spatial reference system by explaining the application's purpose. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no description information is recorded.

The data type of this parameter is VARCHAR(256).

With maximum possible extend (version 2)

srs_name
Identifies the spatial reference system. You must specify a non-null value for this parameter.

The *srs_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

srs_id
Uniquely identifies the spatial reference system. This numeric identifier is used as an input parameter for various spatial functions. You must specify a non-null value for this parameter.

The data type of this parameter is INTEGER.

x_min
Specifies the minimum possible X coordinate value for all geometries that use this spatial reference system. You must specify a non-null value for this parameter.

The data type of this parameter is DOUBLE.

x_max
Specifies the maximum possible X coordinate value for all geometries that use this spatial reference system. You must specify a non-null value for this parameter.

Depending on the value of *x_scale*, the value that is shown in the view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS might be larger than the value that is specified here. The value from the view is correct.

The data type of this parameter is DOUBLE.

x_scale
Specifies the scale factor for all X coordinates of geometries that are represented in this spatial reference system. The scale factor is applied (multiplication) after the offset *x_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. The calculation of the offset *x_offset* is based on the *x_min* value. You must supply a non-null value for this parameter.

If both the *x_scale* and *y_scale* parameters are specified, the values must match.

The data type of this parameter is DOUBLE.

y_min
Specifies the minimum possible Y coordinate value for all geometries that use this spatial reference system. You must supply a non-null value for this parameter.

The data type of this parameter is DOUBLE.

y_max
Specifies the maximum possible Y coordinate value for all geometries that use this spatial reference system. You must supply a non-null value for this parameter.

Depending on the value of *y_scale*, the value that is shown in the view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS might be larger than the value that is specified here. The value from the view is correct.

The data type of this parameter is DOUBLE.

y_scale
Specifies the scale factor for all Y coordinates of geometries that are represented in this spatial reference system. The scale factor is applied (multiplication) after the offset *y_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. The calculation of the offset *y_offset* is based on the *y_min* value. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value of the *x_scale* parameter is used. If both the *y_scale* and *x_scale* parameters are specified, the values must match.

The data type of this parameter is DOUBLE.

z_min
Specifies the minimum possible Z coordinate value for all geometries that use this spatial reference system. You must specify a non-null value for this parameter.

The data type of this parameter is DOUBLE.

z_max
Specifies the maximum possible Z coordinate value for all geometries that use this spatial reference system. You must specify a non-null value for this parameter.

Depending on the value of *z_scale*, the value that is shown in the view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS might be larger than the value that is specified here. The value from the view is correct.

The data type of this parameter is DOUBLE.

z_scale
Specifies the scale factor for all Z coordinates of geometries that are represented in this spatial reference system. The scale factor is applied (multiplication) after the offset *z_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. The calculation of the offset *z_offset* is based on the *z_min* value. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of 1 is used.

The data type of this parameter is DOUBLE.

m_min
Specifies the minimum possible M coordinate value for all geometries that use this spatial reference system. You must specify a non-null value for this parameter.

The data type of this parameter is DOUBLE.

m_max
Specifies the maximum possible M coordinate value for all geometries that use this spatial reference system. You must specify a non-null value for this parameter.

Depending on the value of *m_scale*, the value that is shown in the view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS might be larger than the value that is specified here. The value from the view is correct.

The data type of this parameter is DOUBLE.

m_scale
Specifies the scale factor for all M coordinates of geometries that are represented in this spatial reference system. The scale factor is applied (multiplication) after the offset *m_offset* is subtracted when geometries are converted from external representations (WKT, WKB, shape) to the DB2 Spatial Extender internal representation. The calculation of the offset *m_offset* is based on the *m_min* value. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of 1 is used.

The data type of this parameter is DOUBLE.

coordsys_name
Uniquely identifies the coordinate system on which this spatial reference system is based. The coordinate system must be listed in the view ST_COORDINATE_SYSTEMS. You must specify a non-null value for this parameter.

The *coordsys_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

description
Describes the spatial reference system by explaining the application's purpose. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no description information is recorded.

The data type of this parameter is VARCHAR(256).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_create_srs stored procedure. This example uses a DB2 CALL command to create a spatial reference system named SRSDEMO with the following parameter values:

- *srs_id*: 1000000
- *x_offset*: -180
- *x_scale*: 1000000
- *y_offset*: -90
- *y_scale*: 1000000

```
call db2gse.ST_create_srs('SRSDEMO',1000000,
                     -180,1000000, -90, 1000000,
                     0, 1, 0, 1,'NORTH_AMERICAN',
                     'SRS for GSE Demo Program: customer table',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_disable_autogeocoding

Use this stored procedure to specify that DB2 Spatial Extender is to stop synchronizing a geocoded column with its associated geocoding column or columns.

A *geocoding column* is used as input to the geocoder.

This stored procedure replaces db2gse.gse_disable_autogc.

Authorization

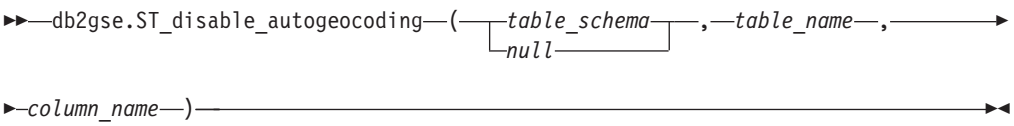
The user ID under which this stored procedure is invoked must have one of the following authorities or privileges:

- SYSADM or DBADM authority on the database that contains the table on which the triggers that are being dropped are defined

- CONTROL privilege on this table
- ALTER and UPDATE privileges on this table

Note: For CONTROL and ALTER privileges, you must have DROPIN authority on the DB2GSE schema.

Syntax



Parameter descriptions

table_schema
Names the schema to which the table or view that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table or view.

The *table_schema* value is converted to uppercase unless you enclose it in quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name
Specifies the unqualified name of the table on which the triggers that you want dropped are defined. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

column_name
Names the geocoded column that is maintained by the triggers that you want dropped. You must specify a non-null value for this parameter.

The *column_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is

returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_disable_autogeocoding stored procedure. This example uses a DB2 CALL command to disable autogeocoding on the LOCATION column in the table named CUSTOMERS:

```
call db2gse.ST_disable_autogeocoding(NULL,'CUSTOMERS','LOCATION',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_disable_db

Use this stored procedure to remove resources that allow DB2 Spatial Extender to store and support spatial data.

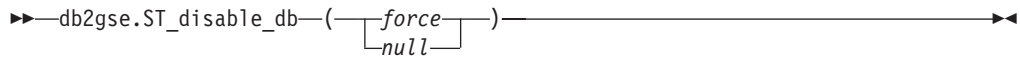
This stored procedure helps you resolve problems or issues that arise after you enable your database for spatial operations. For example, you might enable a database for spatial operations and then decide to use another database with DB2 Spatial Extender instead. If you did not define any spatial columns or import any spatial data, you can invoke this stored procedure to remove all spatial resources from the first database. Because of the interdependency between spatial columns and the type definitions, you cannot drop the type definitions when columns of those types exist. If you already defined spatial columns but still want to disable a database for spatial operations, you must specify a value other than 0 (zero) for the *force* parameter to remove all spatial resources in the database that do not have other dependencies on them.

This stored procedure replaces db2gse.gse_disable_db.

Authorization

The user ID under which this stored procedure is invoked must have either SYSADM or DBADM authority on the database from which DB2 Spatial Extender resources are to be removed.

Syntax



Parameter descriptions

force

Specifies that you want to disable a database for spatial operations, even though you might have database objects that are dependent on the spatial types or spatial functions. Although you must specify a value for this parameter, the value can be null. If you specify a value other than 0 (zero) or null for the *force* parameter, the database is disabled, and all resources of the

DB2 Spatial Extender are removed (if possible). If you specify 0 (zero) or null, the database is not disabled if any database objects are dependent on spatial types or spatial functions. Database objects that might have such dependencies include tables, views, constraints, triggers, generated columns, methods, functions, procedures, and other data types (subtypes or structured types with a spatial attribute).

The data type of this parameter is SMALLINT.

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_disable_db stored procedure. This example uses a DB2 CALL command to disable the database for spatial operations, with a *force* parameter value of 1:

```
call db2gse.ST_disable_db(1,?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_drop_coordsys

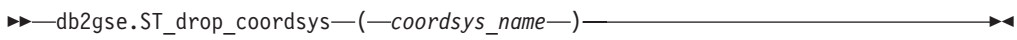
Use this stored procedure to delete information about a coordinate system from the database. When this stored procedure is processed, information about the coordinate system is removed from the DB2GSE.ST_COORDINATE_SYSTEMS catalog view.

Restriction:
You cannot drop a coordinate system on which a spatial reference system is based.

Authorization

The user ID under which the stored procedure is invoked must have either SYSADM or DBADM authority.

Syntax



Parameter descriptions

coordsys_name
Uniquely identifies the coordinate system. You must specify a non-null value for this parameter.

The *coordsys_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_drop_coordsys stored procedure. This example uses a DB2 CALL command to delete a coordinate system named NORTH_AMERICAN_TEST from the database:

```
call db2gse.ST_drop_coordsys('NORTH_AMERICAN_TEST',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_drop_srs

Use this stored procedure to drop a spatial reference system.

When this stored procedure is processed, information about the spatial reference system is removed from the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view.

Restriction: You cannot drop a spatial reference system if a spatial column that uses that spatial reference system is registered.

Important:
Use care when you use this stored procedure. If you use this stored procedure to drop a spatial reference system, and if any spatial data is associated with that spatial reference system, you can no longer perform spatial operations on the spatial data.

This stored procedure replaces db2gse.gse_disable_sref.

Authorization

The user ID under which the stored procedure is invoked must have either SYSADM or DBADM authority.

Syntax

Parameter descriptions

srs_name
Identifies the spatial reference system. You must specify a non-null value for this parameter.

The *srs_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_drop_srs stored procedure. This example uses a DB2 CALL command to delete a spatial reference system named SRSDEMO:

```
call db2gse.ST_drop_srs('SRSDEMO',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are

displayed after the stored procedure runs.

ST_enable_autogeocoding

Use this stored procedure to specify that DB2 Spatial Extender is to synchronize a geocoded column with its associated geocoding column or columns.

A *geocoding column* is used as input to the geocoder. Each time that values are inserted into, or updated in, the geocoding column or columns, triggers are activated. These triggers invoke the associated geocoder to geocode the inserted or updated values and to place the resulting data in the geocoded column.

Restriction: You can enable autogeocoding only on tables on which INSERT and UPDATE triggers can be created. Consequently, you cannot enable autogeocoding on views or nicknames.

Prerequisite: Before enabling autogeocoding, you must perform the geocoding setup step by invoking the ST_setup_geocoding stored procedure. The geocoding setup step specifies the geocoder and the geocoding parameter values. It also identifies the geocoding columns that are to be synchronized with the geocoded columns.

This stored procedure replaces db2gse.gse_enable_autogc.

Authorization

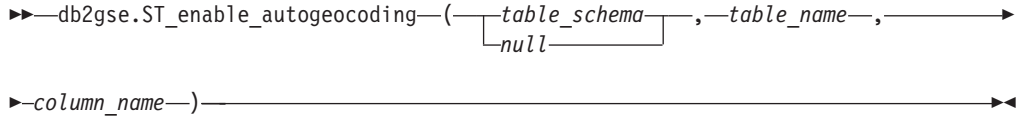
The user ID under which this stored procedure is invoked must have one of the following authorities or privileges:

- SYSADM or DBADM authority on the database that contains the table on which the triggers that are created by this stored procedure are defined
- CONTROL privilege on the table
- ALTER privilege on the table

If the authorization ID of the statement does not have SYSADM or DBADM authority, the privileges that the authorization ID of the statement holds (without considering PUBLIC or group privileges) must include all of the following privileges as long as the trigger exists:

- SELECT privilege on the table on which autogeocoding is enabled
- Necessary privileges to evaluate the SQL expressions that are specified for the parameters in the geocoding setup

Syntax



Parameter descriptions

table_schema
Identifies the schema to which the table that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the

value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table.

The *table_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name
Specifies the unqualified name of the table that contains the column into which the geocoded data is to be inserted or updated. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

column_name
Identifies the column into which the geocoded data is to be inserted or updated. This column is referred to as the geocoded column. You must specify a non-null value for this parameter.

The *column_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_enable_autogeocoding stored procedure. This example uses a DB2 CALL command to enable autogeocoding on the LOCATION column in the table named CUSTOMERS:

```
call db2gse.ST_enable_autogeocoding(NULL,'CUSTOMERS','LOCATION',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_enable_db

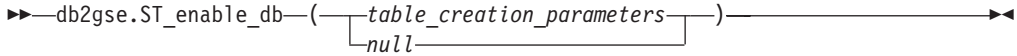
Use this stored procedure to supply a database with the resources that it needs to store spatial data and to support spatial operations. These resources include spatial data types, spatial index types, catalog views, supplied functions, and other stored procedures.

This stored procedure replaces db2gse.gse_enable_db.

Authorization

The user ID under which the stored procedure is invoked must have either SYSADM or DBADM authority on the database that is being enabled.

Syntax



Parameter descriptions

table_creation_parameters
Specifies any options that are to be added to the CREATE TABLE statements for the DB2 Spatial Extender catalog tables. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no options are added to the CREATE TABLE statements.

To specify these options, use the syntax of the DB2 CREATE TABLE statement. For example, to specify a table space in which to create the tables, use:

```
IN tsName INDEX IN indexTsName
```

The data type of this parameter is VARCHAR(32K).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

The following example shows how to use Call Level Interface (CLI) to invoke the ST_enable_db stored procedure:

```
SQLHANDLE  henv;
  SQLHANDLE  hdbc;
  SQLHANDLE  hstmt;
  SQLCHAR    uid[MAX_UID_LENGTH + 1];
  SQLCHAR    pwd[MAX_PWD_LENGTH + 1];
  SQLINTEGER ind[3];
  SQLINTEGER msg_code = 0;
  char       msg_text[1024] = "";
  SQLRETURN  rc;
  char       *table_creation_parameters = NULL;

  /* Allocate environment handle */
  rc = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &henv);

  /* Allocate database handle */
  rc = SQLAllocHandle(SQL_HANDLE_DBC, henv, &hdbc);

  /* Establish a connection to database "testdb" */
  rc = SQLConnect(hdbc, (SQLCHAR *)"testdb", SQL_NTS, (SQLCHAR *)uid,SQL_NTS,
                  (SQLCHAR *)pwd, SQL_NTS);


  /* Allocate statement handle */
  rc = SQLAllocHandle(SQL_HANDLE_STMT, hdbc, &hstmt) ;

  /* Associate SQL statement to call the ST_enable_db stored procedure    */
  /* with statement handle and send the statement to DBMS to be prepared. */
  rc = SQLPrepare(hstmt, "call db2gse!ST_enable_db(?,?,?)", SQL_NTS);

  /* Bind 1st parameter marker in the SQL call statement, the input */
  /* parameter for table creation parameters, to variable           */
  /* table_creation_parameters.                                     */
  ind[0] = SQL_NULL_DATA;
  rc = SQLBindParameter(hstmt, 1, SQL_PARAM_OUTPUT, SQL_C_CHAR,
       SQL_VARCHAR, 255, 0, table_creation_parameters, 256, &ind[0]);

  /* Bind 2nd parameter marker in the SQL call statement, the output */
  /* parameter for returned message code, to variable msg_code.      */
  ind[1] = 0;
  rc = SQLBindParameter(hstmt, 2, SQL_PARAM_OUTPUT, SQL_C_LONG,
                        SQL_INTEGER, 0, 0, &msg_code, 4, &ind[1]);

  /* Bind 3rd parameter marker in the SQL call statement, the output */
  /* parameter returned message text, to variable msg_text.          */
  ind[2] = 0;
  rc = SQLBindParameter(hstmt, 3, SQL_PARAM_OUTPUT, SQL_C_CHAR,
                        SQL_VARCHAR, (sizeof(msg_text)-1), 0, msg_text,
                         sizeof(msg_text), &ind[2]);
  rc = SQLExecute(hstmt);
```

ST_export_shape

Use this stored procedure to export a spatial column and its associated table to a shape file.

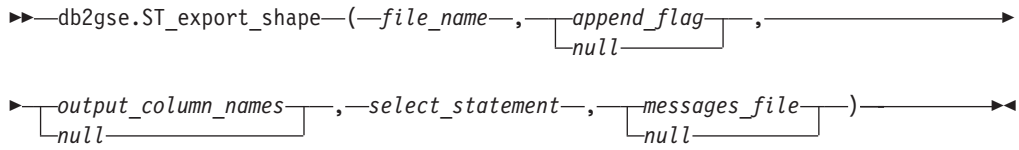
This stored procedure replaces db2gse.gse_export_shape.

Authorization

The user ID under which this stored procedure is invoked must have the necessary privileges to successfully execute the SELECT statement from which the data is to be exported.

The stored procedure, which runs as a process that is owned by the DB2 instance owner, must have the necessary privileges on the server machine to create or write to the shape files.

Syntax



Parameter descriptions

file_name
Specifies the full path name of a shape file to which the specified data is to be exported. You must specify a non-null value for this parameter.

You can use the ST_export_shape stored procedure to export a new file or to export to an existing file by appending the exported data to it:

- If you are exporting to a new file, you can specify the optional file extension as .shp or .SHP. If you specify .shp or .SHP for the file extension, DB2 Spatial Extender creates the file with the specified *file_name* value. If you do not specify the optional file extension, DB2 Spatial Extender creates the file that has the name of the *file_name* value that you specify and with an extension of .shp.
- If you are exporting data by appending the data to an existing file, DB2 Spatial Extender first looks for an exact match of the name that you specify for the *file_name* parameter. If DB2 Spatial Extender does not find an exact match, it looks first for a file with the .shp extension, and then for a file with the .SHP extension.

If the value of the *append_flag* parameter indicates that you are not appending to an existing file, but the file that you name in the *file_name* parameter already exists, DB2 Spatial Extender returns an error and does not overwrite the file.

See Usage notes for a list of files that are written on the server machine. The stored procedure, which runs as a process that is owned by the DB2 instance owner, must have the necessary privileges on the server machine to create or write to the files.

The data type of this parameter is VARCHAR(256).

append_flag
Indicates whether the data that is to be exported is to be appended to an existing shape file. Although you must specify a value for this parameter, the value can be null. Indicate whether you want to append to an existing shape file as follows:

- If you want to append data to an existing shape file, specify any value other than 0 (zero) and null. In this case, the file structure must match the exported data; otherwise an error is returned.
- If you want to export to a new file, specify 0 (zero) or null. In this case, DB2 Spatial Extender does not overwrite any existing files.

The data type of this parameter is SMALLINT.

output_column_names
Specifies one or more column names (separated by commas) that are to be used for non-spatial columns in the output dBASE file. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the names that are derived from the SELECT statement are used.

If you specify this parameter but do not enclose column names in double quotation marks, the column names are converted to uppercase. The number of specified columns must match the number of columns that are returned from the SELECT statement, as specified in the *select_statement* parameter, excluding the spatial column.

The data type of this parameter is VARCHAR(32K).

select_statement
Specifies the subselect that returns the data that is to be exported. The subselect must reference exactly one spatial column and any number of attribute columns. You must specify a non-null value for this parameter.

The data type of this parameter is VARCHAR(32K).

messages_file
Specifies the full path name of the file (on the server machine) that is to contain messages about the export operation. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no file for DB2 Spatial Extender messages is created.

The messages that are sent to this messages file can be:

- Informational messages, such as a summary of the export operation
- Error messages for data that could not be exported, for example because of different coordinate systems

The stored procedure, which runs as a process that is owned by the DB2 instance owner, must have the necessary privileges on the server to create the file.

The data type of this parameter is VARCHAR(256).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Usage notes

You can export only one spatial column at a time.

The ST_export_shape stored procedure creates or writes to the following four files:

- The main shape file (.shp extension).
- The shape index file (.shx extension).
- A dBASE file that contains data for non-spatial columns (.dbf extension). This file is created only if attribute columns actually need to be exported
- A projection file that specifies the coordinate system that is associated with the spatial data, if the coordinate system is not equal to ″UNSPECIFIED″ (.prj extension). The coordinate system is obtained from the first spatial record. An error occurs if subsequent records have different coordinate systems.

The following table describes how DB2 data types are stored in dBASE attribute files. All other DB2 data types are not supported.

Table 28. Storage of DB2 data types in attribute files

SQL type	.dbf type	.dbf length	.dbf decimals	Comments
SMALLINT	N	6	0	
INTEGER	N	11	0	
BIGINT	N	20	0	
DECIMAL	N	precision+2	scale	
REAL FLOAT(1) through FLOAT(24)	F	14	6	
DOUBLE FLOAT(25) through FLOAT(53)	F	19	9	
CHARACTER, VARCHAR, LONG VARCHAR, and DATALINK	C	*len*	0	length ≤ 255
DATE	D	8	0	
TIME	C	8	0	
TIMESTAMP	C	26	0	

All synonyms for data types and distinct types that are based on the types listed in the preceding table are supported.

Example

This example shows how to use the DB2 command line processor to invoke the ST_export_shape stored procedure. This example uses a DB2 CALL command to export all rows from the CUSTOMERS table to a shape file that is to be created and named `/tmp/export_file`:

```
call db2gse.ST_export_shape('/tmp/export_file',0,NULL,
     'select * from customers','/tmp/export_msg',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_import_shape

Use this stored procedure to import a shape file to a database that is enabled for spatial operations.

The stored procedure can operate in either of two ways, based on the *create_table_flag* parameter:

- DB2 Spatial Extender can create a table that has a spatial column and attribute columns, and it can then load the table's columns with the file's data.
- Otherwise, the shape and attribute data can be loaded into an existing table that has a spatial column and attribute columns that match the file's data.

This stored procedure replaces db2gse.gse_import_shape.

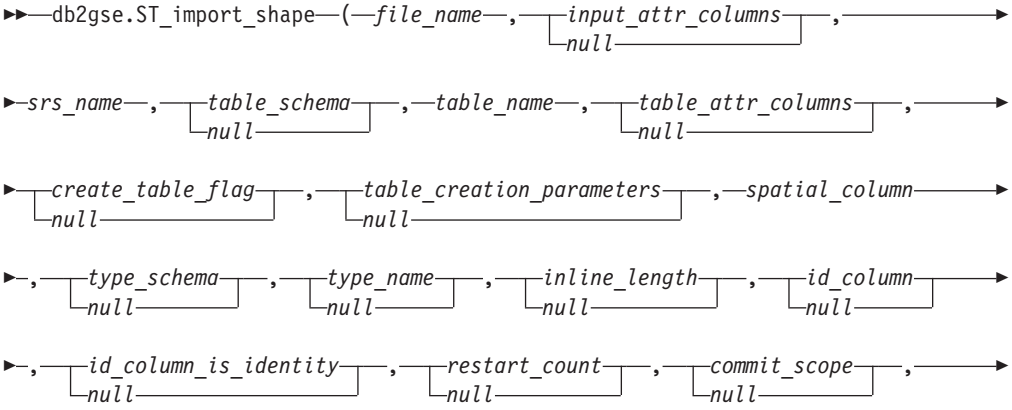
Authorization

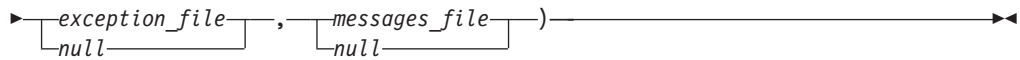
The owner of the DB2 instance must have the necessary privileges on the server machine for reading the input files and optionally writing error files. Additional authorization requirements vary based on whether you are importing into an existing table or into a new table.

- **When importing into an existing table**, the user ID under which this stored procedure is invoked must hold one of the following authorities or privileges:
  - SYSADM or DBADM
  - CONTROL privilege on the table or view
  - INSERT and SELECT privilege on the table or view
- **When importing into a new table**, the user ID under which this stored procedure is invoked must hold one of the following authorities or privileges:
  - SYSADM or DBADM
  - CREATETAB authority on the database

  The user ID must also have one of the following authorities:
  - IMPLICIT_SCHEMA authority on the database, if the schema name of the table does not exist
  - CREATEIN privilege on the schema, if the schema of the table exists

Syntax





Parameter descriptions

file_name
Specifies the full path name of the shape file that is to be imported. You must specify a non-null value for this parameter.

If you specify the optional file extension, specify either .shp or .SHP. DB2 Spatial Extender first looks for an exact match of the specified file name. If DB2 Spatial Extender does not find an exact match, it looks first for a file with the .shp extension, and then for a file with the .SHP extension.

See Usage notes for a list of required files, which must reside on the server machine. The stored procedure, which runs as a process that is owned by the DB2 instance owner, must have the necessary privileges on the server to read the files.

The data type of this parameter is VARCHAR(256).

input_attr_columns
Specifies a list of attribute columns to import from the dBASE file. Although you must specify a value for this parameter, the value can be null. If this parameter is null, all columns are imported. If the dBASE file does not exist, this parameter must be the empty string or null.

To specify a non-null value for this parameter, use one of the following specifications:

- **List the attribute column names.** The following example shows how to specify a list of the names of the attribute columns that are to be imported from the dBASE file:

  ```
  N(COLUMN1,COLUMN5,COLUMN3,COLUMN7)
  ```

  If a column name is not enclosed in double quotation marks, it is converted to uppercase. Each name in the list must be separated by a comma. The resulting names must exactly match the column names in the dBASE file.
- **List the attribute column numbers.** The following example shows how to specify a list of the numbers of the attribute columns that are to be imported from the dBASE file:

  ```
  P(1,5,3,7)
  ```

  Columns are numbered beginning with 1. Each number in the list must be separated by a comma.
- **Indicate that no attribute data is to be imported.** Specify *""*, which is an empty string that explicitly specifies that DB2 Spatial Extender is to import *no* attribute data.

The data type of this parameter is VARCHAR(32K).

srs_name
Identifies the spatial reference system that is to be used for the geometries that are imported into the spatial column. You must specify a non-null value for this parameter.

The spatial column will not be registered. The spatial reference system (SRS) must exist before the data is imported. The import process does not implicitly create the SRS, but it does compare the coordinate system of the SRS with the

coordinate system that is specified in the .prj file (if available with the shape file). The import process also verifies that the extents of the data in the shape file can be represented in the given spatial reference system. That is, the import process verifies that the extents lie within the minimum and maximum possible X, Y, Z, and M coordinates of the SRS.

The *srs_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_schema
Names the schema to which the table that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table or view.

The *table_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name
Specifies the unqualified name of the table into which the imported shape file is to be loaded. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_attr_columns
Specifies the table column names where attribute data from the dBASE file is to be stored. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the names of the columns in the dBASE file are used.

If this parameter is specified, the number of names must match the number of columns that are imported from the dBASE file. If the table exists, the column definitions must match the incoming data. See Usage notes for an explanation of how attribute data types are mapped to DB2 data types.

The data type of this parameter is VARCHAR(32K).

create_table_flag
Specifies whether the import process is to create a new table. Although you must specify a value for this parameter, the value can be null. If this parameter is null or any other value other than 0 (zero), a new table is created. (If the table already exists, an error is returned.) If this parameter is 0 (zero), no table is created, and the table must already exist.

The data type of this parameter is INTEGER.

table_creation_parameters
Specifies any options that are to be added to the CREATE TABLE statement that creates a table into which data is to be imported. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no options are added to the CREATE TABLE statement.

To specify any CREATE TABLE options, use the syntax of the DB2 CREATE TABLE statement. For example, to specify a table space in which to create the tables, specify:

```
IN tsName INDEX IN indexTsName LONG IN longTsName
```

The data type of this parameter is VARCHAR(32K).

spatial_column
Name of the spatial column in the table into which the shape data is to be loaded. You must specify a non-null value for this parameter.

For a new table, this parameter specifies the name of the new spatial column that is to be created. Otherwise, this parameter specifies the name of an existing spatial column in the table.

The *spatial_column* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

type_schema
Specifies the schema name of the spatial data type (specified by the *type_name* parameter) that is to be used when creating a spatial column in a new table. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of DB2GSE is used.

The *type_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

type_name
Names the data type that is to be used for the spatial values. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the data type is determined by the shape file and is one of the following types:

- ST_Point
- ST_MultiPoint
- ST_MultiLineString
- ST_MultiPolygon

Note that shape files, by definition, allow a distinction only between points and multipoints, but not between polygons and multipolygons or between linestrings and multilinestrings.

If you are importing into a table that does not yet exist, this data type is also used for the data type of the spatial column. In that case, the data type can also be a super type of ST_Point, ST_MultiPoint, ST_MultiLineString, or ST_MultiPolygon.

The *type_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

inline_length
Specifies, for a new table, the maximum number of bytes that are to be allocated for the spatial column within the table. Although you must specify a

value for this parameter, the value can be null. If this parameter is null, no explicit INLINE LENGTH option is used in the CREATE TABLE statement, and DB2 defaults are used implicitly.

Spatial records that exceed this size are stored separately in the LOB table space, which might be slower to access.

Typical sizes that are needed for various spatial types are as follows:

- **One point:** 292.
- **Multipoint, line, or polygon:** As large a value as possible. Consider that the total number of bytes in one row should not exceed the limit for the page size of the table space for which the table is created.

See the DB2 documentation about the CREATE TABLE SQL statement for a complete description of this value. See also the db2dart utility to determine the number of inline geometries for existing tables and the ability to alter the inline length.

The data type of this parameter is INTEGER.

id_column
Names a column that is to be created to contain a unique number for each row of data. (ESRI tools require a column named SE_ROW_ID.) The unique values for that column are generated automatically during the import process. Although you must specify a value for this parameter, the value can be null if no column (with a unique ID in each row) exists in the table or if you are not adding such a column to a newly created table. If this parameter is null, no column is created or populated with unique numbers.

Restriction: You cannot specify an *id_column* name that matches the name of any column in the dBASE file.

The requirements and effect of this parameter depend on whether the table already exists.

- **For an existing table**, the data type of the *id_column* parameter can be any integer type (INTEGER, SMALLINT, or BIGINT).
- **For a new table that is to be created**, the column is added to the table when the stored procedure creates it. The column will be defined as follows:

  ```
  INTEGER NOT NULL PRIMARY KEY
  ```

  If the value of the *id_column_is_identity* parameter is not null and not 0 (zero), the definition is expanded as follows:

  ```
  INTEGER NOT NULL PRIMARY KEY GENERATED ALWAYS AS IDENTITY
  ( START WITH 1 INCREMENT BY 1 )
  ```

The *id_column* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

id_column_is_identity
Indicates whether the specified *id_column* is to be created using the IDENTITY clause. Although you must specify a value for this parameter, the value can be null. If this parameter is 0 (zero) or null, the column is not created as the identity column. If the parameter is any value other than 0 or null, the column is created as the identity column. This parameter is ignored for tables that already exist.

The data type of this parameter is SMALLINT.

restart_count
Specifies that an import operation is to be started at record *n* + 1. The first *n* records are skipped. Although you must specify a value for this parameter, the value can be null. If this parameter is null, all records (starting with record number 1) are imported.

The data type of this parameter is INTEGER.

commit_scope
Specifies that a COMMIT is to be performed after at least *n* records are imported. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a value of 0 (zero) is used, and no records are committed.

The data type of this parameter is INTEGER.

exception_file
Specifies the full path name of a shape file in which the shape data that could not be imported is stored. Although you must specify a value for this parameter, the value can be null. If the parameter is null, no files are created.

If you specify a value for the parameter and include the optional file extension, specify either .shp or .SHP. If the extension is null, an extension of .shp is appended.

The exception file holds the complete block of rows for which a single insert statement failed. For example, assume that one row cannot be imported because the shape data is incorrectly encoded. A single insert statement attempts to import 20 rows, including the one that is in error. Because of the problem with the single row, the entire block of 20 rows is written to the exception file.

Records are written to the exception file only when those records can be correctly identified, as is the case when the shape record type is not valid. Some types of corruption to the shape data (.shp files) and shape index (.shx files) do not allow the appropriate records to be identified. In this case, no records are written to the exception file, and an error message is issued to report the problem.

If you specify a value for this parameter, four files are created on the server machine. See Usage notes for an explanation these files. The stored procedure, which runs as a process that is owned by the DB2 instance owner, must have the necessary privileges on the server to create the files. If the files already exist, the stored procedure returns an error.

The data type of this parameter is VARCHAR(256).

messages_file
Specifies the full path name of the file (on the server machine) that is to contain messages about the import operation. Although you must specify a value for this parameter, the value can be null. If the parameter is null, no file for DB2 Spatial Extender messages is created.

The messages that are written to the messages file can be:

- Informational messages, such as a summary of the import operation
- Error messages for data that could not be imported, for example because of different coordinate systems

These messages correspond to the shape data that is stored in the exception file (identified by the *exception_file* parameter).

The stored procedure, which runs as a process that is owned by the DB2 instance owner, must have the necessary privileges on the server to create the file. If the file already exists, the stored procedure returns an error.

The data type of this parameter is VARCHAR(256).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Usage notes

The ST_import_shape stored procedure uses from one to four files:

- The main shape file (.shp extension). This file is required.
- The shape index file (.shx extension). This file is optional. If it is present, performance of the import operation might improve.
- A dBASE file that contains attribute data (.dbf extension). This file is required only if attribute data is to be imported.
- The projection file that specifies the coordinate system of the shape data (.prj extension). This file is optional. If this file is present, the coordinate system that is defined in it is compared with the coordinate system of the spatial reference system that is specified by the *srs_id* parameter.

The following table describes how dBASE attribute data types are mapped to DB2 data types. All other attribute data types are not supported.

Table 29. Relationship between DB2 data types and dBASE attribute data types

.dbf type	.dbf lengthb (See note)	.dbf decimalsb (See note)	SQL type	Comments
N	< 5	0	SMALLINT	
N	< 10	0	INTEGER	
N	< 20	0	BIGINT	
N	*len*	*dec*	DECIMAL(*len*,*dec*)	*len*<32
F	*len*	*dec*	REAL	*len* + *dec* < 7
F	*len*	*dec*	DOUBLE	
C	*len*		CHAR(*len*)	
L			CHAR(1)	
D			DATE	

Note: This table includes the following variables, both of which are defined in the header of the dBASE file:

- *len*, which represents the total length of the column in the dBASE file. DB2 Spatial Extender uses this value for two purposes:
  - To define the precision for the SQL data type DECIMAL or the length for the SQL data type CHAR
  - To determine which of the integer or floating-point types is to be used
- *dec*, which represents the maximum number of digits to the right of the decimal point of the column in the dBASE file. DB2 Spatial Extender uses this value to define the scale for the SQL data type DECIMAL.

For example, assume that the dBASE file contains a column of data whose length (*len*) is defined as 20. Assume that the number of digits to the right of the decimal point (*dec*) is defined as 5. When DB2 Spatial Extender imports data from that column, it uses the values of *len* and *dec* to derive the following SQL data type: DECIMAL(20,5).

Example

This example shows how to use the DB2 command line processor to invoke the ST_import_shape stored procedure. This example uses a DB2 CALL command to import a shape file named `/tmp/officesShape` into the table named OFFICES:

```
call db2gse.ST_import_shape('/tmp/officesShape',NULL,'USA_SRS_1',NULL,
                    'OFFICES',NULL,0,NULL,'LOCATION',NULL,NULL,NULL,NULL,
                    NULL,NULL,NULL,NULL,'/tmp/import_msg',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_register_geocoder

Use this stored procedure to register a geocoder other than the DB2SE_USA_GEOCODER geocoder, which is shipped with DB2 Spatial Extender. The DB2SE_USA_GEOCODER geocoder is registered by DB2 Spatial Extender when the database is enabled.

Prerequisites: Before registering a geocoder:

- Ensure that the function that implements the geocoder is already created. Each geocoder function can be registered as a geocoder with a uniquely identified geocoder name.
- Obtain information from the geocoder vendor, such as:
  - The SQL statement that creates the function
  - The values to use with the ST_create_srs parameters so that geometric data can be supported
  - Information for registering the geocoder, such as:
    - A description of the geocoder
    - Descriptions of the parameters for the geocoder
    - The default values of the geocoder parameters

The geocoder function's return type must match the data type of the geocoded column. The geocoding parameters can be either a column name (called a *geocoding column*) which contains data that the geocoder needs. For example, the geocoder

parameters can identify addresses or a value of particular meaning to the geocoder, such as the minimum match score. If the geocoding parameter is a column name, the column must be in the same table or view as the geocoded column.

The geocoder function's return type serves as the data type for the geocoded column. The return type can be any DB2 data type, user-defined type, or structured type. If a user-defined type or structured type is returned, the geocoder function is responsible for returning a valid value of the respective data type. If the geocoder function returns values of a spatial type, that is ST_Geometry or one of its subtypes, the geocoder function is responsible for constructing a valid geometry. The geometry must be represented using an existing spatial reference system. The geometry is valid if you invoke the ST_IsValid spatial function on the geometry and a value of 1 is returned. The returned data from the geocoder function is updated in or is inserted into the geocoded column, depending on which operation (INSERT or UPDATE) caused the generation of the geocoded value.

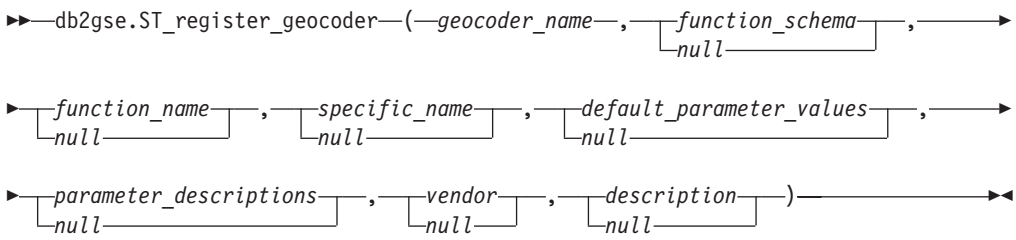
To find out whether a geocoder is already registered, examine the DB2GSE.ST_GEOCODERS catalog view.

This stored procedure replaces db2gse.gse_register_gc.

Authorization

The user ID under which this stored procedure is invoked must hold either SYSADM or DBADM authority on the database that contains the geocoder that this stored procedure registers.

Syntax



Parameter descriptions

geocoder_name
Uniquely identifies the geocoder. You must specify a non-null value for this parameter.

The *geocoder_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

function_schema
Names the schema for the function that implements this geocoder. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the function.

The *function_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

function_name
Specifies the unqualified name of the function that implements this geocoder. The function must already be created and listed in SYSCAT.ROUTINES.

For this parameter, you can specify null if the *specific_name* parameter is specified. If the *specific_name* parameter is not specified, the *function_name* value, together with the implicitly or explicitly defined *function_schema* value, must uniquely identify the function. If the *function_name* parameter is not specified, DB2 Spatial Extender retrieves the *function_name* value from the SYSCAT.ROUTINES catalog view.

The *function_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

specific_name
Identifies the specific name of the function that implements the geocoder. The function must already be created and listed in SYSCAT.ROUTINES.

For this parameter, you can specify null if the *function_name* parameter is specified and the combination of *function_schema* and *function_name* uniquely identifies the geocoder function. If the geocoder function name is overloaded, the *specific_name* parameter cannot be null. (A function name is *overloaded* if it has the same name, but not the same parameters or parameter data types, as one or more other functions.)

The *specific_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

default_parameter_values
Specifies the list of default geocoding parameter values for the geocoder function. Although you must specify a value for this parameter, the value can be null. If the entire *default_parameter_values* parameter is null, all parameter default values are null.

If you specify any parameter values, specify them in the order that the function defined them, and separate them with a comma. For example:

```
default_parm1_value,default_parm2_value,...
```

Each parameter value is an SQL expression. Follow these guidelines:

- If a value is a string, enclose it in single quotation marks.
- If a parameter value is a number, do not enclose it in single quotation marks.
- If the parameter value is null, cast it to the correct type. For example, instead of specifying just NULL, specify:

  ```
  CAST(NULL AS INTEGER)
  ```
- If the geocoding parameter is to be a geocoding column, do not specify the default parameter value.

If any parameter value is not specified (that is, if you specify two consecutive commas (`...,,...`)), this parameter must be specified either when geocoding

is set up or when geocoding is run in batch mode with the *parameter_values* parameter of the respective stored procedures.

The data type of this parameter is VARCHAR(32K).

parameter_descriptions
Specifies the list of geocoding parameter descriptions for the geocoder function. Although you must specify a value for this parameter, the value can be null.

If the entire *parameter_descriptions* parameter is null, all parameter descriptions are null. Each parameter description that you specify explains the meaning and usage of the parameter, and can be up to 256 characters long. The descriptions for the parameters must be separated by commas and must appear in the order of the parameters as defined by the function. If a comma shall be used within the description of a parameter, enclose the string in single or double quotation marks. For example:

```
description,'description2, which contains a comma',description3
```

The data type of this parameter is VARCHAR(32K).

vendor
Names the vendor who implemented the geocoder. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no information about the vendor who implemented the geocoder is recorded.

The data type of this parameter is VARCHAR(128).

description
Describes the geocoder by explaining its application. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no description information about the geocoder is recorded.

Recommendation: Include the following information:

- Coordinate system name if spatial data, such as well-known text (WKT) or well-known binary (WKB), is to be returned
- Spatial reference system, if ST_Geometry or any of its subtypes are to be returned
- Name of the geographical area to which this geocoder applies
- Any other information about the geocoder that users should know

The data type of this parameter is VARCHAR(256).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is

returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example assumes that you want to create a geocoder that takes latitude and longitude as input and geocodes into ST_Point spatial data. To do this, you first create a function named lat_long_gc_func. Then you register a geocoder named SAMPLEGC, which uses the function lat_long_gc_func.

Here is an example of the SQL statement that creates the function lat_long_gc_func that returns ST_Point:

```
CREATE FUNCTION lat_long_gc_func(latitude double,
   longitude double, srId integer)
   RETURNS db2gse.ST_Point
   LANGUAGE SQL
   RETURN db2gse.ST_Point(latitude, longitude, srId)
```

After the function is created, you can register it as a geocoder. This example shows how to use the DB2 command line processor CALL command to invoke the ST_register_geocoder stored procedure to register a geocoder named SAMPLEGC with function lat_long_gc_func:

```
call db2gse.ST_register_geocoder ('SAMPLEGC',NULL,'LAT_LONG_GC_FUNC',',,1'
            ,NULL,'My Company','Latitude/Longitude to
            ST_Point Geocoder'?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_register_spatial_column

Use this stored procedure to register a spatial column and to associate a spatial reference system (SRS) with it.

When this stored procedure is processed, information about the spatial column that is being registered is added to the DB2GSE.ST_GEOMETRY_COLUMNS catalog view. Registering a spatial column creates a constraint on the table, if possible, to ensure that all geometries use the specified SRS.

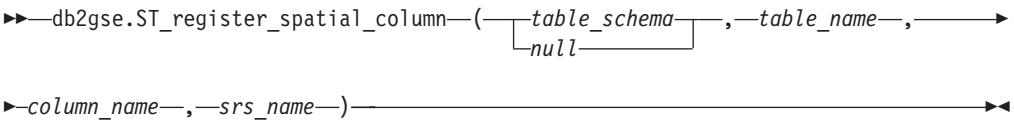
This stored procedure replaces db2gse.gse_register_layer.

Authorization

The user ID under which this stored procedure is invoked must hold one of the following authorities or privileges:

- SYSADM or DBADM authority on the database that contains the table to which the spatial column that is being registered belongs
- CONTROL or ALTER privilege on this table

Syntax



Parameter descriptions

table_schema
Names the schema to which the table or view that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table or view.

The *table_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name
Specifies the unqualified name of the table or view that contains the column that is being registered. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

column_name
Names the column that is being registered. You must specify a non-null value for this parameter.

The *column_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

srs_name
Names the spatial reference system that is to be used for this spatial column. You must specify a non-null value for this parameter.

The *srs_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is

returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_register_spatial_column stored procedure. This example uses a DB2 CALL command to register the spatial column named LOCATION in the table named CUSTOMERS. This CALL command specifies the *srs_name* parameter value as USA_SRS_1:

```
call db2gse.ST_register_spatial_column(NULL,'CUSTOMERS','LOCATION',
     'USA_SRS_1',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_remove_geocoding_setup

Use this stored procedure to remove all the geocoding setup information for the geocoded column.

This stored procedure removes information that is associated with the specified geocoded column from the DB2GSE.ST_GEOCODING and DB2GSE.ST_GEOCODING_PARAMETERS catalog views.

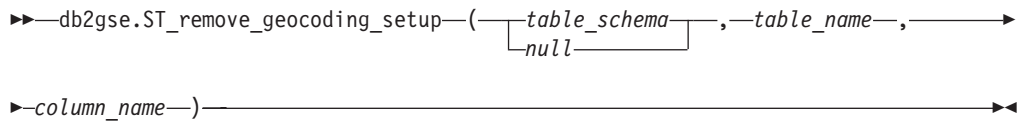
Restriction:
You cannot remove a geocoding setup if autogeocoding is enabled for the geocoded column.

Authorization

The user ID under which this stored procedure is invoked must hold one of the following authorities or privileges:

- SYSADM or DBADM authority on the database that contains the table on which the specified geocoder is to operate
- CONTROL or UPDATE privilege on this table

Syntax



Parameter descriptions

table_schema
Names the schema to which the table or view that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table or view.

The *table_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name
Specifies the unqualified name of the table or view that contains the column into which the geocoded data is to be inserted or updated. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

column_name
Names the column into which the geocoded data is to be inserted or updated. You must specify a non-null value for this parameter.

The *column_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type for this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_remove_geocoding_setup stored procedure. This example uses a DB2 CALL command to remove the geocoding setup for the table named CUSTOMER and the column named LOCATION:

```
call db2gse.ST_remove_geocoding_setup(NULL, 'CUSTOMERS', 'LOCATION',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_run_geocoding

Use this stored procedure to run a geocoder in batch mode on a geocoded column.

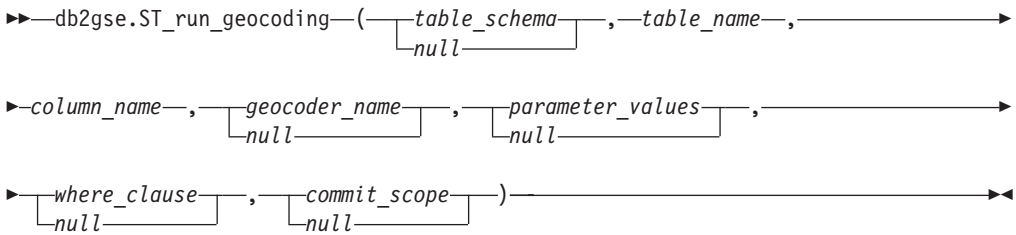
This stored procedure replaces db2gse.gse_run_gc.

Authorization

The user ID under which this stored procedure is invoked must hold one of the following authorities or privileges:

- SYSADM or DBADM authority on the database that contains the table on which the specified geocoder is to operate
- CONTROL or UPDATE privilege on this table

Syntax



Parameter descriptions

table_schema
Names the schema to which the table or view that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table or view.

The *table_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name
Specifies the unqualified name of the table or view that contains the column into which the geocoded data is to be inserted or updated. If a view name is specified, the view must be an updatable view. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

column_name
Names the column into which the geocoded data is to be inserted or updated. You must specify a non-null value for this parameter.

The *column_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

geocoder_name
Names the geocoder that is to perform the geocoding. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the geocoding is performed by the geocoder that was specified when geocoding was set up.

The *geocoder_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

parameter_values
Specifies the list of geocoding parameter values for the geocoder function. Although you must specify a value for this parameter, the value can be null. If the entire *parameter_values* parameter is null, the values that are used are either the parameter values that were specified when the geocoder was set up or the default parameter values for the geocoder if the geocoder was not set up.

If you specify any parameter values, specify them in the order that the function defined them, and separate them with a comma. For example:

```
parameter1-value,parameter2-value,...
```

Each parameter value can be a column name, a string, a numeric value, or null.

Each parameter value is an SQL expression. Follow these guidelines:

- If a parameter value is a geocoding column name, ensure that the column is in the same table or view where the geocoded column resides.
- If a parameter value is a string, enclose it in single quotation marks.
- If a parameter value is a number, do not enclose it in single quotation marks.
- If the parameter is null, cast it to the correct type. For example, instead of specifying just NULL, specify:

  ```
  CAST(NULL AS INTEGER)
  ```

If any parameter value is not specified (that is, if you specify two consecutive commas `(...,,...)`), this parameter must be specified either when geocoding is set up or when geocoding is run in batch mode with the *parameter_values* parameter of the respective stored procedures.

The data type of this parameter is VARCHAR(32K).

where_clause
Specifies the body of the WHERE clause, which defines a restriction on the set of records that are to be geocoded. Although you must specify a value for this parameter, the value can be null.

If the *where_clause* parameter is null, the resulting behavior depends on whether geocoding was set up for the column (specified in the *column_name* parameter) before the stored procedure runs. If the *where_clause* parameter is null, and:

- A value was specified when geocoding was set up, that value is used for the *where_clause* parameter.

- Either geocoding was not set up or no value was specified when geocoding was set up, no where clause is used.

You can specify a clause that references any column in the table or view that the geocoder is to operate on. Do not specify the keyword WHERE.

The data type of this parameter is VARCHAR(32K).

commit_scope
Specifies that a COMMIT is to be performed after every *n* records that are geocoded. Although you must specify a value for this parameter, the value can be null.

If the *commit_scope* parameter is null, the resulting behavior depends on whether geocoding was set up for the column (specified in the *column_name* parameter) before the stored procedure runs. If the *commit_scope* parameter is null and:

- A value was specified when geocoding was set up for the column, that value is used for the *commit_scope* parameter.
- Either geocoding was not set up or it was set up but no value was specified, the default value of 0 (zero) is used, and no COMMIT is performed.

The data type of this parameter is INTEGER.

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_run_geocoding stored procedure. This example uses a DB2 CALL command to geocode the LOCATION column in the table named CUSTOMER. This CALL command specifies the *geocoder_name* parameter value as DB2SE_USA_GEOCODER and the *commit_scope* parameter value as 10. A COMMIT is to be performed after every 10 records are geocoded:

```
call db2gse.ST_run_geocoding(NULL, 'CUSTOMERS', 'LOCATION',
     'DB2SE_USA_GEOCODER',NULL,NULL,10,?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_setup_geocoding

Use this stored procedure to associate a column that is to be geocoded with a geocoder and to set up the corresponding geocoding parameters. Information that is set up here is recorded in the DB2GSE.ST_GEOCODING and DB2GSE.ST_GEOCODING_PARAMETERS catalog views.

This stored procedure does not invoke geocoding. It provides a way for you to specify parameter settings for the column that is to be geocoded. With these settings, the subsequent invocation of either batch geocoding or autogeocoding can be done with a much simpler interface. Parameter settings that are specified in this setup step override any of the default parameter values for the geocoder that were specified when the geocoder was registered. You can also override these parameter settings by running the ST_run_geocoding stored procedure in batch mode.

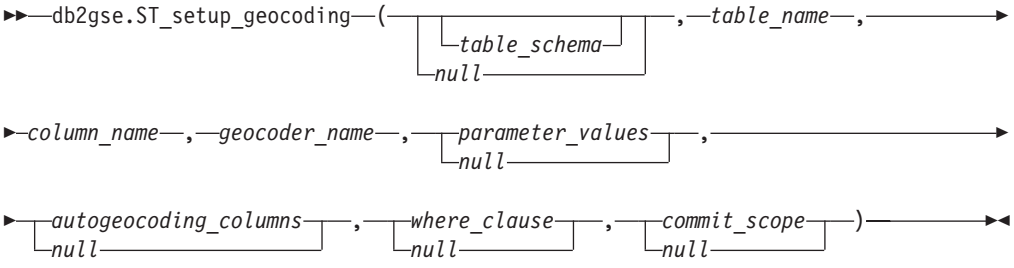
This step is a prerequisite for autogeocoding. You cannot enable autogeocoding without first setting up the geocoding parameters. This step is not a prerequisite for batch geocoding. You can run geocoding in batch mode with or without performing the setup step. However, if the setup step is done prior to batch geocoding, parameter values are taken from the setup time if they are not specified at run time.

Authorization

The user ID under which this stored procedure is invoked must hold one of the following authorities or privileges:

- SYSADM or DBADM authority on the database that contains the table on which the specified geocoder is to operate
- CONTROL or UPDATE privilege on this table

Syntax



Parameter descriptions

table_schema

Names the schema to which the table or view that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table or view.

The *table_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name
Specifies the unqualified name of the table or view that contains the column into which the geocoded data is to be inserted or updated. If a view name is specified, the view must be updatable. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

column_name
Names the column into which the geocoded data is to be inserted or updated. You must specify a non-null value for this parameter.

The *column_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

geocoder_name
Names the geocoder that is to perform the geocoding. You must specify a non-null value for this parameter.

The *geocoder_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

parameter_values
Specifies the list of geocoding parameter values for the geocoder function. Although you must specify a value for this parameter, the value can be null. If the entire *parameter_values* parameter is null, the values that are used are taken from the default parameter values at the time the geocoder was registered.

If you specify parameter values, specify them in the order that the function defined them, and separate them with a comma. For example:

```
parameter1-value,parameter2-value,...
```

Each parameter value is an SQL expression and can be a column name, a string, a numeric value, or null. Follow these guidelines:

- If a parameter value is a geocoding column name, ensure that the column is in the same table or view where the geocoded column resides.
- If a parameter value is a string, enclose it in single quotation marks.
- If a parameter value is a number, do not enclose it in single quotation marks.
- If the parameter value is specified as a null value, cast it to the correct type. For example, instead of specifying just NULL, specify:

  ```
  CAST(NULL AS INTEGER)
  ```

If any parameter value is not specified (that is, if you specify two consecutive commas (`...,,...`)), this parameter must be specified either when geocoding is set up or when geocoding is run in batch mode with the *parameter_values* parameter of the respective stored procedures.

The data type of this parameter is VARCHAR(32K).

autogeocoding_columns
Specifies the list of column names on which the trigger is to be created. Although you must specify a value for this parameter, the value can be null. If this parameter is null and autogeocoding is enabled, an update of any column in the table causes the trigger to be activated.

If you specify a value for the *autogeocoding_columns* parameter, specify column names in any order, and separate column names with a comma. The column name must exist in the same table where the geocoded column resides.

This parameter setting applies only to subsequent autogeocoding.

The data type of this parameter is VARCHAR(32K).

where_clause
Specifies the body of the WHERE clause, which defines a restriction on the set of records that are to be geocoded. Although you must specify a value for this parameter, the value can be null. If this parameter is null, no restrictions are defined in the WHERE clause.

The clause can reference any column in the table or view that the geocoder is to operate on. Do not specify the keyword WHERE.

This parameter setting applies only to subsequent batch-mode geocoding.

The data type of this parameter is VARCHAR(32K).

commit_scope
Specifies that a COMMIT is to be performed for every *n* records that are geocoded. Although you must specify a value for this parameter, the value can be null. If this parameter is null, a COMMIT is performed after all records are geocoded.

This parameter setting applies only to subsequent batch-mode geocoding.

The data type of this parameter is INTEGER.

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_setup_geocoding stored procedure. This example uses a DB2 CALL command to set up a geocoding process for the geocoded column named LOCATION in the

table named CUSTOMER. This CALL command specifies the *geocoder_name* parameter value as DB2SE_USA_GEOCODER:

```
call db2gse.ST_setup_geocoding(NULL, 'CUSTOMERS', 'LOCATION',
    'DB2SE_USA_GEOCODER','ADDRESS,CITY,STATE,ZIP,1,100,80,,,,"$HOME/sqllib/
     gse/refdata/ky.edg","$HOME/sqllib/samples/extenders/spatial/EDGESample.loc"',
     'ADDRESS,CITY,STATE,ZIP',NULL,10,?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs

ST_unregister_geocoder

Use this stored procedure to unregister a geocoder other than the DB2SE_USA_GEOCODER geocoder, which is shipped with DB2 Spatial Extender.

Restriction:
You cannot unregister a geocoder if it is specified in the geocoding setup for any column.

To determine whether a geocoder is specified in the geocoding setup for a column, check the DB2GSE.ST_GEOCODING and DB2GSE.ST_GEOCODING_PARAMETERS catalog views. To find information about the geocoder that you want to unregister, consult the DB2GSE.ST_GEOCODERS catalog view.

This stored procedure replaces db2gse.gse_unregist_gc.

Authorization

The user ID under which this stored procedure is invoked must hold either SYSADM or DBADM authority on the database that contains the geocoder that is to be unregistered.

Syntax

Parameter descriptions

geocoder_name
Uniquely identifies the geocoder. You must specify a non-null value for this parameter.

The *geocoder_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this

parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_unregister_geocoder stored procedure. This example uses a DB2 CALL command to unregister the geocoder named SAMPLEGC:

```
call db2gse.ST_unregister_geocoder('SAMPLEGC',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

ST_unregister_spatial_column

Use this stored procedure to remove the registration of a spatial column.

The stored procedure removes the registration by:

- Removing association of the spatial reference system with the spatial column. The ST_GEOMETRY_COLUMNS catalog view continues to contain the spatial column, but the column is no longer associated with any spatial reference system.
- For a base table, dropping the constraint that DB2 Spatial Extender placed on this table to ensure that the geometry values in this spatial column are all represented in the same spatial reference system.

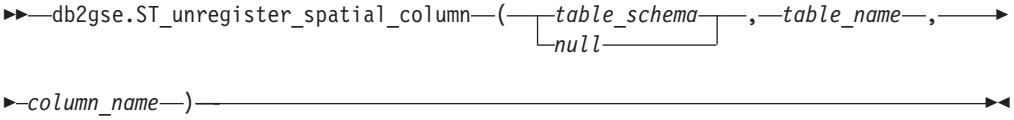
This stored procedure replaces db2gse.gse_unregist_layer.

Authorization

The user ID under which this stored procedure is invoked must hold one of the following authorities or privileges:

- SYSADM or DBADM authority
- CONTROL or ALTER privilege on this table

Syntax



Parameter descriptions

table_schema
Names the schema to which the table that is specified in the *table_name* parameter belongs. Although you must specify a value for this parameter, the value can be null. If this parameter is null, the value in the CURRENT SCHEMA special register is used as the schema name for the table or view.

The *table_schema* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

table_name
Specifies the unqualified name of the table that contains the column that is specified in the *column_name* parameter. You must specify a non-null value for this parameter.

The *table_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

column_name
Names the spatial column that you want to unregister. You must specify a non-null value for this parameter.

The *column_name* value is converted to uppercase unless you enclose it in double quotation marks.

The data type of this parameter is VARCHAR(128) or, if you enclose the value in double quotation marks, VARCHAR(130).

Output parameters

msg_code
Specifies the message code that is returned from the stored procedure. The value of this output parameter identifies the error, success, or warning condition that was encountered during the processing of the procedure. If this parameter value is for a success or warning condition, the procedure finished its task. If the parameter value is for an error condition, no changes to the database were performed.

The data type of this output parameter is INTEGER.

msg_text
Specifies the actual message text, associated with the message code, that is returned from the stored procedure. The message text can include additional information about the success, warning, or error condition, such as where an error was encountered.

The data type of this output parameter is VARCHAR(1024).

Example

This example shows how to use the DB2 command line processor to invoke the ST_unregister_spatial_column stored procedure. This example uses a DB2 CALL command to unregister the spatial column named LOCATION in the table named CUSTOMERS:

```
call db2gse.ST_unregister_spatial_column(NULL,'CUSTOMERS','LOCATION',?,?)
```

The two question marks at the end of this CALL command represent the output parameters, *msg_code* and *msg_text*. The values for these output parameters are displayed after the stored procedure runs.

Chapter 21. Catalog views

Spatial and Geodetic Data Management Feature's catalog views give useful information.

Spatial Extender's catalog views contain information about:

"The DB2GSE.ST_COORDINATE_SYSTEMS catalog view" on page 245
Coordinate systems that you can use

"The DB2GSE.ST_GEOMETRY_COLUMNS catalog view"
Spatial columns that you can populate or update.

"The DB2GSE.ST_GEOCODERS catalog view" on page 248 and "The DB2GSE.ST_GEOCODING_PARAMETERS catalog view" on page 250
Geocoders that you can use

"The DB2GSE.ST_GEOCODING catalog view" on page 249 and "The DB2GSE.ST_GEOCODING_PARAMETERS catalog view" on page 250
Specifications for setting up a geocoder to run automatically and for setting, in advance, operations to be performed during batch geocoding.

"The DB2GSE.ST_SIZINGS catalog view" on page 251
Allowable maximum lengths of values that you can assign to variables.

"The DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view" on page 252
Spatial reference systems that you can use.

"The DB2GSE.ST_UNITS_OF_MEASURE catalog view" on page 254
The units of measure (meters, miles, feet, and so on) in which distances generated by spatial functions can be expressed.

The DB2GSE.ST_GEOMETRY_COLUMNS catalog view

Use the DB2GSE.ST_GEOMETRY_COLUMNS catalog view to find information about all spatial columns in all tables that contain spatial data in the database.

If a spatial column was registered in association with a spatial reference system, you can also use the view to find out the spatial reference system's name and numeric identifier. For additional information about spatial columns, query DB2's SYSCAT.COLUMN catalog view.

For a description of DB2GSE.ST_GEOMETRY_COLUMNS, see the following table.

Table 30. Columns in the DB2GSE.ST_GEOMETRY_COLUMNS catalog view

Name	Data type	Nullable?	Content
TABLE_SCHEMA	VARCHAR(128)	No	Name of the schema to which the table that contains this spatial column belongs.
TABLE_NAME	VARCHAR(128)	No	Unqualified name of the table that contains this spatial column.
COLUMN_NAME	VARCHAR(128)	No	Name of this spatial column. The combination of TABLE_SCHEMA, TABLE_NAME, and COLUMN_NAME uniquely identifies the column.

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Table 30. Columns in the DB2GSE.ST_GEOMETRY_COLUMNS catalog view (continued)

Name	Data type	Nullable?	Content
TYPE_SCHEMA	VARCHAR(128)	No	Name of the schema to which the declared data type of this spatial column belongs. This name is obtained from the DB2 catalog.
TYPE_NAME	VARCHAR(128)	No	Unqualified name of the declared data type of this spatial column. This name is obtained from the DB2 catalog.
SRS_NAME	VARCHAR(128)	Yes	Name of the spatial reference system that is associated with this spatial column. If no spatial reference system is associated with the column, then SRS_NAME is null.
SRS_ID	INTEGER	Yes	Numeric identifier of the spatial reference system that is associated with this spatial column. If no spatial reference system is associated with the column, then SRS_ID is null.

The DB2GSE.SPATIAL_REF_SYS catalog view

When you create a spatial reference system, DB2 Spatial Extender registers it by recording its identifier and information related to it in a catalog table. Selected columns from this table comprise the DB2GSE.SPATIAL_REF_SYS catalog view, which is described in the following table.

Table 31. Columns in the DB2GSE.SPATIAL_REF_SYS catalog view

Name	Data Type	Nullable?	Content
SRID	INTEGER	No	User-defined identifier for this spatial reference system.
SR_NAME	VARCHAR(64)	No	Name of this spatial reference system.
CSID	INTEGER	No	Numeric identifier for the coordinate system that underlies this spatial reference system.
CS_NAME	VARCHAR(64)	No	Name of the coordinate system that underlies this spatial reference system.
AUTH_NAME	VARCHAR(256)	Yes	Name of the organization that sets the standards for this spatial reference system.
AUTH_SRID	INTEGER	Yes	The identifier that the organization specified in the AUTH_NAME column assigns to this spatial reference system.
SRTEXT	VARCHAR(2048)	No	Annotation text for this spatial reference system.
FALSEX	FLOAT	No	A number that, when subtracted from a negative X coordinate value, leaves a non-negative number (that is, a positive number or a zero).
FALSEY	FLOAT	No	A number that, when subtracted from a negative Y coordinate value, leaves a non-negative number (that is, a positive number or a zero).
XYUNITS	FLOAT	No	A number that, when multiplied by a decimal X coordinate or a decimal Y coordinate, yields an integer that can be stored as a 32–bit data item.
FALSEZ	FLOAT	No	A number that, when subtracted from a negative Z coordinate value, leaves a non-negative number (that is, a positive number or a zero).
ZUNITS	FLOAT	No	A number that, when multiplied by a decimal Z coordinate, yields an integer that can be stored as a 32–bit data item.

Table 31. Columns in the DB2GSE.SPATIAL_REF_SYS catalog view (continued)

Name	Data Type	Nullable?	Content
FALSEM	FLOAT	No	A number that, when subtracted from a negative measure, leaves a non-negative number (that is, a positive number or a zero).
MUNITS	FLOAT	No	A number that, when multiplied by a decimal measure, yields an integer that can be stored as a 32–bit data item.

The DB2GSE.ST_COORDINATE_SYSTEMS catalog view

Query the DB2GSE.ST_COORDINATE_SYSTEMS catalog view to retrieve information about registered coordinate systems.

Spatial Extender automatically registers coordinate systems in the Spatial Extender catalog at the following times:

- When you enable a database for spatial operations.
- When users define additional coordinate systems to the database.

For a description of columns in this view, see the following table.

Table 32. Columns in the DB2GSE.ST_COORDINATE_SYSTEMS catalog view

Name	Data type	Nullable?	Content
COORDSYS_NAME	VARCHAR(128)	No	Name of this coordinate system. The name is unique within the database.
COORDSYS_TYPE	VARCHAR(128)	No	Type of this coordinate system: **PROJECTED** Two-dimensional. **GEOGRAPHIC** Three-dimensional. Uses X and Y coordinates. **GEOCENTRIC** Three-dimensional. Uses X, Y, and Z coordinates. **UNSPECIFIED** Abstract or non-real world coordinate system. The value for this column is obtained from the DEFINITION column.
DEFINITION	VARCHAR(2048)	No	Well-known text representation of the definition of this coordinate system.
ORGANIZATION	VARCHAR(128)	Yes	Name of the organization (for example, a standards body such as the European Petrol Survey Group, or ESPG) that defined this coordinate system. This column is null if the ORGANIZATION_COORDSYS_ID column is null.

Table 32. Columns in the DB2GSE.ST_COORDINATE_SYSTEMS catalog view (continued)

Name	Data type	Nullable?	Content
ORGANIZATION_ COORDSYS_ID	INTEGER	Yes	Numeric identifier assigned to this coordinate system by the organization that defined the coordinate system. This identifier and the value in the ORGANIZATION column uniquely identify the coordinate system unless the identifier and the value are both null. If the ORGANIZATION column is null, then the ORGANIZATION_COORDSYS_ID column is also null.
DESCRIPTION	VARCHAR(256)	Yes	Description of the coordinate system that indicates its application.

The DB2GSE.ST_GEOMETRY_COLUMNS catalog view

Use the DB2GSE.ST_GEOMETRY_COLUMNS catalog view to find information about all spatial columns in all tables that contain spatial data in the database.

If a spatial column was registered in association with a spatial reference system, you can also use the view to find out the spatial reference system's name and numeric identifier. For additional information about spatial columns, query DB2's SYSCAT.COLUMN catalog view.

For a description of DB2GSE.ST_GEOMETRY_COLUMNS, see the following table.

Table 33. Columns in the DB2GSE.ST_GEOMETRY_COLUMNS catalog view

Name	Data type	Nullable?	Content
TABLE_SCHEMA	VARCHAR(128)	No	Name of the schema to which the table that contains this spatial column belongs.
TABLE_NAME	VARCHAR(128)	No	Unqualified name of the table that contains this spatial column.
COLUMN_NAME	VARCHAR(128)	No	Name of this spatial column. The combination of TABLE_SCHEMA, TABLE_NAME, and COLUMN_NAME uniquely identifies the column.
TYPE_SCHEMA	VARCHAR(128)	No	Name of the schema to which the declared data type of this spatial column belongs. This name is obtained from the DB2 catalog.
TYPE_NAME	VARCHAR(128)	No	Unqualified name of the declared data type of this spatial column. This name is obtained from the DB2 catalog.
SRS_NAME	VARCHAR(128)	Yes	Name of the spatial reference system that is associated with this spatial column. If no spatial reference system is associated with the column, then SRS_NAME is null.
SRS_ID	INTEGER	Yes	Numeric identifier of the spatial reference system that is associated with this spatial column. If no spatial reference system is associated with the column, then SRS_ID is null.

The DB2GSE.ST_GEOCODER_PARAMETERS catalog view

When you enable a database for spatial operations, information about the parameters of the supplied geocoder, DB2GSE_USA_GEOCODER, is automatically recorded in the DB2 Spatial Extender catalog. If you register additional geocoders, information about their parameters is also recorded in the catalog. To retrieve information about a geocoders' parameters from the catalog, query the DB2GSE.ST_GEOCODER_PARAMETERS catalog view. For a description of columns in this view, see the following table.

For more information about geocoders' parameters, query DB2's SYSCAT.ROUTINEPARMS catalog view. For a description of this view, see the SQL Reference.

Table 34. Columns in the DB2GSE.ST_GEOCODER_PARAMETERS

Name	Data type	Nullable?	Content
GEOCODER_NAME	VARCHAR(128)	No	Name of the geocoder to which this parameter belongs.
ORDINAL	SMALLINT	No	Position of this parameter (that is, the parameter specified in the PARAMETER_NAME column) in the signature of the function that serves as the geocoder specified in the GEOCODER_NAME column. The combined values in the GEOCODER_NAME and ORDINAL columns uniquely identify this parameter. A record in DB2's SYSCAT.ROUTINEPARMS catalog view also contains information about this parameter. This record contains a value that appears in the ORDINAL column of SYSCAT.ROUTINEPARMS. This value is the same one that appears in the ORDINAL column of the DB2GSE.ST_GEOCODER_PARAMETERS view.
PARAMETER_NAME	VARCHAR(128)	Yes	Name of this parameter. If a name was not specified when the function to which this parameter belongs was created, the PARAMETER_NAME column is null. The content of the PARAMETER_NAME column is obtained from the DB2 catalog.
TYPE_SCHEMA	VARCHAR(128)	No	Name of the schema to which this parameter belongs. This name is obtained from the DB2 catalog.
TYPE_NAME	VARCHAR(128)	No	Unqualified name of the data type of the values assigned to this parameter. This name is obtained from the DB2 catalog.

Table 34. Columns in the DB2GSE.ST_GEOCODER_PARAMETERS (continued)

Name	Data type	Nullable?	Content
PARAMETER_DEFAULT	VARCHAR(2048)	Yes	The default value that is to be assigned to this parameter. DB2 will interpret this value as an SQL expression. If the value is enclosed in quotation marks, it will be passed to the geocoder as a string. Otherwise, the evaluation of the SQL expression will determine what parameter's data type will be when it is passed to the geocoder. If the PARAMETER_DEFAULT column contains a null, then this null value will be passed to the geocoder. The default value can have a corresponding value in the DB2GSE.ST_GEOCODING_PARAMETERS catalog view. It can also have a corresponding value in the input to the ST_run_geocoding stored procedure. If either corresponding value differs from the default value, the corresponding value will override the default value.
DESCRIPTION	VARCHAR(256)	Yes	Description of the parameter indicating its application.

The DB2GSE.ST_GEOCODERS catalog view

When you enable a database for spatial operations, the supplied geocoder, DB2GSE_USA_GEOCODER, is automatically registered in the DB2 Spatial Extender catalog. When you want to make additional geocoders available to users, you need to register these geocoders. To retrieve information about registered geocoders, query the DB2GSE.ST_GEOCODERS catalog view. For a description of columns in this view, see the following table.

For information about geocoders' parameters, query DB2 Spatial Extender's DB2GSE.ST_GEOCODER_PARAMETERS catalog view and DB2's SYSCAT.ROUTINEPARMS catalog view. For information about functions that are used as geocoders, query DB2's SYSCAT.ROUTINES catalog view.

Table 35. Columns in the DB2GSE.ST_GEOCODERS catalog view

Name	Data type	Nullable?	Content
GEOCODER_NAME	VARCHAR(128)	No	Name of this geocoder. It is unique within the database.
FUNCTION_SCHEMA	VARCHAR(128)	No	Name of the schema to which the function that is being used as this geocoder belongs.
FUNCTION_NAME	VARCHAR(128)	No	Unqualified name of the function that is being used as this geocoder.
SPECIFIC_NAME	VARCHAR(128)	No	Specific name of the function that is being used as this geocoder. The combined values of FUNCTION_SCHEMA and SPECIFIC_NAME uniquely identify the function that is being used as this geocoder.
RETURN_TYPE_SCHEMA	VARCHAR(128)	No	Name of the schema to which the data type of this geocoder's output parameter belongs. This name is obtained from the DB2 catalog.
RETURN_TYPE_NAME	VARCHAR(128)	No	Unqualified name of the data type of this geocoder's output parameter. This name is obtained from the DB2 catalog.

Table 35. Columns in the DB2GSE.ST_GEOCODERS catalog view (continued)

Name	Data type	Nullable?	Content
VENDOR	VARCHAR(256)	Yes	Name of the vendor that created this geocoder.
DESCRIPTION	VARCHAR(256)	Yes	Description of the geocoder that indicates its application.

The DB2GSE.ST_GEOCODING catalog view

When you set up geocoding operations, the particulars of your settings are automatically recorded in the DB2 Spatial Extender catalog. To find out these particulars, query the DB2GSE.ST_GEOCODING and DB2GSE.ST_GEOCODING_PARAMETERS catalog views. The DB2GSE.ST_GEOCODING catalog view, which is described in the following table, contains particulars of all settings; for example, the number of records that a geocoder is to process before each commit. The DB2GSE.ST_GEOCODING_PARAMETERS catalog view contains particulars that are specific to each geocoder. For example, set-ups for the supplied geocoder, DB2GSE_USA_GEOCODER, include the minimum degree to which addresses given as input and actual addresses must match in order for the geocoder to geocode the input. This minimum requirement, called the minimum match score, is recorded in the DB2GSE.ST_GEOCODING_PARAMETERS catalog view.

Table 36. Columns in the DB2GSE.ST_GEOCODING catalog view

Name	Data type	Nullable?	Content
TABLE_SCHEMA	VARCHAR(128)	No	Name of the schema that contains the table that contains the column identified in the COLUMN_NAME column.
TABLE_NAME	VARCHAR(128)	No	Unqualified name of the table that contains the column identified in the COLUMN_NAME column.
COLUMN_NAME	VARCHAR(128)	No	Name of the spatial column to be populated according to the specifications shown in this catalog view. The combined values in the TABLE_SCHEMA, TABLE_NAME, and COLUMN_NAME columns uniquely identify the spatial column.
GEOCODER_NAME	VARCHAR(128)	No	Name of the geocoder that is to produce data for the spatial column specified in the COLUMN_NAME column. Only one geocoder can be assigned to a spatial column.
MODE	VARCHAR(128)	No	Mode for the geocoding process: **BATCH** Only batch geocoding is enabled. **AUTO** Automatic geocoding is set up and activated. **INVALID** An inconsistency in the spatial catalog tables was detected; the geocoding entry is invalid.
SOURCE_COLUMNS	VARCHAR(10000)	Yes	Names of table columns set up for automatic geocoding. Whenever these columns are updated, a trigger prompts the geocoder to geocode the updated data.

Table 36. Columns in the DB2GSE.ST_GEOCODING catalog view (continued)

Name	Data type	Nullable?	Content
WHERE_CLAUSE	VARCHAR(10000)	Yes	Search condition within a WHERE clause. This condition indicates that when the geocoder runs in batch mode, it is geocode only data within a specified subset of records.
COMMIT_COUNT	INTEGER	Yes	The number of rows that are to be processed during batch geocoding before a commit is issued. If the value in the COMMIT_COUNT column is 0 (zero) or null, then no commits are issued.

The DB2GSE.ST_GEOCODING_PARAMETERS catalog view

When you set up geocoding operations for a particular geocoder, geocoder-specific aspects of the settings are automatically recorded in the Spatial Extender catalog. For example, an operation specific to the supplied geocoder, DB2GSE_USA_GEOCODER, is to compare addresses given as input to reference data, and to geocode the former if they match the latter to a specified degree, or to a degree higher than the specified one. When you set up operations for this geocoder, you specify what this degree, called the minimum match score, should be; and your specification is recorded in the catalog.

To find out the geocoder-specific aspects of a settings for geocoding operations, query the DB2GSE.ST_GEOCODING_PARAMETERS catalog view. This view is described in the following table.

Certain defaults for set-ups of geocoding operations are available in the DB2GSE.ST_GEOCODER_PARAMETERS catalog view. Values in the DB2GSE.ST_GEOCODING_PARAMETERS view override the defaults.

Table 37. Columns in the DB2GSE.ST_GEOCODING_PARAMETERS catalog view

Name	Data type	Nullable?	Content
TABLE_SCHEMA	VARCHAR(128)	No	Name of the schema that contains the table that contains the column identified in the COLUMN_NAME column.
TABLE_NAME	VARCHAR(128)	No	Unqualified name of the table that contains the spatial column.
COLUMN_NAME	VARCHAR(128)	No	Name of the spatial column to be populated according to the specifications shown in this catalog view. The combined values in the TABLE_SCHEMA, TABLE_NAME, and COLUMN_NAME columns uniquely identify this spatial column.

Table 37. Columns in the DB2GSE.ST_GEOCODING_PARAMETERS catalog view (continued)

Name	Data type	Nullable?	Content
ORDINAL	SMALLINT	No	Position of this parameter (that is, the parameter specified in the PARAMETER_NAME column) in the signature of the function that serves as the geocoder for the column identified in the COLUMN_NAME column. A record in DB2's SYSCAT.ROUTINEPARMS catalog view also contains information about this parameter. This record contains a value that appears in the ORDINAL column of SYSCAT.ROUTINEPARMS. This value is the same one that appears in the ORDINAL column of the DB2GSE.ST_GEOCODING_PARAMETERS view.
PARAMETER_NAME	VARCHAR(128)	Yes	Name of a parameter in the definition of the geocoder. If no name was specified when the geocoder was defined, PARAMETER_NAME is null. This content of the PARAMETER_NAME column is obtained from the DB2 catalog.
PARAMETER_VALUE	VARCHAR(2048)	Yes	The value that is assigned to this parameter. DB2 will interpret this value as an SQL expression. If the value is enclosed in quotation marks, it will be passed to the geocoder as a string. Otherwise, the evaluation of the SQL expression will determine what the parameter's data type will be when it is passed to the geocoder. If the PARAMETER_VALUE column contains a null, then this null is passed to the geocoder. The PARAMETER_VALUE column corresponds to the PARAMETER_DEFAULT column in the DB2GSE.ST_GEOCODER_PARAMETERS catalog view. If the PARAMETER_VALUE column contains a value, this value overrides the default value in the PARAMETER_DEFAULT column. If the PARAMETER_VALUE column is null, the default value will be used.

The DB2GSE.ST_SIZINGS catalog view

Use the DB2GSE.ST_SIZINGS catalog view to retrieve:

- All the variables supported by Spatial Extender; for example, coordinate system name, geocoder name, and variables to which well-known text representations of spatial data can be assigned.
- The allowable maximum length, if known, of values assigned to these variables (for example, the maximum allowable lengths of names of coordinate systems, of names of geocoders, and of well-known text representations of spatial data).

For a description of columns in the view, see the following table.

Table 38. Columns in the DB2GSE.ST_SIZINGS catalog view

Name	Data type	Nullable?	Content
VARIABLE_NAME	VARCHAR(128)	No	Term that denotes a variable. The term is unique within the database.
SUPPORTED_VALUE	INTEGER	Yes	Allowable maximum length of the values assigned to the variable shown in the VARIABLE_NAME column. Possible values in the SUPPORTED_VALUE column are: **A numeric value other than 0** The allowable maximum length of values assigned to this variable. **0** Either any length is allowed, or the allowable length cannot be determined. **NULL** Spatial Extender does not support this variable.
DESCRIPTION	VARCHAR(128)	Yes	Description of this variable.

The DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view

Query the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view to retrieve information about registered spatial reference systems. Spatial Extender automatically registers spatial reference systems in the Spatial Extender catalog at the following times:

- When you enable a database for spatial operations, five default spatial reference systems and 318 predefined geodetic spatial reference systems.
- When users create additional spatial reference systems.

To get full value from the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view, you need to understand that each spatial reference system is associated with a coordinate system. The spatial reference system is designed partly to convert coordinates derived from the coordinate system into values that DB2 can process with maximum efficiency, and partly to define the maximum possible extent of space that these coordinates can reference.

To find out the name and type of the coordinate system associated with a given spatial reference system, query the COORDSYS_NAME and COORDSYS_TYPE columns of the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view. For more information about the coordinate system, query the DB2GSE.ST_COORDINATE_SYSTEMS catalog view.

Table 39. Columns in the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view

Name	Data type	Nullable?	Content
SRS_NAME	VARCHAR(128)	No	Name of the spatial reference system. This name is unique within the database.
SRS_ID	INTEGER	No	Numerical identifier of the spatial reference system. Each spatial reference system has a unique numerical identifier. Geodetic spatial reference systems have SRS_ID values in the range 2000000000 to 2000001000. Spatial functions specify spatial reference systems by their numerical identifiers rather than by their names.

Table 39. Columns in the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view (continued)

Name	Data type	Nullable?	Content
X_OFFSET	DOUBLE	No	Offset to be subtracted from all X coordinates of a geometry. The subtraction is a step in the process of converting the geometry's coordinates into values that DB2 can process with maximum efficiency. A subsequent step is to multiply the figure resulting from the subtraction by the scale factor shown in the X_SCALE column.
X_SCALE	DOUBLE	No	Scale factor by which to multiply the figure that results when an offset is subtracted from an X coordinate. This factor is identical to the value shown in the Y_SCALE column.
Y_OFFSET	DOUBLE	No	Offset to be subtracted from all Y coordinates of a geometry. The subtraction is a step in the process of converting the geometry's coordinates into values that DB2 can process with maximum efficiency. A subsequent step is to multiply the figure resulting from the subtraction by the scale factor shown in the Y_SCALE column.
Y_SCALE	DOUBLE	No	Scale factor by which to multiply the figure that results when an offset is subtracted from a Y coordinate. This factor is identical to the value shown in the X_SCALE column.
Z_OFFSET	DOUBLE	No	Offset to be subtracted from all Z coordinates of a geometry. The subtraction is a step in the process of converting the geometry's coordinates into values that DB2 can process with maximum efficiency. A subsequent step is to multiply the figure resulting from the subtraction by the scale factor shown in the Z_SCALE column.
Z_SCALE	DOUBLE	No	Scale factor by which to multiply the figure that results when an offset is subtracted from a Z coordinate.
M_OFFSET	DOUBLE	No	Offset to be subtracted from all measures associated with a geometry. The subtraction is a step in the process of converting the measures into values that DB2 can process with maximum efficiency. A subsequent step is to multiply the figure resulting from the subtraction by the scale factor shown in the M_SCALE column.
M_SCALE	DOUBLE	No	Scale factor by which to multiply the figure that results when an offset is subtracted from a measure.
MIN_X	DOUBLE	No	Minimum possible value for X coordinates in the geometries to which this spatial reference system applies. This value is derived from the values in the X_OFFSET and X_SCALE columns.
MAX_X	DOUBLE	No	Maximum possible value for X coordinates in the geometries to which this spatial reference system applies. This value is derived from the values in the X_OFFSET and X_SCALE columns.
MIN_Y	DOUBLE	No	Minimum possible value for Y coordinates in the geometries to which this spatial reference system applies. This value is derived from the values in the Y_OFFSET and Y_SCALE columns.

Table 39. Columns in the DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS catalog view (continued)

Name	Data type	Nullable?	Content
MAX_Y	DOUBLE	No	Maximum possible value for Y coordinates in the geometries to which this spatial reference system applies. This value is derived from the values in the Y_OFFSET and Y_SCALE columns.
MIN_Z	DOUBLE	No	Minimum possible value for Z coordinates in geometries to which this spatial reference system applies This value is derived from the values in the Z_OFFSET and Z_SCALE columns.
MAX_Z	DOUBLE	No	Maximum possible value for Z coordinates in geometries to which this spatial reference system applies. This value is derived from the values in the Z_OFFSET and Z_SCALE columns.
MIN_M	DOUBLE	No	Minimum possible value for measures that can be stored with geometries to which this spatial reference system applies. This value is derived from the values in the M_OFFSET and M_SCALE columns.
MAX_M	DOUBLE	No	Maximum possible value for measures that can be stored with geometries to which this spatial reference system applies. This value is derived from the values in the M_OFFSET and M_SCALE columns.
COORDSYS_NAME	VARCHAR(128)	No	Identifying name of the coordinate system on which this spatial reference system is based.
COORDSYS_TYPE	VARCHAR(128)	No	Type of the coordinate system on which this spatial reference system is based.
ORGANIZATION	VARCHAR(128)	Yes	Name of the organization (for example, a standards body) that defined the coordinate system on which this spatial reference system is based. ORGANIZATION is null if ORGANIZATION_COORSYS_ID is null.
ORGANIZATION_ COORDSYS_ID	INTEGER	Yes	Name of the organization (for example, a standards body) that defined the coordinate system on which this spatial reference system is based. ORGANIZATION_COORDSYS_ID is null if ORGANIZATION is null.
DEFINITION	VARCHAR(2048)	No	Well-known text representation of the definition of the coordinate system.
DESCRIPTION	VARCHAR(256)	Yes	Description of the spatial reference system.

The DB2GSE.ST_UNITS_OF_MEASURE catalog view

Certain spatial functions accept or return values that denote a specific distance. In some cases, you can choose what unit of measure the distance is to be expressed in. For example, ST_Distance returns the minimum distance between two specified geometries. On one occasion you might require ST_Distance to return the distance in terms of miles; on another, you might require a distance expressed in terms of meters. To find out what units of measure you can choose from, consult the DB2GSE.ST_UNITS_OF_MEASURE catalog view.

Table 40. Columns in the DB2GSE.ST_UNITS_OF_MEASURE catalog view

Name	Data type	Nullable?	Content
UNIT_NAME	VARCHAR(128)	No	Name of the unit of measure. This name is unique in the database.
UNIT_TYPE	VARCHAR(128)	No	Type of the unit of measure. Possible values are: **LINEAR** The unit of measure is linear. **ANGULAR** The unit of measure is angular.
CONVERSION_FACTOR	DOUBLE	No	Numeric value used to convert this unit of measure to its base unit. The base unit for linear units of measure is METER; the base unit for angular units of measure is RADIAN. The base unit itself has a conversion factor of 1.0.
DESCRIPTION	VARCHAR(256)	Yes	Description of the unit of measure.

Chapter 22. Spatial functions: categories and uses

This chapter introduces all the spatial functions, organizing them by category.

Spatial functions: categories and uses

DB2® Spatial Extender provides functions that:

- Convert geometries to and from various data exchange formats. These functions are called constructor functions.
- Compare geometries for boundaries, intersections, and other information. These functions are called comparison functions.
- Return information about properties of geometries, such as coordinates and measures within geometries, relationships between geometries, and boundary and other information.
- Generate new geometries from existing geometries.
- Measure the shortest distance between points in geometries.
- Provide information about index parameters.
- Provide projections and conversions between different coordinate systems.

Spatial functions that convert geometry values to data exchange formats

DB2 Spatial Extender provides spatial functions that convert geometries to and from the following data exchange formats:

- Well-known text (WKT) representation
- Well-known binary (WKB) representation
- ESRI shape representation
- Geography Markup Language (GML) representation

The functions for creating geometries from these formats are known as *constructor functions*.

Constructor functions

DB2 Spatial Extender provides spatial functions that convert geometries to and from the following data exchange formats:

- Well-known text (WKT) representation
- Well-known binary (WKB) representation
- ESRI shape representation
- Geography Markup Language (GML) representation

The functions for creating geometries from these formats are known as *constructor functions*. Constructor functions have the same name as the geometry data type of the column into which the data will be inserted. These functions operate consistently on each of the input data exchange formats. This section provides:

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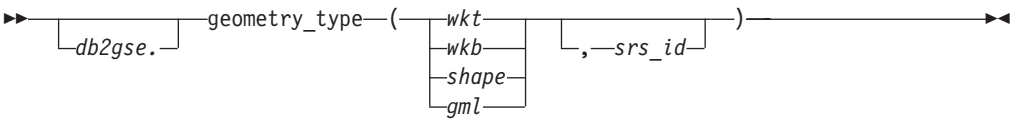
- The SQL for calling functions that operate on data exchange formats, and the type of geometry returned by these functions
- The SQL for calling a function that creates points from X and Y coordinates, and the type of geometry returned by this function
- Examples of code and result sets

Functions that operate on data exchange formats

This section provides the syntax for calling functions that operate on data exchange formats, describes the input parameters for the functions, and identifies the type of geometry that these functions return.

Syntax



Parameters and other elements of syntax

db2gse
Name of the schema to which the spatial data types supplied by DB2® Spatial Extender belong.

geometry_type
One of the following constructor functions:

- ST_Point
- ST_LineString
- \
- ST_Polygon
- ST_MultiPoint
- ST_MultiLineString
- ST_MultiPolygon
- ST_GeomCollection
- ST_Geometry

wkt A value of type CLOB(2G) that contains the well-known text representation of the geometry.

wkb A value of type BLOB(2G) that contains the well-known binary representation of the geometry.

shape A value of type BLOB(2G) that contains the ESRI shape representation of the geometry.

gml A value of type CLOB(2G) that contains the Geography Markup Language (GML) representation of the geometry.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting geometry.

If the *srs_id* parameter is omitted, then the spatial reference system with the numeric identifier 0 (zero) is used.

Return Type

geometry_type

If *geometry_type* is *ST_Geometry*, the dynamic type of the returned geometry type corresponds to the geometry indicated by the input value.

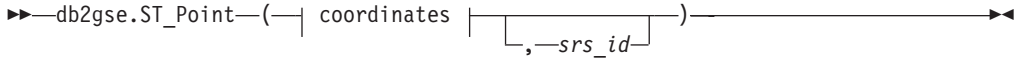
If *geometry_type* is any other type, the dynamic type of the returned geometry type corresponds to the function name. If the geometry indicated by the input value does not match the function name or the name of one of its subtypes, an error is returned.

A function that creates geometries from coordinates

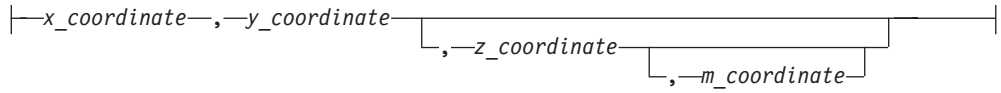
This section provides the syntax for calling ST_Point, an explanation of its parameters, and information about the type of geometry that it returns.

The ST_Point function creates geometries not only from data exchange formats, but also from numeric coordinate values—a very useful capability if your location data is already stored in your database.

Syntax



coordinates:



Parameters

x_coordinate
A value of type DOUBLE that specifies the X coordinate for the resulting point.

y_coordinate
A value of type DOUBLE that specifies the Y coordinate for the resulting point.

z_coordinate
A value of type DOUBLE that specifies the Z coordinate for the resulting point.

If the *z_coordinate* parameter is omitted, the resulting point will not have a Z coordinate. The result of ST_Is3D is 0 (zero) for such a point.

m_coordinate
A value of type DOUBLE that specifies the M coordinate for the resulting point.

If the *m_coordinate* parameter is omitted, the resulting point will not have a measure. The result of ST_IsMeasured is 0 (zero) for such a point.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting point.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_Point

Examples

This section provides examples of code for invoking constructor functions, code for creating tables to contain the output of constructor functions, code for retrieving the output, and the output itself.

The following example inserts a row into the SAMPLE_GEOMETRY table with ID 100 and a point value with an X coordinate of 30, a Y coordinate of 40, and in spatial reference system 1 using the coordinate representation and well-known text (WKT) representation. It then inserts another row with ID 200 and a linestring value with the coordinates indicated.

```
CREATE TABLE sample_geometry (id INT, geom db2gse.ST_Geometry);

INSERT INTO sample_geometry(id, geom)
       VALUES(100,db2gse.ST_Geometry('point(30 40)', 1));

INSERT INTO sample_geometry(id, geom)
       VALUES(200,db2gse.ST_Geometry('linestring(50 50, 100 100', 1));

SELECT id, TYPE_NAME(geom) FROM sample_geometry

ID      2
------  --------------------------------
   100  "ST_POINT"
   200  "ST_LINESTRING"
```

If you know that the spatial column can only contain ST_Point values, you can use the following example, which inserts two points. Attempting to insert a linestring or any other type which is not a point results in an SQL error. The first insert creates a point geometry from the well-known-text representation (WKT). The second insert creates a point geometry from numeric coordinate values. Note that these input values could also be selected from existing table columns.

```
CREATE TABLE sample_points (id INT, geom db2gse.ST_Point);

INSERT INTO sample_points(id, geom)
       VALUES(100,db2gse.ST_Point('point(30 40)', 1));

INSERT INTO sample_points(id, geom)
       VALUES(101,db2gse.ST_Point(50, 50, 1));

SELECT id, TYPE_NAME(geom) FROM sample_geometry

ID      2
------  --------------------------------
   100 "ST_POINT"
   101 "ST_POINT"
```

The following example uses embedded SQL and assumes that the application fills the data areas with the appropriate values.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id = 0;
   SQL TYPE IS CLOB(10000) wkt_buffer;
   SQL TYPE IS CLOB(10000) gml_buffer;
   SQL TYPE IS BLOB(10000) wkb_buffer;
   SQL TYPE IS BLOB(10000) shape_buffer;
EXEC SQL END DECLARE SECTION;

// * Application logic to read into buffers goes here */

EXEC SQL INSERT INTO sample_geometry(id, geom)
         VALUES(:id, db2gse.ST_Geometry(:wkt_buffer,1));

EXEC SQL INSERT INTO sample_geometry(id, geom)
         VALUES:id, db2gse.ST_Geometry(:wkb_buffer,1));

EXEC SQL INSERT INTO sample_geometry(id, geom)
         VALUES(:id, db2gse.ST_Geometry(:gml_buffer,1));

EXEC SQL INSERT INTO sample_geometry(id, geom)
         VALUES(:id, db2gse.ST_Geometry(:shape_buffer,1));
```

The following sample Java™ code uses JDBC to insert point geometries using X, Y numeric coordinate values and uses the WKT representation to specify the geometries.

```
String ins1 = "INSERT into sample_geometry (id, geom)
              VALUES(?, db2gse.ST_PointFromText(CAST( ?
              as VARCHAR(128)), 1))";
PreparedStatement pstmt = con.prepareStatement(ins1);
pstmt.setInt(1, 100);                    // id value
pstmt.setString(2, "point(32.4 50.7)");  // wkt value
int rc = pstmt.executeUpdate();

String ins2 = "INSERT into sample_geometry (id, geom)
              VALUES(?, db2gse.ST_Point(CAST( ? as double),
              CAST(? as double), 1))";
pstmt = con.prepareStatement(ins2);
pstmt.setInt(1, 200);         // id value
pstmt.setDouble(2, 40.3);     // lat
pstmt.setDouble(3, -72.5);    // long
rc = pstmt.executeUpdate();
```

Conversion to well-known text (WKT) representation

Text representations are CLOB values representing ASCII character strings. They allow geometries to be exchanged in ASCII text form.

The **ST_AsText** function converts a geometry value stored in a table to a WKT string. The following example uses a simple command-line query to select the values that were previously inserted into the SAMPLE_GEOMETRY table.

```
SELECT id, VARCHAR(db2gse.ST_AsText(geom), 50) AS WKTGEOM
FROM sample_geometry;

ID   WKTGEOM
------  --------------------------------
   100   POINT ( 30.00000000 40.00000000)
   200   LINESTRING ( 50.00000000 50.00000000, 100.00000000 100.00000000)
```

The following example uses embedded SQL to select the values that were previously inserted into the SAMPLE_GEOMETRY table.

```
EXEC SQL BEGIN DECLARE SECTION;
sqlint32 id = 0;
SQL TYPE IS CLOB(10000) wkt_buffer;
short wkt_buffer_ind = -1;
EXEC SQL END DECLARE SECTION;

EXEC SQL
SELECT id, db2gse.ST_AsText(geom)
INTO :id, :wkt_buffer :wkt_buffer_ind
FROM sample_geometry
WHERE id = 100;
```

Alternatively, you can use the ST_WellKnownText transform group to implicitly convert geometries to their well-known text representation when binding them out. The following sample code shows how to use the transform group.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id = 0;
   SQL TYPE IS CLOB(10000) wkt_buffer;
   short wkt_buffer_ind = -1;
EXEC SQL END DECLARE SECTION;

EXEC SQL
   SET CURRENT DEFAULT TRANSFORM GROUP = ST_WellKnownText;

EXEC SQL
  SELECT id, geom
  INTO :id, :wkt_buffer :wkt_buffer_ind
  FROM sample_geometry
  WHERE id = 100;
```

No spatial function is used in the SELECT statement to convert the geometry.

In addition to the functions explained in this section, DB2® Spatial Extender provides other functions that also convert geometries to and from well-known text representations. DB2 Spatial Extender provides these other functions to implement the OGC "Simple Features for SQL" specification and the ISO SQL/MM Part 3: Spatial standard. These functions are:

- **ST_WKTToSQL**
- **ST_GeomFromText**
- **ST_GeomCollFromTxt**
- **ST_PointFromText**
- **ST_LineFromText**
- **ST_PolyFromText**
- **ST_MPointFromText**
- **ST_MLineFromText**
- **ST_MPolyFromText**

Conversion to well-known binary (WKB) representation

The WKB representation consists of binary data structures that must be BLOB values. These BLOB values represent binary data structures that must be managed by an application program written in a programming language that DB2® supports and for which DB2 has a language binding.

The **ST_AsBinary** function converts a geometry value stored in a table to the well-known binary (WKB) representation, which can be fetched into a BLOB

variable in program storage. The following example uses embedded SQL to select the values that were previously inserted into the SAMPLE_GEOMETRY table.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id = 0;
   SQL TYPE IS BLOB(10000) wkb_buffer;
   short wkb_buffer_ind = -1;
EXEC SQL END DECLARE SECTION;

EXEC SQL
   SELECT id, db2gse.ST_AsBinary(geom)
   INTO :id, :wkb_buffer :wkb_buffer_ind
   FROM sample_geometry
   WHERE id = 200;
```

Alternatively, you can use the ST_WellKnownBinary transform group to implicitly convert geometries to their well-known binary representation when binding them out. The following sample code shows how to use this transform group.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id = 0;
   SQL TYPE IS BLOB(10000) wkb_buffer;
   short wkb_buffer_ind = -1;
EXEC SQL END DECLARE SECTION;

EXEC SQL
   SET CURRENT DEFAULT TRANSFORM GROUP = ST_WellKnownBinary;

EXEC SQL
   SELECT id, geom
   INTO :id, :wkb_buffer :wkb_buffer_ind
   FROM sample_geometry
   WHERE id = 200;
```

No spatial function is used in the SELECT statement to convert the geometry.

In addition to the functions explained in this section, there are other functions that also convert geometries to and from well-known binary representations. DB2 Spatial Extender provides these other functions to implement the OGC "Simple Features for SQL" specification and the ISO SQL/MM Part 3: Spatial standard. These functions are:

- **ST_WKBToSQL**
- **ST_GeomFromWKB**
- **ST_GeomCollFromWKB**
- **ST_PointFromWKB**
- **ST_LineFromWKB**
- **ST_PolyFromWKB**
- **ST_MPointFromWKB**
- **ST_MLineFromWKB**
- **ST_MPolyFromWKB**

Conversion to ESRI shape representation

The ESRI Shape representation consists of binary data structures that must be managed by an application program written in a supported language.

The **ST_AsShape** function converts a geometry value stored in a table to the ESRI Shape representation, which can be fetched into a BLOB variable in program

storage. The following example uses embedded SQL to select the values that were previously inserted into the SAMPLE_GEOMETRY table.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id;
   SQL TYPE IS BLOB(10000) shape_buffer;
EXEC SQL END DECLARE SECTION;

EXEC SQL
   SELECT id, db2gse.ST_AsShape(geom)
   INTO :id, :shape_buffer
   FROM sample_geometry;
```

Alternatively, you can use the ST_Shape transform group to implicitly convert geometries to their shape representation when binding them out. The following sample code shows how to use the transform group.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id = 0;
   SQL TYPE IS BLOB(10000) shape_buffer;
   short shape_buffer_ind = -1;
EXEC SQL END DECLARE SECTION;

EXEC SQL
   SET CURRENT DEFAULT TRANSFORM GROUP = ST_Shape;

EXEC SQL
   SELECT id, geom
   FROM sample_geometry
   WHERE id = 300;
```

No spatial function is used in the SELECT statement to convert the geometry.

Conversion to Geography Markup Language (GML) representation

Geography Markup Language (GML) representations are ASCII strings. They allow geometries to be exchanged in ASCII text form.

The **ST_AsGML** function converts a geometry value stored in a table to a GML text string. The following example selects the values that were previously inserted into the SAMPLE_GEOMETRY table. The results shown in the example have been reformatted for readability. The spacing in your results might vary according to your online display.

```
SELECT id, VARCHAR(db2gse.ST_AsGML(geom), 500) AS GMLGEOM
FROM sample_geometry;

ID           GMLGEOM
-----------  ------------------------------------------------------------
        100 <gml:Point srsName="EPSG:4269">
            <gml:coord><gml:X>30</gml:X><gml:Y>40</gml:Y></gml:coord>
            </gml:Point>
        200 <gml:LineString srsName="EPSG:4269">
            <gml:coord><gml:X>50</gml:X><gml:Y>50</gml:Y></gml:coord>
            <gml:coord><gml:X>100</gml:X><gml:Y>100</gml:Y></gml:coord>
            </gml:LineString>
```

Alternatively, you can use the ST_GML transform group to implicitly convert geometries to their HTML representation when binding them out.

```
SET CURRENT DEFAULT TRANSFORM GROUP = ST_GML

SELECT id, geom AS GMLGEOM
FROM sample_geometry;
```

```
ID          GMLGEOM
----------  ------------------------------------------------------------
       100  <gml:Point srsName="EPSG:4269">
            <gml:coord><gml:X>30</gml:X><gml:Y>40</gml:Y></gml:coord>
            </gml:Point>
       200  <gml:LineString srsName="EPSG:4269">
            <gml:coord><gml:X>50</gml:X><gml:Y>50</gml:Y></gml:coord>
            <gml:coord><gml:X>100</gml:X><gml:Y>100</gml:Y></gml:coord>
            </gml:LineString>
```

No spatial function is used in the SELECT statement to convert the geometry.

Functions that compare geographic features

Certain spatial functions return information about ways in which geographic features relate to one another or compare with one another. Other spatial functions return information as to whether two definitions of coordinate systems or two spatial reference systems are the same. In all cases, the information returned is a result of a comparison between geometries, between definitions of coordinate systems, or between spatial reference systems. The functions that provide this information are called comparison functions.

Table 41. Comparison functions by purpose

Pupose	**Functions**
Determine whether the interior of one geometry intersects the interior of another.	• ST_Contains • ST_Within
Return information about intersections of geometries.	• ST_Crosses • ST_Intersects • ST_Overlaps • ST_Touches
Determine whether the smallest rectangle that encloses one geometry intersects with the smallest rectangle that encloses another geometry.	• ST_EnvIntersects • ST_MBRIntersects
Determine whether two objects are identical.	• ST_Equals • ST_EqualCoordsys • ST_EqualSRS
Determines whether the geometries being compared meet the conditions of the DE-9IM pattern matrix string.	• ST_Relate
Checks whether an intersection exists between two geometries.	• ST_Disjoint

Comparison functions

DB2® Spatial Extender's comparison functions return a value of 1 (one) if a comparison meets certain criteria, a value of 0 (zero) if a comparison fails to meet the criteria, and a null value if the comparison could not be performed. Comparisons cannot be performed if the comparison operation has not been defined for the input parameters, or if either of the parameters is null.

Comparisons can be performed if geometries with different data types or dimensions are assigned to the parameters.

The Dimensionally Extended 9 Intersection Model (DE-9IM) is a mathematical approach that defines the pair-wise spatial relationship between geometries of different types and dimensions. This model expresses spatial relationships between all types of geometries as pair-wise intersections of their interiors, boundaries, and exteriors, with consideration for the dimension of the resulting intersections.

Given geometries *a* and *b*: I(*a*), B(*a*), and E(*a*) represent the interior, boundary, and exterior of *a*, respectively. And, I(b), B(b), and E(b) represent the interior, boundary, and exterior of *b*. The intersections of I(a), B(a), and E(a) with I(b), B(b), and E(b) produce a 3–by–3 matrix. Each intersection can result in geometries of different dimensions. For example, the intersection of the boundaries of two polygons consists of a point and a linestring, in which case the dim function returns the maximum dimension of 1.

The dim function returns a value of –1, 0, 1 or 2. The –1 corresponds to the null set or dim(null), which is returned when no intersection was found.

Results returned by comparison functions can be understood or verified by comparing the results returned by a comparison function with a pattern matrix that represents the acceptable values for the DE-9IM.

The pattern matrix contains the acceptable values for each of the intersection matrix cells. The possible pattern values are:

T An intersection must exist; dim = 0, 1, or 2.

F An intersection must not exist; dim = -1.

***** It does not matter if an intersection exists; dim = -1, 0, 1, or 2.

0 An intersection must exist and its exact dimension must be 0; dim = 0.

1 An intersection must exist and its maximum dimension must be 1; dim = 1.

2 An intersection must exist and its maximum dimension must be 2; dim = 2.

For example, the following pattern matrix for the ST_Within function includes the values T, F, and *.

Table 42. Matrix for ST_Within. The pattern matrix of the ST_Within function for geometry combinations.

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Interior	T	*	F
Geometry a Boundary	*	*	F
Geometry a Exterior	*	*	*

The ST_Within function returns a value of 1 when the interiors of both geometries intersect and when the interior or boundary of *a* does not intersect the exterior of *b.* All other conditions do not matter.

Each function has at least one pattern matrix, but some require more than one to describe the relationships of various geometry type combinations.

The DE-9IM was developed by Clementini and Felice, who dimensionally extended the 9 Intersection Model of Egenhofer and Herring. The DE-9IM is a collaboration of four authors (Clementini, Eliseo, Di Felice, and van Osstrom) who published the model in "A Small Set of Formal Topological Relationships Suitable for End-User Interaction," D. Abel and B.C. Ooi (Ed.), *Advances in Spatial Database—Third International Symposium. SSD '93*. LNCS 692. Pp. 277-295. The 9 Intersection model by M. J. Egenhofer and J. Herring (Springer-Verlag Singapore [1993]) was published in "Categorizing binary topological relationships between regions, lines, and points in geographic databases," *Tech. Report, Department of Surveying Engineering*, University of Maine, Orono, ME 1991.

Spatial comparison functions

The comparison functions are:

- ST_Contains
- ST_Crosses
- ST_Disjoint
- ST_EnvIntersects
- ST_EqualCoordsys
- ST_Equals
- ST_EqualSRS
- ST_Intersects
- ST_MBRIntersects
- ST_Overlaps
- ST_Relate
- ST_Touches
- ST_Within

Functions that check whether one geometry contains another

ST_Contains and ST_Within both take two geometries as input and determine whether the interior of one intersects the interior of the other. In colloquial terms, ST_Contains determines whether the first geometry given to it encloses the second geometry (whether the first contains the second). ST_Within determines whether the first geometry is completely inside the second (whether the first is within the second).

ST_Contains

Use ST_Contains to determine whether one geometry is completely contained by anther geometry.

ST_Contains returns a value of 1 (one) if the second geometry is completely contained by the first geometry. The ST_Contains function returns the exact opposite result of the ST_Within function.

Figure 44 on page 268 shows examples of ST_Contains:

- A multipoint geometry contains a point or multipoint geometries when all of the points are within the first geometry.

- A polygon geometry contains a multipoint geometry when all of the points are either on the boundary of the polygon or in the interior of the polygon.
- A linestring geometry contains a point, multipoint, or linestring geometries when all of the points are within the first geometry.
- A polygon geometry contains a point, linestring or polygon geometries when the second geometry is in the interior of the polygon.

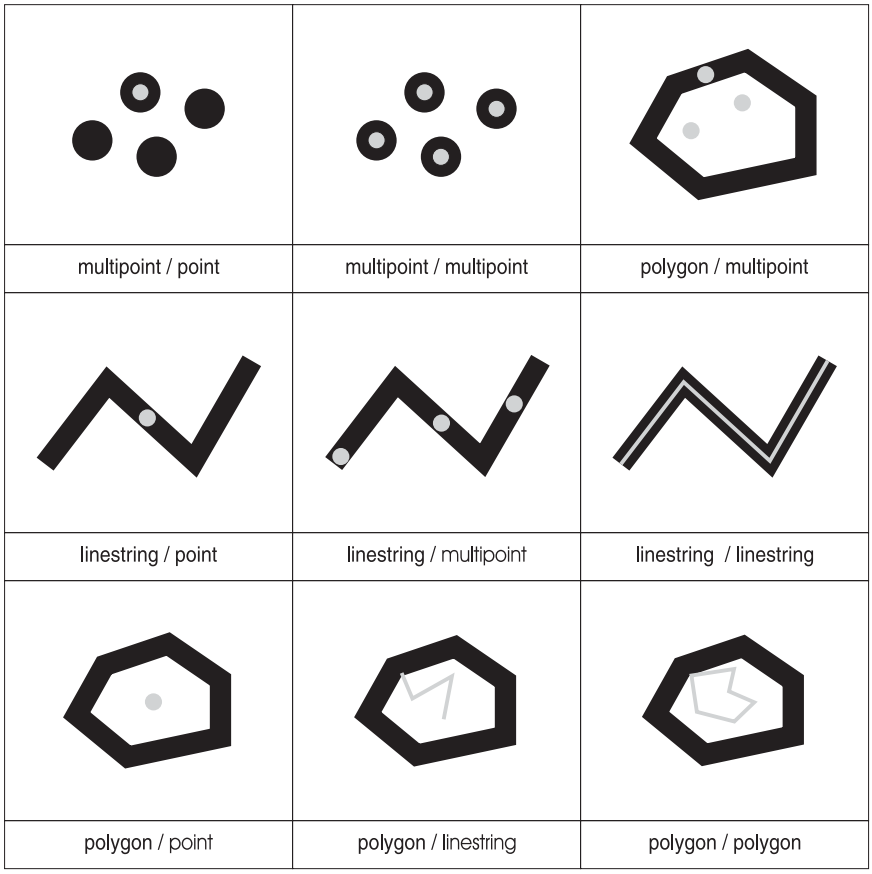


Figure 44. ST_Contains. The dark geometries represent geometry a and the gray geometries represent geometry b. In all cases, geometry a contains geometry b completely.

The pattern matrix of the ST_Contains function states that the interiors of both geometries must intersect and that the interior or boundary of the secondary (geometry *b*) must not intersect the exterior of the primary (geometry *a*). The asterisk (*) indicates that it does not matter if an intersection exists between these parts of the geometries.

Table 43. Matrix for ST_Contains

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Interior	T	*	*
Geometry a Boundary	*	*	*
Geometry a Exterior	F	F	*

ST_Within

Use ST_Within to determine whether one geometry is completely within another geometry.

ST_Within returns a value of 1 (one) if the first geometry is completely within the second geometry. ST_Within returns the exact opposite result of ST_Contains.

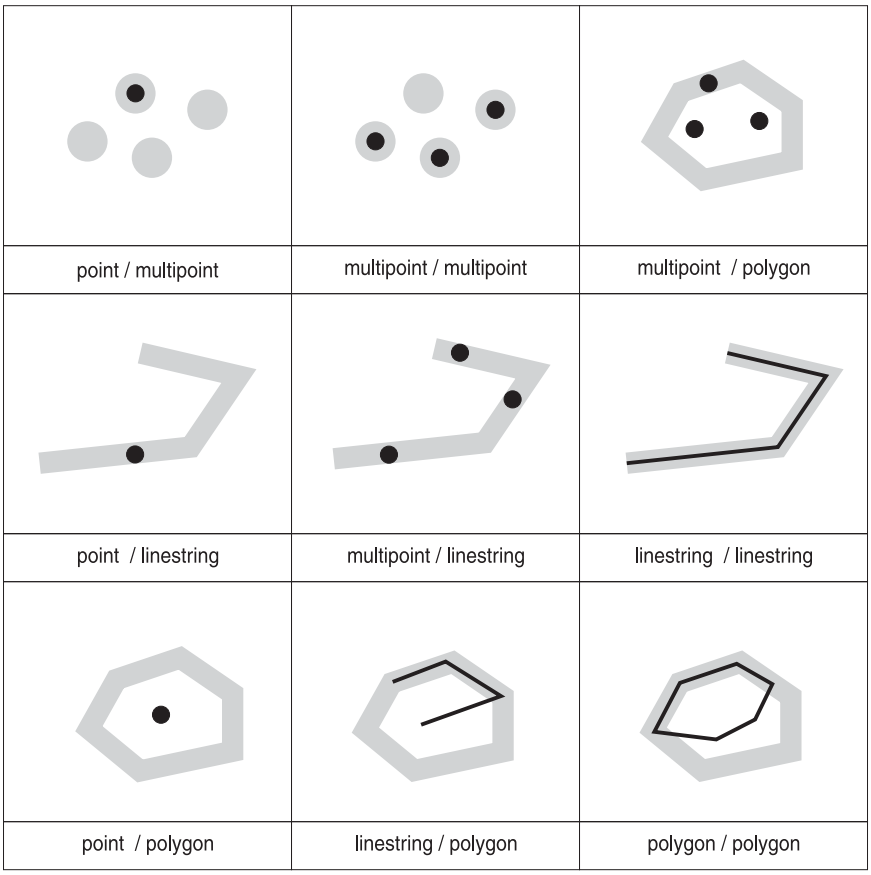


Figure 45. ST_Within

The ST_Within function pattern matrix states that the interiors of both geometries must intersect, and that the interior or boundary of the primary geometry (geometry *a*) must not intersect the exterior of the secondary (geometry *b*). The asterisk (*) indicates that all other intersections do not matter.

Table 44. Matrix for ST_Within

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Interior	T	*	F
Geometry a Boundary	*	*	F
Geometry a Exterior	*	*	*

Figure 45 shows examples of ST_Within:

- A point geometry is within a multipoint geometry when its interior intersects one of the points in the second geometry.
- A multipoint geometry is within a multipoint geometry when the interiors of all points intersect the second geometry.
- A multipoint geometry is within a polygon geometry when all of the points are either on the boundary of the polygon or in the interior of the polygon.
- A point geometry is within a linestring geometry when all of the points are within the second geometry. In Figure 45 on page 269, the point is not within the linestring because its interior does not intersect the linestring; however, the multipoint geometry is within the linestring because all of its points intersect the interior of the linestring.
- A linestring geometry is within another linestring geometries when all of its points intersect the second geometry.
- A point geometry is not within a polygon geometry because its interior does not intersect the boundary or interior of the polygon.
- A linestring geometry is within a polygon geometry when all of its points intersect either the boundary or interior of the polygon.
- A polygon geometry is within a polygon geometry when all of its points intersect either the boundary or interior of the polygon.

Functions that check intersections between geometries

ST_Intersects, ST_Crosses, ST_Overlaps, and ST_Touches all determine whether one geometry intersects another. They differ mainly as to the scope of intersection that they test for:

- ST_Intersects tests to determine whether the two geometries given to it meet one of four conditions: that the geometries' interiors intersect, that their boundaries intersect, that the boundary of the first geometry intersects with the interior of the second, or that the interior of the first geometry intersects with the boundary of the second.
- ST_Crosses is used to analyze the intersection of geometries of different dimensions, with one exception: it can also analyze the intersection of linestrings. In all cases, the place of intersection is itself considered a geometry; and ST_Crosses requires that this geometry be of a lesser dimension than the greater of the intersecting geometries (or, if both are linestrings, that the place of intersection be of a lesser dimension than a linestring). For example, the dimensions of a linestring and polygon are 1 and 2, respectively. If two such geometries intersect, and if the place of intersection is linear (the linestring's path along the polygon), then that place can itself be considered a linestring. And because a linestring's dimension (1) is lesser than a polygon's (2), ST_Crosses, after analyzing the intersection, would return a value of 1.
- The geometries given to ST_Overlaps as input must be of the same dimension. ST_Overlaps requires that these geometries overlap part-way, forming a new geometry (the region of overlap) that is the same dimension as they are.
- ST_Touches determines whether the boundaries of two geometries intersect.

ST_Intersects

Use ST_Intersects to determine whether two geometries intersect.

ST_Intersects returns a value of 1 (one) if the intersection does not result in an empty set. ST_Intersects returns the exact opposite result of ST_Disjoint.

The ST_Intersects function returns 1 (one) if the conditions of any of the following pattern matrices returns TRUE.

Table 45. Matrix for ST_Intersects (1). The ST_Intersects function returns 1 (one) if the interiors of both geometries intersect.

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Boundary	*	*	*
Geometry a Interior	T	*	*
Geometry a Exterior	*	*	*

Table 46. Matrix for ST_Intersects (2). The ST_Intersects function returns 1 (one) if the boundary of the first geometry intersects the boundary of the second geometry.

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Boundary	*	*	*
Geometry a Interior	*	T	*
Geometry a Exterior	*	*	*

Table 47. Matrix for ST_Intersects (3). The ST_Intersects function returns 1 (one) if the boundary of the first geometry intersects the interior of the second.

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Boundary	T	*	*
Geometry a Interior	*	*	*
Geometry a Exterior	*	*	*

Table 48. Matrix for ST_Intersects (4). The ST_Intersects function returns 1 (one) if the boundaries of either geometry intersect.

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Boundary	*	T	*
Geometry a Interior	*	*	*
Geometry a Exterior	*	*	*

ST_Crosses

Use ST_Crosses to determine whether one geometry crosses another.

ST_Crosses takes two geometries and returns a value of 1 (one) if:

- The intersection results in a geometry whose dimension is less than the maximum dimension of the source geometries.
- The intersection set is interior to both source geometries.

ST_Crosses returns a null if the first geometry is a surface or multisurface or if the second geometry is a point or multipoint. For all other combinations, ST_Crosses returns either a value of 1 (indicating that the two geometries cross) or a value of 0 (indicating that they do not cross).

The following figure illustrates multipoints crossing linestring, linestring crossing linestring, multiple points crossing a polygon, and linestring crossing a pollygon. In three of the four cases, geometry b crosses geometry a. In the fourth case geometry a is a multipoint which does not cross the line, but does touch the area inside the geometry b polygon.

The dark geometries represent geometry a; the gray geometries represent geometry b.

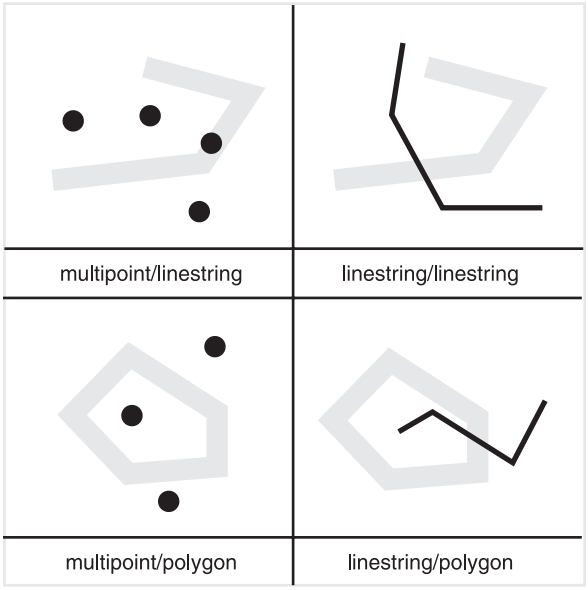


Figure 46. ST_Crosses

The pattern matrix in Table 49 applies if the first geometry is a point or multipoint, or if the first geometry is a curve or multicurve, and the second geometry is a surface. The matrix states that the interiors must intersect and that the interior of the primary (geometry *a*) must intersect the exterior of the secondary (geometry *b*).

Table 49. Matrix for ST_Crosses (1)

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Boundary	*	*	*
Geometry a Interior	T	*	T
Geometry a Exterior	*	*	*

The pattern matrix in Table 50 applies if the first and second geometries are both curves or multicurves. The 0 indicates that the intersection of the interiors must be a point (dimension 0). If the dimension of this intersection is 1 (intersect at a linestring), the ST_Crosses function returns a value of 0 (indicating that the geometries do not cross); however, the ST_Overlaps function returns a value of 1 (indicating that the geometries overlap).

Table 50. Matrix for ST_Crosses (2)

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Boundary	*	*	*

Table 50. Matrix for ST_Crosses (2) (continued)

	Geometry b Interior	Geometry b Boundary	Geometry b Exterior
Geometry a Interior	0	*	*
Geometry a Exterior	*	*	*

ST_Overlaps

Use ST_Overlaps to determine whether two geometries of the same dimension overlap.

ST_Overlaps compares two geometries of the same dimension. It returns a value of 1 (one) if their intersection set results in a geometry that is different from both, but that has the same dimension.

The dark geometries represent geometry *a*; the gray geometries represent geometry *b*. In all cases, both geometries have the same dimension, and one overlaps the other partway. The area of overlap is a new geometry; it has the same dimension as geometries *a* and *b*.

The following figure illustrates overlaps in geometries. The three examples show overlaps with points, linestrings, and polygons. With points the actual points overlap. With linestrings, a portion of the line overlaps. With polygons a portion of the area overlaps.

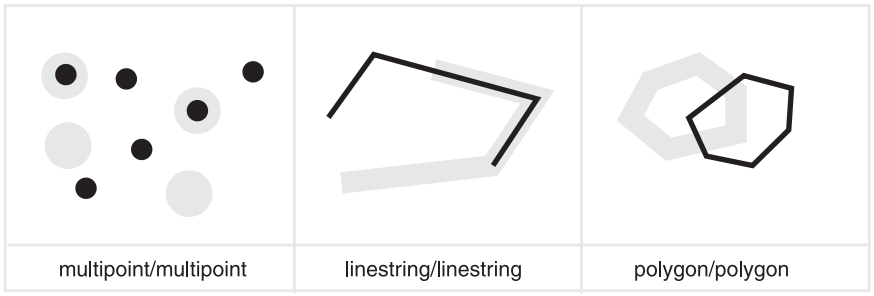


Figure 47. ST_Overlaps

The pattern matrix in Table 51 applies if the first and second geometries are both either points, multipoints, surfaces, or multisurfaces. ST_Overlaps returns a value of 1 if the interior of each geometry intersects the other geometry's interior and exterior.

Table 51. Matrix for ST_Overlaps (1)

	Geometry b Interior	Geometry b Boundary	Geometry b Exterior
Geometry a Boundary	*	*	*
Geometry a Interior	T	*	T
Geometry a Exterior	T	*	*

The pattern matrix in Table 52 on page 274 applies if the first and second geometries are both curves or multicurves. In this case, the intersection of the geometries must result in a geometry that has a dimension of 1 (another curve). If the dimension of the intersection of the interiors is 0, ST_Overlaps returns a value of 0 (indicating that the geometries do not overlap); however the ST_Crosses

function would return a value of 1 (indicating that the geometries cross).

Table 52. Matrix for ST_Overlaps (2)

	Geometry b Interior	Geometry b Boundary	Geometry b Exterior
Geometry a Boundary	*	*	*
Geometry a Interior	1	*	T
Geometry a Exterior	T	*	*

ST_Touches

ST_Touches returns a value of 1 (one) if all the points common to both geometries can be found only on the boundaries.

The interiors of the geometries must not intersect one another. At least one geometry must be a curve, surface, multicurve, or multisurface.

The dark geometries represent geometry a; the gray geometries represent geometry b. In all cases, the boundary of geometry b intersects geometry a. The interior of geometry b remains separate from geometry a.

The following figure shows examples of touching with types of geometries, such as point and linestring, linestring and linestring, point and polygon, multipoint and polygon, and linestring and polygon.

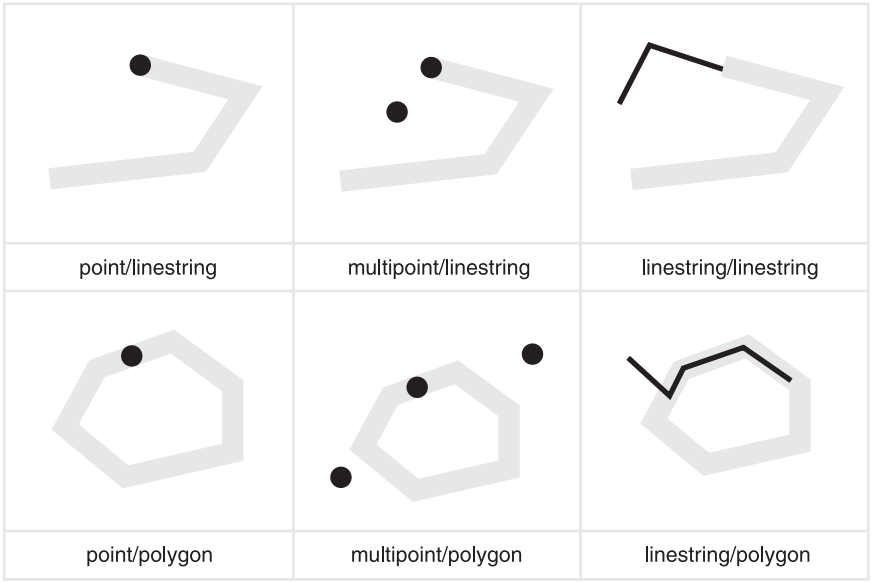


Figure 48. ST_Touches

The pattern matrices show that the ST_Touches function returns 1 (one) when the interiors of the geometry do not intersect, and the boundary of either geometry intersects the other's interior or its boundary.

Table 53. Matrix for ST_Touches (1)

	Geometry b Interior	Geometry b Boundary	Geometry b Exterior
Geometry a Boundary	*	*	*

Table 53. Matrix for ST_Touches (1) (continued)

	Geometry b Interior	Geometry b Boundary	Geometry b Exterior
Geometry a Interior	F	T	*
Geometry a Exterior	*	*	*

Table 54. Matrix for ST_Touches (2)

	Geometry b Interior	Geometry b Boundary	Geometry b Exterior
Geometry a Boundary	T	*	*
Geometry a Interior	F	*	*
Geometry a Exterior	*	*	*

Table 55. Matrix for ST_Touches (3)

	Geometry b Interior	Geometry b Boundary	Geometry b Exterior
Geometry a Boundary	*	T	*
Geometry a Interior	F	*	*
Geometry a Exterior	*	*	*

Functions that compare geometries' envelopes

ST_EnvIntersects and ST_MBRIntersects are similar in that they determine whether the smallest rectangle that encloses one geometry intersects with the smallest rectangle that encloses another geometry. Such a rectangle has traditionally been called an envelope. Multipolygons, polygons, multilinestrings, and crooked linestrings abut against the sides of their envelopes; horizontal linestrings, vertical linestrings, and points are slightly smaller than their envelopes. ST_EnvIntersects tests to determine whether envelopes of geometries intersect.

The smallest rectangular area into which a geometry can fit is called a minimum bounding rectangle (MBR). The envelopes surrounding multipolygons, polygons, multilinestrings, and crooked linestrings are actually MBRs. But the envelopes surrounding horizontal linestrings, vertical linestrings, and points are not MBRs, because they do not constitute a minimum area in which these latter geometries fit. These latter geometries occupy no definable space and therefore cannot have MBRs. Nevertheless, a convention has been adopted whereby they are referred to as their own MBRs. Therefore, with respect to multipolygons, polygons, multilinestrings, and crooked linestrings, ST_MBRIntersects tests the intersection of the same surrounding rectangles that ST_EnvIntersects tests. But for horizontal linestrings, vertical linestrings, and points, ST_MBRIntersects tests the intersections of these geometries themselves.

ST_EnvIntersects

ST_EnvIntersects returns a value of 1 (one) if the envelopes of two geometries intersect. It is a convenience function that efficiently implements ST_Intersects (`ST_Envelope(g1),ST_Envelope(g2)`).

ST_MBRIntersects

ST_MBRIntersects returns a value of 1 (one) if the minimum bounding rectangles (MBRs) of two geometries intersect.

Functions that check whether two things are identical

ST_EqualCoordsys

ST_EqualCoordsys returns a value of 1 (one) if two coordinate system definitions are identical.

In comparing the definitions, ST_EqualCoordsys disregards differences in case, spaces, parentheses, and representation of floating point numbers.

ST_Equals

ST_Equals returns a value of 1 (one) if two geometries are identical.

The order of the points used to define the geometries is not relevant to the test of equality.

In the six examples (point, multipoint, linestring, multistring, polygon, and multipolygon) geometry a and geometry b are the same.

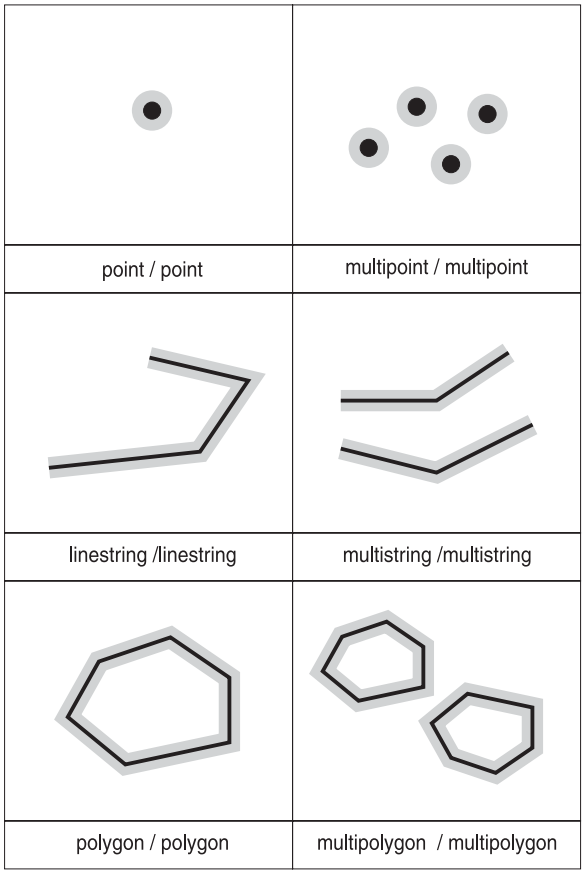


Figure 49. ST_Equals. The dark geometries represent geometry a; the gray geometries represent geometry b. In all cases, geometry a is equal to geometry b.

Table 56. Matrix for equality. The DE-9IM pattern matrix for equality ensures that the interiors intersect and that no part interior or boundary of either geometry intersects the exterior of the other.

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Boundary	*	*	F
Geometry a Interior	T	*	F
Geometry a Exterior	F	F	*

ST_EqualSRS

Use ST_EqualSRS to test whether two spatial reference systems are identical.

ST_EqualSRS returns a value of 1 (one) if two spatial reference systems are identical, provided that the numeric identifier of either or both systems is not null.

Function that checks for no intersection between two geometries

ST_Disjoint returns a value of 1 (one) if the intersection of the two geometries is an empty set. This function returns the exact opposite of what ST_Intersects returns.

The illustration shows different geometries and how the boundaries do not intersect at any point.

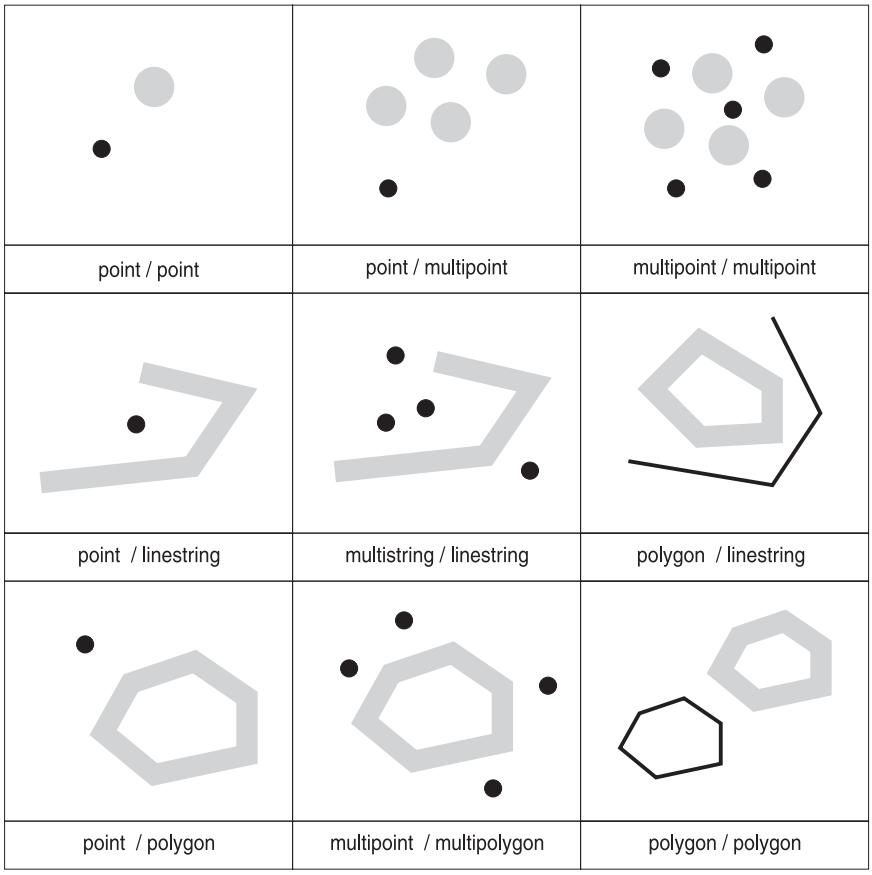


Figure 50. ST_Disjoint. The dark geometries represent geometry a; the gray geometries represent geometry b. In all cases, geometry a and geometry b are disjoint from one another.

Table 57. Matrix for ST_Disjoint. This matrix simply states that neither the interiors nor the boundaries of either geometry intersect.

	Geometry b Interior	**Geometry b Boundary**	**Geometry b Exterior**
Geometry a Boundary	F	F	*
Geometry a Interior	F	F	*
Geometry a Exterior	*	*	*

Function that compares geometries to the DE-9IM pattern matrix string

The ST_Relate function compares two geometries and returns a value of 1 (one) if the geometries meet the conditions specified by the DE-9IM pattern matrix string; otherwise, the function returns a value of 0 (zero).

Functions that return information about properties of geometries

This section introduces spatial functions that return information about properties of geometries. This information concerns:

- Data types of geometries
- Coordinates and measures within a geometry
- Rings, boundaries, envelopes, and minimum bounding rectangles (MBRs)
- Dimensions
- The qualities of being closed, empty, or simple
- Base geometries within a geometry collection
- Spatial reference systems

Some properties are geometries in their own right; for example, the exterior and interior rings of a surface, or the start- and endpoints of a curve. These geometries are produced by some of the functions in this category. Functions that produce other kinds of geometries—for example, geometries that represent zones that surround a given location—belong to another category. For information about this other category, which is called "Spatial functions that generate new geometries", see the appropriate link or cross-reference at the end of this section.

Function that returns data-type information

ST_GeometryType takes a geometry as an input parameter and returns the fully-qualified type name of the dynamic type of that geometry.

Functions that return coordinate and measure information

The following functions return information about the coordinates and measures within a geometry. For example, ST_X can return the X coordinate within a specified point, ST_MaxX returns the highest X coordinate within a geometry, and ST_MinX returns the lowest X coordinate within a geometry.

These functions are:

- ST_CoordDim
- ST_IsMeasured
- ST_IsValid
- ST_Is3D
- ST_M
- ST_MaxM
- ST_MaxX
- ST_MaxY
- ST_MaxZ
- ST_MinM
- ST_MinX
- ST_MinY
- ST_MinZ
- ST_X
- ST_Y

- ST_Z

ST_CoordDim

ST_CoordDim returns a value that denotes what types of coordinates a geometry has, and whether the geometry also contains any measures.

This value is called a *coordinate dimension*. A coordinate dimension is not the same thing as the property referred to as dimension. The latter indicates whether a geometry has breadth or length, not whether it contains coordinates of a specific type or measures.

ST_IsMeasured

ST_IsMeasured takes a geometry as an input parameter and returns 1 if the given geometry has M coordinates (measures). Otherwise 0 (zero) is returned.

ST_IsValid

ST_IsValid takes a geometry as an input parameter and returns 1 if it is valid. Otherwise 0 (zero) is returned. A geometry is valid only if all of the attributes in the structured type are consistent with the internal representation of geometry data, and if the internal representation is not corrupted.

ST_Is3D

ST_Is3d takes a geometry as an input parameter and returns 1 if the given geometry has Z coordinates. Otherwise, 0 (zero) is returned.

ST_M

If a measure is stored with a given point, ST_M can take the point as an input parameter and return the measure.

ST_MaxM

ST_MaxM takes a geometry as an input parameter and returns its maximum measure.

ST_MaxX

ST_MaxX takes a geometry as an input parameter and returns its maximum X coordinate.

ST_MaxY

ST_MaxY takes a geometry as an input parameter and returns its maximum Y coordinate.

ST_MaxZ

ST_MaxZ takes a geometry as an input parameter and returns its maximum Z coordinate.

ST_MinM

ST_MinM takes a geometry as an input parameter and returns its minimum measure.

ST_MinX

ST_MinX takes a geometry as an input parameter and returns its minimum X coordinate.

ST_MinY

ST_MinY takes a geometry as an input parameter and returns its minimum Y coordinate.

ST_MinZ

ST_MinY takes a geometry as an input parameter and returns its minimum Z coordinate.

ST_X

ST_X can take a point as an input parameter and return the point's X coordinate.

ST_Y

ST_Y can take a point as an input parameter and return the point's Y coordinate.

ST_Z

If a Z coordinate is stored with a given point, ST_Z can take the point as an input parameter and return the Z coordinate.

Functions that return information about geometries within a geometry

The following functions return information about geometries within a geometry. Some functions identify specific points within a geometry; others return the number of base geometries within a collection.

These functions are:

- ST_Centroid
- ST_EndPoint
- ST_GeometryN
- ST_LineStringN
- ST_MidPoint
- ST_NumGeometries
- ST_NumLineStrings
- ST_NumPoints
- ST_NumPolygons
- ST_PointN
- ST_PolygonN
- ST_StartPoint

ST_Centroid

ST_Centroid takes a geometry as an input parameter and returns the geometric center, which is the center of the minimum bounding rectangle of the given geometry, as a point.

ST_EndPoint

ST_Endpoint takes a curve as an input parameter and returns the point that is the last point of the curve.

ST_GeometryN

ST_GeometryN takes a geometry collection and an index as input parameters and returns the geometry in the collection that is identified by the index.

ST_LineStringN

ST_LineStringN takes a multilinestring and an index as input parameters and returns the linestring that is identified by the index.

ST_MidPoint

ST_MidPoint takes a curve as an input parameter and returns the point on the curve that is equidistant from both end points of the curve, measured along the curve.

ST_NumGeometries

ST_NumGeometries takes a geometry collection as an input parameter and returns the number of geometries in the collection.

ST_NumLineStrings

ST_NumLineStrings takes a multilinestring as an input parameter and returns the number of linestrings that it contains.

ST_NumPoints

ST_NumPoints takes a geometry as an input parameter and returns the number of points that were used to define that geometry. For example, if the geometry is a polygon and five points were used to define that polygon, then the returned number is 5.

ST_NumPolygons

ST_NumPolygons takes a multipolygon as an input parameter and returns the number of polygons that it contains.

ST_PointN

ST_PointN takes a linestring or a multipoint and an index as input parameters and returns that point in the linestring or multipoint that is identified by the index.

ST_PolygonN

ST_PolygonN takes a multipolygon and an index as input parameters and returns the polygon that is identified by the index.

ST_StartPoint

ST_StartPoint takes a curve as an input parameter and returns the point that is the first point of the curve.

Functions that show information about boundaries, envelopes, and rings

The following functions return information about demarcations that divide an inner part of a geometry from an outer part, or that divide the geometry itself from the space external to it. For example, ST_Boundary returns a geometry's boundary in the form of a curve.

These functions are:

- ST_Boundary
- ST_Envelope
- ST_EnvIntersects
- ST_ExteriorRing
- ST_InteriorRingN
- ST_MBR
- ST_MBRIntersects
- ST_NumInteriorRing
- ST_Perimeter

ST_Envelope

ST_Envelope takes a geometry as an input parameter and returns an envelope around the geometry. The envelope is a rectangle that is represented as a polygon.

ST_EnvIntersects

ST_EnvIntersects takes two geometries as input parameters and returns 1 if the envelopes of two geometries intersect. Otherwise, 0 (zero) is returned.

ST_ExteriorRing

ST_ExteriorRing takes a polygon as an input parameter and returns its exterior ring as a curve.

ST_InteriorRingN

ST_InteriorRingN takes a polygon and an index as input parameters and returns the interior ring identified by the given index as a linestring. The interior rings are organized according to the rules defined by the internal geometry verification routines.

ST_MBR

ST_MBR takes a geometry as an input parameter and returns its minimum bounding rectangle.

ST_MBRIntersects

ST_MBRIntersects returns a value of 1 (one) if the minimum bounding rectangles (MBRs) of two geometries intersect.

ST_NumInteriorRing

ST_NumInteriorRing takes a polygon as an input parameter and returns the number of its interior rings.

ST_Perimeter

ST_Perimeter takes a surface or multisurface and, optionally, a unit as input parameters and returns the perimeter of the surface or multisurface (that is, the length of its boundary) measured in the given units.

Functions that return information about a geometry's dimensions

The following functions return information about the dimension of a geometry. For example, ST_Area reports how much area a given geometry covers.

These functions are:

- ST_Area
- ST_Dimension
- ST_Length

ST_Area

ST_Area takes a geometry and, optionally, a unit as input parameters and returns the area covered by the given geometry in the given unit of measure.

ST_Dimension

ST_Dimension takes a geometry as an input parameter and returns its dimension.

ST_Length

ST_Length takes a curve or multicurve and, optionally, a unit as input parameters and returns the length of the given curve or multicurve in the given unit of measure.

Functions that reveal whether a geometry is closed, empty, or simple

The following functions indicate:

- Whether a given curve or multicurve is closed (that is, whether the start point and end point of the curve or multicurve are the same)
- Whether a given geometry is empty (that is, devoid of points)
- Whether a curve, multicurve, or multipoint is simple (that is, whether such geometries have typical configurations)

ST_IsClosed

ST_IsClosed takes a curve or multicurve as an input parameter and returns 1 if the given curve or multicurve is closed. Otherwise, 0 (zero) is returned.

ST_IsEmpty

ST_IsEmpty takes a geometry as an input parameter and returns 1 if the given geometry is empty. Otherwise 0 (zero) is returned.

ST_IsSimple

ST_IsSimple takes a geometry as an input parameter and returns 1 if the given geometry is simple. Otherwise, 0 (zero) is returned.

Functions that identify a geometry's spatial reference system

The following functions return values that identify the spatial reference system that has been associated with the geometry. In addition, the function ST_SrsID can change the geometry's spatial reference system without changing or transforming the geometry.

ST_SrsId (also called ST_SRID)

ST_SrsId (or ST_SRID) takes a geometry and, optionally, a spatial reference system identifier as input parameters. What this function returns depends on what input parameters are specified:

- If the spatial reference system identifier is specified, the function returns the geometry with its spatial reference system changed to the specified spatial reference system. No transformation of the geometry is performed.
- If no spatial reference system identifier is given as an input parameter, the current spatial reference system identifier of the given geometry is returned.

ST_SrsName

ST_SrsName takes a geometry as an input parameter and returns the name of the spatial reference system in which the given geometry is represented.

Functions that generate new geometries from existing geometries

This section introduces the category of functions that derive new geometries from existing ones. This category does not include functions that derive geometries that represent properties of other geometries. Rather, it is for functions that:

- Convert geometries into other geometries
- Create geometries that represent configurations of space
- Derive individual geometries from multiple geometries
- Create geometries based on measures
- Create modifications of geometries

Functions that convert one geometry to another

The following functions can convert geometries of a supertype into corresponding geometries of a subtype. For example, the ST_ToLineString function can convert a linestring of type ST_Geometry into a linestring of ST_LineString. Some of these functions can also combine base geometries and geometry collections into a single geometry collection. For example, ST_ToMultiLine can convert a linestring and a multilinestring into a single multilinestring.

ST_Polygon

ST_Polygon can construct a polygon from a closed linestring. The linestring will define the exterior ring of the polygon.

ST_ToGeomColl

ST_ToGeomColl takes a geometry as an input parameter and converts it to a geometry collection.

ST_ToLineString

ST_ToLineString takes a geometry as an input parameter and converts it to a linestring.

ST_ToMultiLine

ST_ToMultiLine takes a geometry as an input parameter and converts it to a multilinestring.

ST_ToMultiPoint

ST_ToMultiPoint takes a geometry as an input parameter and converts it to a multipoint.

ST_ToMultiPolygon

ST_ToMultiPolygon takes a geometry as an input parameter and converts it to a multipolygon.

ST_ToPoint

ST_ToPoint takes a geometry as an input parameter and converts it to a point.

ST_ToPolygon

ST_ToPolygon takes a geometry as an input parameter and converts it to a polygon.

Functions that create new geometries with different space configurations

Using existing geometries as a starting point, the following functions create new geometries that represent circular areas or other configurations of space. For example, given a point that represents the center of a proposed airport, ST_Buffer can create a surface that represents, in circular form, the proposed extent of the airport.

These functions are:

- ST_Buffer
- ST_ConvexHull
- ST_Difference
- ST_Intersection
- ST_SymDifference

ST_Buffer

The ST_Buffer function can generate a new geometry that extends outward from an existing geometry by a specified radius. The new geometry will be a surface when the existing geometry is buffered or whenever the elements of a collection are so close that the buffers around the single elements of the collection overlap. However, when the buffers are separate, individual buffer surfaces result, in which case ST_Buffer returns a multisurface.

The following figure illustrates the buffer around single and overlapped elements.

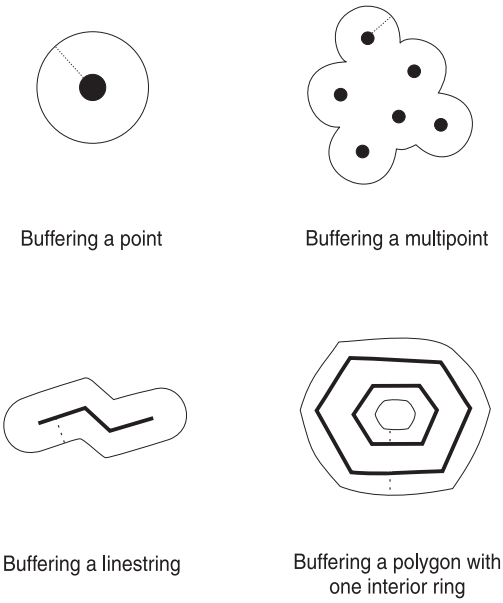


Figure 51. ST_Buffer

The ST_Buffer function accepts both positive and negative distance; however, only geometries with a dimension of two (surfaces and multisurfaces) apply a negative buffer. The absolute value of the buffer distance is used whenever the dimension of the source geometry is less than 2 (all geometries that are not surfaces or multisurfaces).

In general, for exterior rings, positive buffer distances generate surface rings that are away from the center of the source geometry; negative buffer distances generate surface or multisurface rings toward the center. For interior rings of a surface or multisurface, a positive buffer distance generates a buffer ring toward the center, and a negative buffer distance generates a buffer ring away from the center.

The buffering process merges surfaces that overlap. Negative distances greater than one half the maximum interior width of a polygon result in an empty geometry.

ST_ConvexHull

The ST_ConvexHull function returns the convex hull of any geometry that has at least three vertices forming a convex. Vertices are the pairs of X and Y coordinates within geometries. A convex hull is the smallest convex polygon that can be formed by all vertices within a given set of vertices.

The following illustration shows four examples of convex hull. In the first example an irregular shape resembling the letter c has been drawn. The c is closed by the convex hull. In the fourth example there are four points with lines in a zig-zag pattern. The convex line goes between points four and two on one side and three and one on the other side.

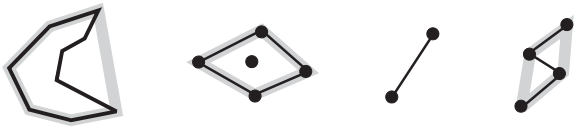


Figure 52. ST_ConvexHull

ST_Difference

ST_Difference takes two geometries of the same dimension as input. The ST_Difference function returns that portion of the first geometry that is not intersected by the second geometry. This operation is the spatial equivalent of the logical AND NOT. The portion of geometry returned by ST_Difference is itself a geometry—a collection that has the same dimension as the geometries taken as input. If these two geometries are equal—that is, if they occupy the same space—the returned geometry is empty.

To the left of each arrow are two geometries that are given to ST_Difference as input. To the right of each arrow is the output of ST_Difference. If part of the first geometry is intersected by the second, the output is that part of the first geometry that is not intersected. If the geometries given as input are equal, the output is an empty geometry (denoted by the term nil)

This figure illustrates input and output for ST_Difference. For example, if input is points, and point a and point b are the same, the output would be null. If point a and point b are different, output would be a new point between the two. If input was a polygon for b and a smaller but identical polygon for geometry a inside the first, the outcome would be null. If the polygons were overlapping, the output would be the outer edges of the combined polygons.

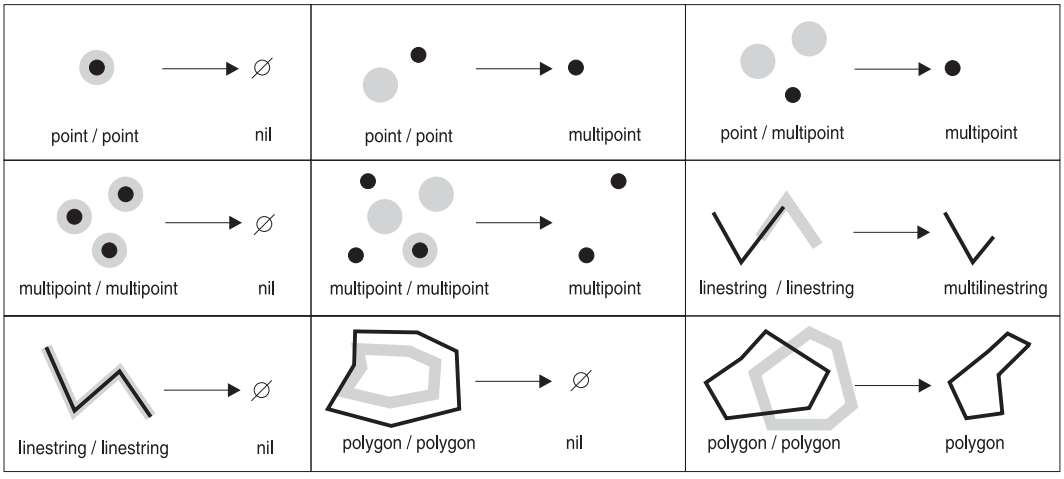


Figure 53. ST_Difference

ST_Intersection

The ST_Intersection function returns a set of points, represented as a geometry, which define the intersection of two given geometries.

If the geometries given to ST_Intersection as input do not intersect, or if they do, and the dimension of their intersection is less than the geometries' dimensions, ST_Intersection returns an empty geometry.

To the left of each arrow are two intersecting geometries that are given to ST_Intersection as input. To the right of each arrow is the output of ST_Intersection—a geometry that represents the intersection created by the geometries at the left.

This figure illustrates ten examples of output of ST_Intersection, which returns information on where given geometries intersect. For example, if b was a linestring and geometry a was a point on the line, the output would be the multipoint where geometry a and geometry b converged. If geometry a and geometry b were overlapping polygons, the output would be a new multipolygon of only that portion that overlapped.

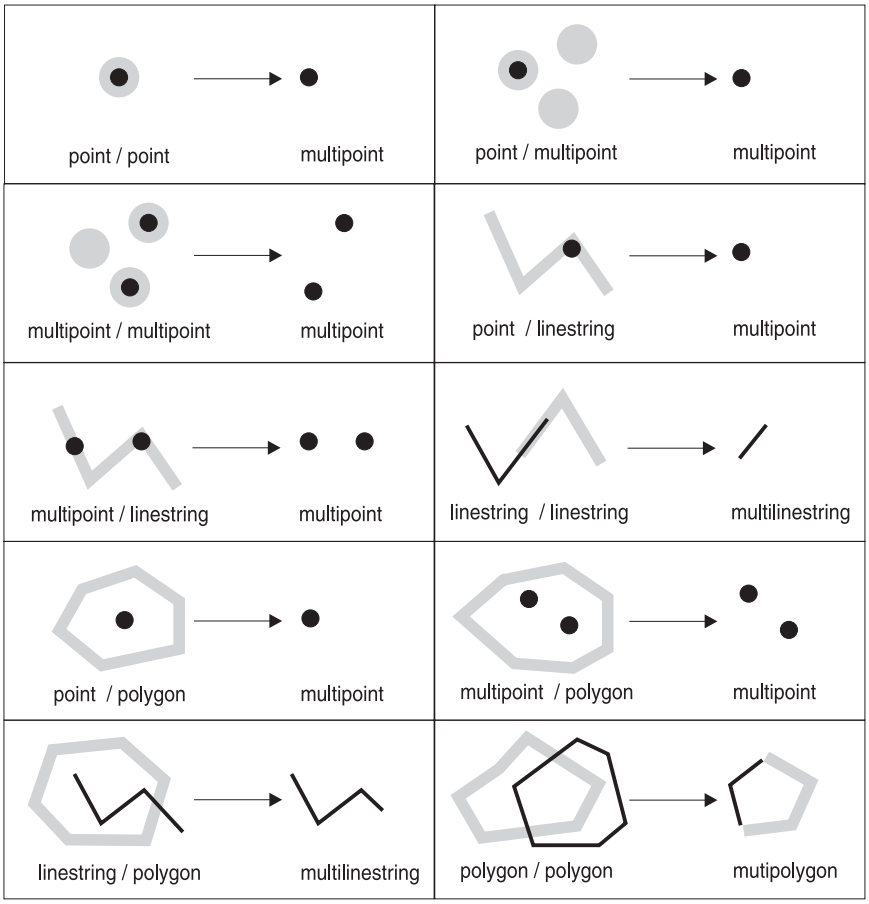


Figure 54. ST_Intersection

ST_SymDifference

The ST_SymDifference function returns the symmetric difference (the spatial equivalent of the logical XOR operation) of two intersecting geometries that have the same dimension. If these geometries are equal, ST_SymDifference returns an empty geometry. If they are not equal, then a portion of one or both of them will lie outside the area of intersection.

Functions that derive one geometry from many

The following functions derive individual geometries from multiple geometries. For example, ST_Union combines two geometries into a single geometry.

MBR Aggregate

The combination of the functions ST_BuildMBRAggr and ST_GetAggrResult aggregates a column of geometries in a selected column to a single geometry by constructing a rectangle that represents the minimum bounding rectangle that encloses all the geometries in the column. Z and M coordinates are discarded when the aggregate is computed.

ST_Union

The ST_Union function returns the union set of two geometries.

This operation is the spatial equivalent of the logical OR. The two geometries must be of the same dimension. ST_Union always returns the result as a collection.

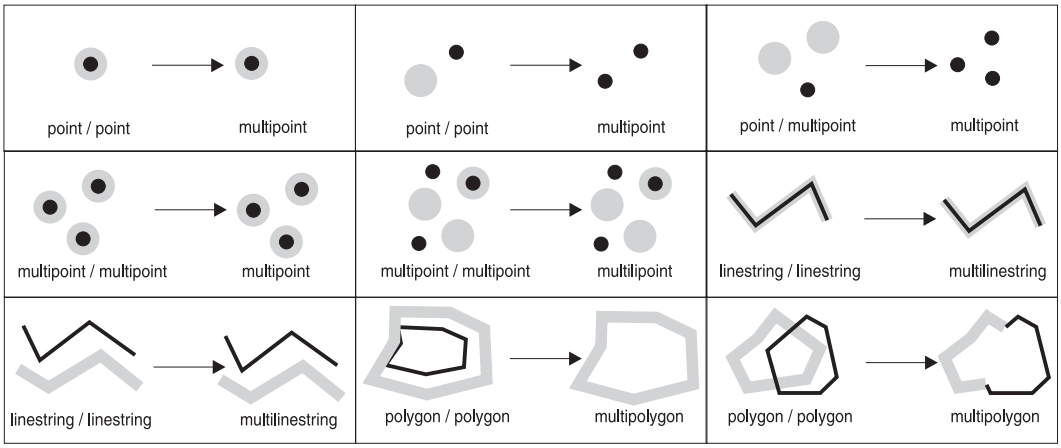


Figure 55. ST_Union

Union Aggregate

A union aggregate is the combination of the ST_BuildUnionAggr and ST_GetAggrResult functions. This combination aggregates a column of geometries in a table to a single geometry by constructing the union.

Functions that derive new geometries based on measures

The functions explained in this section can create geometries whose points are associated with a specific measure or with a specific sequence of two measures. For example, suppose that measures ranging from a value of 4 to a value of 8 are stored with the points in a multicurve. If you want to know with which points a measure with a value of 7 is stored, you could use the ST_FindMeasure function to return those points within a single multipoint.

These functions are:

- ST_FindMeasure (also called ST_LocateAlong)
- ST_MeasureBetween (also called ST_LocateBetween)

ST_FindMeasure (also called ST_LocateAlong)

ST_FindMeasure (or ST_LocateAlong) takes a geometry and measure as input parameters. It returns a multipoint or multicurve of the given geometry that matched the specified measure. For points and multipoints, all the points with the specified measure are returned. For curves, multicurves, surfaces, and multisurfaces, interpolation is performed to compute the result. The computation for surfaces and multisurfaces is performed on the boundary of the geometry.

ST_MeasureBetween (also called ST_LocateBetween)

ST_MeasureBetween (or ST_LocateBetween) takes a geometry and two M coordinates (measures) as input parameters and returns that part of the given geometry that represents the set of disconnected paths or points between the two M coordinates.

For curves, multicurves, surfaces, and multisurfaces, interpolation is performed to compute the result. In Figure 56 points 3, 4, 5, 6, 7, 8, and 9 represent a curve. If the two M coordiates are 4 and 7, ST_MeasureBetween returns the part of the curve between points 4 and 7.

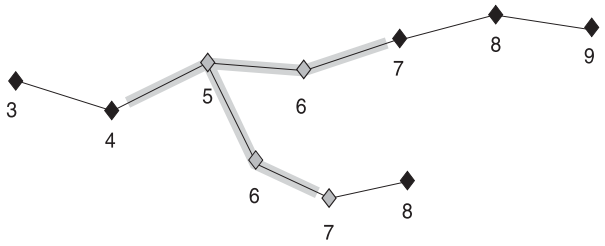


Figure 56. LocateBetween

Functions that create modified forms of existing geometries

The following functions create modified forms of existing geometries. For example, the ST_AppendPoint function creates extended versions of existing curves. Each version includes the points in an existing curve plus an additional point.

These functions are:

- ST_AppendPoint
- ST_ChangePoint
- ST_Generalize
- ST_M
- ST_PerpPoints
- ST_RemovePoint
- ST_X
- ST_Y
- ST_Z

ST_AppendPoint

ST_AppendPoint takes a curve and a point as input parameters and extends the curve by the given point.

ST_ChangePoint

ST_ChangePoint takes a curve and two points as input parameters. It replaces all occurrences of the first point in the given curve with the second point and returns the resulting curve.

ST_Generalize

ST_Generalize takes a geometry and a threshold as input parameters and represents the given geometry with a reduced number of points, while preserving the general characteristics of the geometry. The Douglas-Peucker line-simplification algorithm is used, by which the sequence of points that define the geometry is recursively subdivided until a run of the points can be replaced by a straight line segment. In this line segment, none of the defining points deviates from the straight line segment by more than the given threshold. Z and M coordinates are not considered for the simplification.

ST_M

If a given point is not associated with a measure, ST_M can provide a measure to be stored with the point. If the point has an associated measure, ST_M can replace this measure with another one.

ST_PerpPoints

ST_PerpPoints takes a curve or multicurve and a point as input parameters and returns the perpendicular projection of the given point on the curve or multicurve. The point with the smallest distance between the given point and the perpendicular point is returned. If two or more such perpendicular projected points are equidistant from the given point, they are all returned.

ST_RemovePoint

ST_RemovePoint takes a curve and a point as input parameters and returns the given curve with all points equal to the specified point removed from it. If the given curve has Z or M coordinates, then the point must also have Z or M coordinates.

ST_X

ST_X can replace a point's X coordinate with another X coordinate.

ST_Y

ST_Y can replace a point's Y coordinate with another Y coordinate.

ST_Z

If a given point has no Z coordinate, ST_Z can add a Z coordinate to the point. If the point does have a Z coordinate, ST_Z can replace this coordinate with another Z coordinate.

Function that returns distance information

ST_Distance takes two geometries and, optionally, a unit as input parameters and returns the shortest distance between any point in the first geometry to any point in the second geometry, measured in the given units.

If the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system.

If any of the two given geometries is null or is empty, then null is returned.

For example, ST_Distance could report the shortest distance an aircraft must travel between two locations. Figure 57 illustrates this information.

The figure shows a map of the United States with a straight line between points labeled Los Angeles and Chicago.

Figure 57. Minimum distance between two cities. ST_Distance can take the coordinates for the locations of Los Angeles and Chicago as input, and return a value denoting the minimum distance between these locations.

Function that returns index information

ST_GetIndexParms takes either the identifier for a spatial index or for a spatial column as an input parameter and returns the parameters used to define the index or the index on the spatial column. If an additional parameter number is specified, only the parameter identified by the number is returned.

Conversions between coordinate systems

ST_Transform takes a geometry and a spatial reference system identifier as input parameters and transforms the geometry to be represented in the given spatial reference system. Projections and conversions between different coordinate systems are performed and the coordinates of the geometries are adjusted accordingly.

Chapter 23. Spatial functions: syntax and parameters

This section introduces the spatial functions described in the following sections. It discusses certain factors that are common to all or most spatial functions. The functions are documented here in alphabetical order.

Spatial functions: considerations and associated data types

This section provides information that you need to know when you code spatial functions. This information includes:

- Factors to consider: the requirement to specify the schema to which spatial functions belong, and the fact that some functions can be invoked as methods.
- How to address a situation in which a spatial function cannot process the type of geometries returned by another spatial function.
- A table showing which functions take values of each spatial data type as input

When you use spatial functions, be aware of these factors:

- Before a spatial function can be called, its name must be qualified by the name of the schema to which spatial functions belong: DB2GSE. One way to do this is to explicitly specify the schema in the SQL statement that references the function; for example:

  ```
  SELECT db2gse.ST_Relate (g1, g2, 'T*F**FFF2') EQUALS FROM relate_test
  ```

  Alternatively, to avoid specifying the schema each time a function is to be called, you can add DB2GSE to the CURRENT FUNCTION PATH special register. To obtain the current settings for this special register, type the following SQL command:

  ```
  VALUES CURRENT FUNCTION PATH
  ```

  To update the CURRENT FUNCTION PATH special register with DB2GSE, issue the following SQL command:

  ```
  set CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
  ```

- Some spatial functions can be invoked as methods. In the following code, for example, ST_Area is invoked first as a function and then as a method. In both cases, ST_Area is coded to operate on a polygon that has an ID of 10 and that is stored in the SALES_ZONE column of a table named STORES. When invoked, ST_Area will return the area of the real-world feature—Sales Zone no. 10—that the polygon represents.

  ST_Area invoked as a function:

  ```
  SELECT ST_Area(sales_zone)
  FROM   stores
  WHERE  id = 10
  ```

  ST_Area invoked as a method:

  ```
  SELECT sales_zone..ST_Area()
  FROM   stores
  WHERE  id = 10
  ```

The functions ST_BuildMBRAggr and ST_BuildUnionAggr are described in ″MBR Aggregate″ and ″Union Aggregate″, respectively.

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Factors to consider

Treating values of ST_Geometry as values of a subtype

If a spatial function returns a geometry whose static type is a super type, and if the geometry is passed to a function that accepts only geometries of a type that is subordinate to this super type, a compile-time exception is raised.

For example, the static type of the output parameter of the ST_Union function is ST_Geometry, the super type of all spatial data types. The static input parameter for the ST_PointOnSurface function can be either ST_Polygon or ST_MultiPolygon, two subtypes of ST_Geometry. If DB2® attempts to pass geometries returned by ST_Union to ST_PointOnSurface, DB2 raises the following compile-time exception:

```
SQL00440N No function by the name "ST_POINTONSURFACE"
having compatible arguments was found in the function
path.    SQLSTATE=42884
```

This message indicates that DB2 could not find a function that is named ST_PointOnSurface and that has an input parameter of ST_Geometry.

To let geometries of a super type pass to functions that accept only subtypes of the super type, use the TREAT operator. As indicated earlier, ST_Union returns geometries of a static type of ST_Geometry. It can also return geometries of a dynamic subtype of ST_Geometry. Suppose, for example, that it returns a geometry with a dynamic type of ST_MultiPolygon. In that case, the TREAT operator requires that this geometry be used with the static type ST_MultiPolygon. This matches one of the data types of the input parameter of ST_PointOnSurface. If ST_Union does not return an ST_MultiPolygon value, DB2 raises a run-time exception.

If a function returns a geometry of a super type, the TREAT operator generally can tell DB2 to regard this geometry as a subtype of this super type. But be aware that this operation succeeds only if the subtype matches or is subordinate to a static subtype defined as an input parameter of the function to which the geometry is passed. If this condition is not met, DB2 raises a run-time exception.

Consider another example: suppose that you want to determine the perpendicular points for a given point on the boundary of a polygon that has no holes. You use the ST_Boundary function to derive the boundary from the polygon. The static output parameter of ST_Boundary is ST_Geometry, but ST_PerpPoints accepts ST_Curve geometries. Because all polygons have a linestring (which is also a curve) as a boundary, and because the data type of linestrings (ST_LineString) is subordinate to ST_Curve, the following operation will let an ST_Geometry polygon returned by ST_Boundary pass to ST_PerpPoints:

```
SELECT ST_AsText(ST_PerpPoints(TREAT(ST_Boundary(polygon) as ST_Curve)),
       ST_Point(30.5, 65.3, 1)))
FROM   polygon_table
```

Instead of invoking ST_Boundary and ST_PerpPoints as functions, you can invoke them as methods. To do so, specify the following code:

```
SELECT TREAT(ST_Boundary(polygon) as ST_Curve)..
       ST_PerpPoints(St_Point(30.5, 65.3, ))..ST_AsText()
FROM   polygon_table
```

Spatial functions listed according to input type

Table 58 lists the spatial functions according to the type of input that they can accept.

Important: As noted elsewhere, the spatial data types form a hierarchy, with ST_Geometry as the root. When the documentation for DB2 Spatial Extender indicates that a value of a super type in this hierarchy can be used as input to a function, alternatively, a value of any subtype of this super type can also be used as input to the function.

For example, the first entries in Table 58 indicate that ST_Area and a number of other functions can take values of the ST_Geometry data type as input. Therefore, input to these functions can also be values of any subtype of ST_Geometry: ST_Point, ST_Curve, ST_LineString, and so on.

Table 58. Spatial functions listed according to input type

Data type of input parameter	Function
ST_Geometry	
	EnvelopesIntersect
	ST_Area
	ST_AsBinary
	ST_AsGML
	ST_AsShape
	ST_AsText
	ST_Boundary
	ST_Buffer
	ST_BuildMBRAggr
	ST_BuildUnionAggr
	ST_Centroid
	ST_Contains
	ST_ConvexHull
	ST_CoordDim
	ST_Crosses
	ST_Difference
	ST_Dimension
	ST_Disjoint
	ST_Distance
	ST_Envelope
	ST_EnvIntersects
	ST_Equals
	ST_FindMeasure or ST_LocateAlong
	ST_Generalize
	ST_GeometryType

Table 58. Spatial functions listed according to input type (continued)

Data type of input parameter	Function
ST_Geometry, continued	
	ST_Intersection
	ST_Intersects
	ST_Is3D
	ST_IsEmpty
	ST_IsMeasured
	ST_IsSimple
	ST_IsValid
	ST_MaxM
	ST_MaxX
	ST_MaxY
	ST_MaxZ
	ST_MBR
	ST_MBRIntersects
	ST_MeasureBetween or ST_LocateBetween
	ST_MinM
	ST_MinX
	ST_MinY
	ST_MinZ
	ST_NumPoints
	ST_Overlaps
	ST_Relate
	ST_SRID or ST_SrsId
	ST_SrsName
	ST_SymDifference
	ST_ToGeomColl
	ST_ToLineString
	ST_ToMultiLine
	ST_ToMultiPoint
	ST_ToMultiPolygon
	ST_ToPoint
	ST_ToPolygon
	ST_Touches
	ST_Transform
	ST_Union
	ST_Within
ST_Point	
	ST_M
	ST_X
	ST_Y
	ST_Z
ST_Curve	
	ST_AppendPoint
	ST_ChangePoint
	ST_EndPoint
	ST_IsClosed
	ST_IsRing
	ST_Length
	ST_MidPoint
	ST_PerpPoints
	ST_RemovePoint
	ST_StartPoint
ST_LineString	
	ST_PointN
	ST_Polygon

Table 58. Spatial functions listed according to input type (continued)

Data type of input parameter	Function
ST_Surface	
	ST_Perimeter
	ST_PointOnSurface
ST_GeomCollection	
	ST_GeometryN
	ST_NumGeometries
ST_MultiPoint	ST_PointN
ST_MultiCurve	
	ST_IsClosed
	ST_Length
	ST_PerpPoints
ST_MultiLineString	
	ST_LineStringN
	ST_NumLineStrings
	ST_Polygon
ST_MultiSurface	
	ST_Perimeter
	ST_PointOnSurface
ST_MultiPolygon	
	ST_NumPolygons
	ST_PolygonN

EnvelopesIntersect

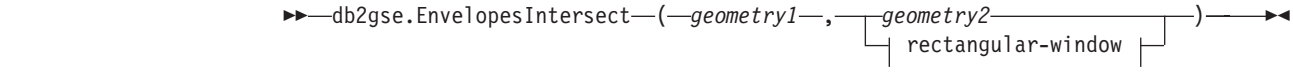
EnvelopesIntersect accepts two types of input parameters:

- Two geometries

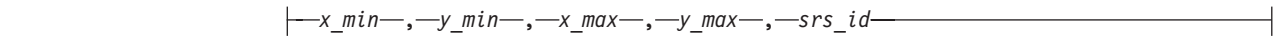
  EnvelopesIntersect returns 1 if the envelope of the first geometry intersects the envelope of the second geometry. Otherwise, 0 (zero) is returned.
- A geometry, four type DOUBLE coordinate values that define the lower-left and upper-right corners of a rectangular window, and the spatial reference system identifier.

  EnvelopesIntersect returns 1 if the envelope of the first geometry intersects with the envelope defined by the four type DOUBLE values. Otherwise, 0 (zero) is returned.

Syntax



rectangular-window:



Parameters

geometry1
A value of type ST_Geometry or one of its subtypes that represents the

geometry whose envelope is to be tested for intersection with the envelope of either *geometry2* or the rectangular window defined by the four type DOUBLE values.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the geometry whose envelope is to be tested for intersection with the envelope of *geometry1*.

x_min
Specifies the minimum X coordinate value for the envelope. You must specify a non-null value for this parameter.

The data type of this parameter is DOUBLE.

For geodetic data, the following conditions apply:

- *x_min* must be a longitude value between –180 and 180 degrees.
- *x_min* is greater than *x_max* when the envelope overlaps the 180th meridian.

y_min
Specifies the minimum Y coordinate value for the envelope. You must specify a non-null value for this parameter.

The data type of this parameter is DOUBLE.

For geodetic data, the following conditions apply:

- *y_min* must be a latitude value between –90 and 90 degrees.
- *y_min* must be less than the *y_max* value.

x_max
Specifies the maximum X coordinate value for the envelope. You must specify a non-null value for this parameter.

The data type of this parameter is DOUBLE.

For geodetic data, the following conditions apply:

- *x_max* must be a longitude value between –180 and 180 degrees.
- *x_max* is less than the *x_min* value when the envelope overlaps the 180th meridian.

y_max
Specifies the maximum Y coordinate value for the envelope. You must specify a non-null value for this parameter.

The data type of this parameter is DOUBLE.

For geodetic data, the following conditions apply:

- *y_max* must be a latitude value between –90 and 90 degrees.
- *y_max* must be greater than the *y_min* value.

srs_id
Uniquely identifies the spatial reference system. The spatial reference system identifier must match the spatial reference system identifier of the geometry parameter. You must specify a non-null value for this parameter.

The data type of this parameter is INTEGER.

Return type

INTEGER

Example

This example creates two polygons that represent counties and then determines if any of them intersect a geographic area specified by the four type DOUBLE values.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE counties (id INTEGER, name CHAR(20), geometry ST_Polygon)

INSERT INTO counties VALUES
       (1, 'County_1', ST_Polygon('polygon((0 0, 30 0, 40 30, 40 35,
        5 35, 5 10, 20 10, 20 5, 0 0))' ,0))

INSERT INTO counties VALUES
       (2, 'County_2', ST_Polygon('polygon((15 15, 15 20, 60 20, 60 15,
        15 15))' ,0))

INSERT INTO counties VALUES
       (3, 'County_3', ST_Polygon('polygon((115 15, 115 20, 160 20, 160 15,
        115 15))' ,0))


SELECT name
FROM counties as c
WHERE EnvelopesIntersect(c.geometry, 15, 15, 60, 20, 0) =1
```

Results:

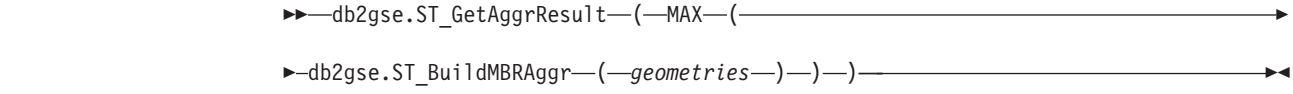
```
Name
--------------------
County_1
County_2
```

MBR Aggregate

The combination of the functions ST_BuildMBRAggr and ST_GetAggrResult aggregates a column of geometries in a selected column to a single geometry by constructing a rectangle that represents the minimum bounding rectangle that encloses all the geometries in the column. Z and M coordinates are discarded when the aggregate is computed.

If all of the geometries to be combined are null, then null is returned. If all of the geometries are either null or empty, then an empty geometry is returned. If the minimum bounding rectangle of all the geometries to be combined results in a point, then this point is returned as an ST_Point value. If the minimum bounding rectangle of all the geometries to be combined results in a horizontal or vertical linestring, then this linestring is returned as an ST_LineString value. Otherwise, the minimum bounding rectangle is returned as an ST_Polygon value.

Syntax



Parameter

geometries
A selected column that has a type of ST_Geometry or one of its subtypes and represents all the geometries for which the minimum bounding rectangle is to be computed.

Return type

db2gse.ST_Geometry

Restrictions

You cannot construct the union aggregate of a spatial column in a full-select in any of the following situations:

- In an MPP environment.
- If GROUP BY clause is used in the full-select.
- If you use a function other than the DB2 aggregate function MAX.

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example shows how to use the ST_BuildMBRAggr function to obtain the maximum bounding rectangle of all of the geometries within a column. In this example, several points are added to the GEOMETRY column in the SAMPLE_POINTS table. The SQL code then determines the maximum bounding rectangle of all of the points put together.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_points (id integer, geometry ST_Point)

INSERT INTO sample_points (id, geometry)
VALUES
    (1, ST_Point(2,   3, 1)),
    (2, ST_Point(4,   5, 1)),
    (3, ST_Point(13, 15, 1)),
    (4, ST_Point(12,  5, 1)),
    (5, ST_Point(23,  2, 1)),
    (6, ST_Point(11,  4, 1))


SELECT cast(ST_GetAggrResult(MAX(ST_BuildMBRAggr
    (geometry))).ST_AsText AS varchar(160))
    AS ";Aggregate_of_Points";
FROM sample_points
```

Results:

```
Aggregate_of_Points
-----------------------------------------------------------
POLYGON (( 2.00000000 2.00000000, 23.00000000 2.00000000,
23.00000000 15.00000000, 2.00000000 15.00000000, 2.00000000
2.00000000))
```

ST_AppendPoint

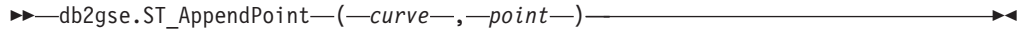
ST_AppendPoint takes a curve and a point as input parameters and extends the curve by the given point. If the given curve has Z or M coordinates, then the point must also have Z or M coordinates. The resulting curve is represented in the spatial reference system of the given curve.

If the point to be appended is not represented in the same spatial reference system as the curve, it will be converted to the other spatial reference system.

If the given curve is closed or simple, the resulting curve might not be closed or simple anymore. If the given curve or point is null, or if the curve is empty, then null is returned. If the point to be appended is empty, then the given curve is returned unchanged and a warning is raised (SQLSTATE 01HS3).

This function can also be called as a method.

Syntax



Parameter

curve A value of type ST_Curve or one of its subtypes that represents the curve to which *point* will be appended.

point A value of type ST_Point that represents the point that is appended to *curve*.

Return type

db2gse.ST_Curve

Examples

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This code creates two linestrings, each with three points.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines(id integer, line ST_Linestring)

INSERT INTO sample_lines VALUES
    (1, ST_LineString('linestring (10 10, 10 0, 0 0 )', 0) )

INSERT INTO sample_lines VALUES
    (2, ST_LineString('linestring z (0 0 4, 5 5 5, 10 10 6)', 0) )
```

Example 1

This example adds the point (5, 5) to the end of a linestring.

```
SELECT CAST(ST_AsText(ST_AppendPoint(line, ST_Point(5, 5)))
    AS VARCHAR(120)) New
FROM   sample_lines
WHERE  id=1
```

Results:

```
NEW
------------------------------------------------------------
LINESTRING ( 10.00000000 10.00000000, 10.00000000 0.00000000,
0.00000000 0.00000000, 5.00000000 5.00000000)
```

Example 2

This example adds the point (15, 15, 7) to the end of a linestring with Z coordinates.

```
SELECT CAST(ST_AsText(ST_AppendPoint(line, ST_Point(15.0, 15.0, 7.0)))
   AS VARCHAR(160)) New
FROM   sample_lines
WHERE  id=2
```

Results:

```
NEW
------------------------------------------------------------------
LINESTRING Z ( 0.00000000 0.00000000 4.00000000, 5.00000000
5.00000000 5.00000000, 10.00000000 10.00000000 6.00000000,
15.00000000 15.00000000 7.00000000)
```

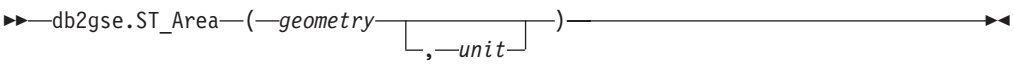
ST_Area

ST_Area takes a geometry and, optionally, a unit as input parameters and returns the area covered by the geometry in either the default or given unit of measure.

If the geometry is a polygon or multipolygon, then the area covered by the geometry is returned. The area of points, linestrings, multipoints, and multilinestrings is 0 (zero). If the geometry is null or is an empty geometry, null is returned.

This function can also be called as a method.

Syntax



Parameters

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that determines the area.

unit A VARCHAR(128) value that identifies the units in which the area is measured. The supported units of measure are listed in the DB2GSE.ST_UNITS_OF_MEASURE catalog view.

If the *unit* parameter is omitted, the following rules are used to determine the unit in which the area is measured:

- If *geometry* is in a projected or geocentric coordinate system, the linear unit associated with this coordinate system is used.
- If *geometry* is in a geographic coordinate system, but is not in a geodetic spatial reference system (SRS), the angular unit associated with this coordinate system is used.
- If *geometry* is in a geodetic SRS, the default unit of measure is square meters.

Restrictions on unit conversions: An error (SQLSTATE 38SU4) is returned if any of the following conditions occur:

- The geometry is in an unspecified coordinate system and the *unit* parameter is specified.
- The geometry is in a projected coordinate system and an angular unit is specified.
- The geometry is in a geographic coordinate system, but is not in a geodetic SRS, and a linear unit is specified.
- The geometry is in a geographic coordinate system, is in a geodetic SRS, and an angular unit is specified.

Return type

DOUBLE

Examples

Example 1

The spatial analyst needs a list of the area covered by each sales region. The sales region polygons are stored in the SAMPLE_POLYGONS table. The area is calculated by applying the ST_Area function to the geometry column.

```
db2se create_srs se_bank  -srsId 4000 -srsName new_york1983 -xOffset 0
    -yOffset 0 -xScale 1 -yScale 1
    -coordsysName NAD_1983_StatePlane_New_York_East_FIPS_3101_Feet

CREATE TABLE sample_polygons (id INTEGER, geometry ST_POLYGON)

INSERT INTO sample_polygons (id, geometry)
VALUES
  (1, ST_Polygon('polygon((0 0, 0 10, 10 10, 10 0, 0 0))', 4000) ),
  (2, ST_Polygon('polygon((20 0, 30 20, 40 0, 20 0 ))', 4000) ),
  (3, ST_Polygon('polygon((20 30, 25 35, 30 30, 20 30))', 4000))
```

The following SELECT statement retrieves the sales region ID and area:

```
SELECT id, ST_Area(geometry) AS area
FROM   sample_polygons
```

Results:

```
ID        AREA
--------- ------------------------
       1   +1.00000000000000E+002
       2   +2.00000000000000E+002
       3   +2.50000000000000E+001
```

Example 2

The following SELECT statement retrieves the sales region ID and area in various units:

```
SELECT id,
       ST_Area(geometry) square_feet,
       ST_Area(geometry, 'METER') square_meters,
       ST_Area(geometry, 'STATUTE MILE') square_miles
FROM   sample_polygons
```

Results:

```
ID  SQUARE_FEET              SQUARE_METERS            SQUARE_MILES
--- ------------------------ ------------------------ ------------------------
  1 +1.00000000000000E+002   +9.29034116132748E+000   +3.58702077598427E-006
  2 +2.00000000000000E+002   +1.85806823226550E+001   +7.17404155196855E-006
  3 +2.50000000000000E+001   +2.32258529033187E+000   +8.96755193996069E-007
```

Example 3

This example finds the area of a polygon defined in State Plane coordinates.

The State Plane spatial reference system with an ID of 3 is created with the following command:

```
db2se create_srs SAMP_DB  -srsId 3 -srsName z3101a -xOffset 0
    -yOffset 0 -xScale 1 -yScale 1
    -coordsysName NAD_1983_StatePlane_New_York_East_FIPS_3101_Feet
```

The following SQL statements add the polygon, in spatial reference system 3, to the table and determines the area in square feet, square meters, and square miles.

```
SET current function path db2gse;
 CREATE TABLE Sample_Poly3 (id integer, geometry ST_Polygon);
 INSERT into Sample_Poly3 VALUES
    (1, ST_Polygon('polygon((567176.0 1166411.0,
                             567176.0 1177640.0,
                             637948.0 1177640.0,
                             637948.0 1166411.0,
                             567176.0 1166411.0 ))', 3));
 SELECT id, ST_Area(geometry) "Square Feet",
            ST_Area(geometry, 'METER') "Square Meters",
            ST_Area(geometry, 'STATUTE MILE') "Square Miles"
 FROM Sample_Poly3;
```

Results:

```
ID   Square Feet               Square Meters             Square Miles
--- ------------------------ ------------------------ ------------------------
  1 +7.94698788000000E+008   +7.38302286101346E+007   +2.85060106320552E+001
```

Example 4

The spatial analyst needs a list of the area covered by each region of exploration. The exploration region polygons are stored in the SAMPLE_GEODETIC_TAB table, and they include the following regions:

- A region around the North Pole
- A region around the South Pole
- A region that straddles the 180th Meridian

The second field in the following input file, samp_wkt_rows.txt, contains polygons that represent these regions:

```
1|'polygon((5 82,15 82,25 82,35 82,45 82,55 82,65 82,75 82,85 82,95 82,
105 82,115 82,125 82,135 82,145 82,155 82,165 82,175 82,-175 82,-165 82,
-155 82,-145 82,-135 82,-125 82,-115 82,-105 82,-95 82,-85 82,-75 82,
-65 82,-55 82,-45 82,-35 82,-25 82,-15 82,-5 82,5 82))'|'North Pole region'
2|'polygon((175 -82,165 -82,155 -82,145 -82,135 -82,125 -82,115 -82,
105 -82,95 -82,85 -82,75 -82,65 -82,55 -82,45 -82,35 -82,25 -82,15 -82,
5 -82,-5 -82,-15 -82,-25 -82,-35 -82,-45 -82,-55 -82,-65 -82,-75 -82,
-85 -82,-95 -82,-105 -82,-115 -82,-125 -82,-135 -82,-145 -82,-155 -82,
-165 -82,-175 -82,175 -82))'|'South Pole region'
3|'polygon((-175 -42,-175 1,-175 42,175 42,175 -1,175 -42,-175 -42))
'|'180th meridian'
```

The following SQL statements add the polygons, in geodetic spatial reference system 2000000000, to the SAMPLE_GEODETIC_TAB table.

```
SET current function path db2gse;
CREATE TABLE db2se_samp.gsege_temp_samp (
            gid      INTEGER,
            g1_wkt   varchar(500),
            comment  varchar(255)
   ) NOT LOGGED INITIALLY;
LOAD FROM samp_wkt_rows.txt OF DEL MODIFIED BY CHARDEL'' COLDEL|
   INSERT INTO db2se_samp.gsege_temp_samp;

CREATE TABLE sample_geodetic_tab
  (gid INTEGER NOT NULL PRIMARY KEY,
   geometry ST_Geometry),
   comment varchar(255));

INSERT INTO sample_geodetic_tab
     SELECT gid, ST_GeomFromText(g1_wkt, 2000000000), comment
   FROM db2se_samp.gsege_temp_samp;
```

The ST_Area function calculates the area of the polygon in the geometry column. The default unit of measure from ST_Area is square meters. The following SELECT statement retrieves the exploration region ID and area in square meters, square feet, and square miles.

```
SELECT id, ST_Area(geometry) AS SQUARE_METERS,
ST_Area(geometry,'FOOT') AS SQUARE_FEET,
ST_Area(geometry, 'STATUTE MILE') AS SQUARE_MILES
FROM sample_geodetic_tab
WHERE id BETWEEN 1 AND 9 ORDER BY id;
```

```
ID  SQUARE_METERS            SQUARE_FEET              SQUARE_MILES
--- -----------------------  -----------------------  -----------------------
  1 +2.52472719957839E+012   +2.71759374028922E+013   +9.74802621488040E+005
  2 +2.52475431563494E+012   +2.71762292776957E+013   +9.74813091056005E+005
  3 +9.43568029137069E+012   +1.01564817377028E+014   +3.64313652781464E+006
```

ST_AsBinary

ST_AsBinary takes a geometry as an input parameter and returns its well-known binary representation. The Z and M coordinates are discarded and will not be represented in the well-known binary representation.

If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes to be converted to the corresponding well-known binary representation.

Return type

BLOB(2G)

Examples

The following code illustrates how to use the ST_AsBinary function to convert the points in the geometry columns of the SAMPLE_POINTS table into well-known binary (WKB) representation in the BLOB column.

```
CREATE TABLE SAMPLE_POINTS (id integer, geometry ST_POINT, wkb BLOB(32K))

INSERT INTO SAMPLE_POINTS (id, geometry)
VALUES
    (1100, ST_Point(10, 20, 1))
```

Example 1

This example populates the WKB column, with an ID of 1111, from the GEOMETRY column, with an ID of 1100.

```
INSERT INTO sample_points(id, wkb)
VALUES (1111,
  (SELECT  ST_AsBinary(geometry)
   FROM    sample_points
   WHERE   id = 1100))

SELECT id, cast(ST_Point(wkb)..ST_AsText AS varchar(35)) AS point
FROM   sample_points
WHERE  id = 1111
```

Results:

```
ID          Point
----------- ----------------------------------
       1111 POINT ( 10.00000000 20.00000000)
```

Example 2

This example displays the WKB binary representation.

```
SELECT id, substr(ST_AsBinary(geometry), 1, 21) AS point_wkb
FROM   sample_points
WHERE  id = 1100
```

Results:

```
ID     POINT_WKB
------ ---------------------------------------------
  1100 x'0101000000000000000000024400000000000003440'
```

ST_AsGML

ST_AsGML takes a geometry as an input parameter and returns its representation using the geography markup language.

If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes to be converted to the corresponding GML representation.

Return type

CLOB(2G)

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code fragment illustrates how to use the ST_AsGML function to view the GML fragment. This example populates the GML column, from the geometry column, with an ID of 2222.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE SAMPLE_POINTS (id integer, geometry ST_POINT, gml CLOB(32K))

INSERT INTO SAMPLE_POINTS (id, geometry)
VALUES
    (1100, ST_Point(10, 20, 1))

INSERT INTO sample_points(id, gml)
VALUES (2222,
  (SELECT  ST_AsGML(geometry)
   FROM    sample_points
   WHERE   id = 1100))
```

The following SELECT statement lists the ID and the GML representation of the geometries. The geometry is converted to a GML fragment by the ST_AsGML function.

```
SELECT id, cast(ST_AsGML(geometry) AS varchar(110)) AS gml_fragment
FROM   sample_points
WHERE  id = 1100
```

Results:

```
The SELECT statement returns the following result set:

ID          GML_FRAGMENT

----------- ------------------------------------------------------------
       1100 <gml:Point srsName";EPSG:4269";><gml:coord>
            <gml:X>10</gml:X><gml:Y>20</gml:Y>
            </gml:coord></gml:Point>
```

ST_AsShape

St_AsShape takes a geometry as an input parameter and returns its ESRI shape representation.

If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes to be converted to the corresponding ESRI shape representation.

Return type

BLOB(2G)

Example

The following code fragment illustrates how to use the ST_AsShape function to convert the points in the geometry column of the SAMPLE_POINTS table into shape binary representation in the shape BLOB column. This example populates the shape column from the geometry column. The shape binary representation is used to display the geometries in geobrowsers, which require geometries to comply with the ESRI shapefile format, or to construct the geometries for the *.SHP file of the shape file.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE SAMPLE_POINTS (id integer, geometry ST_POINT, shape BLOB(32K))

INSERT INTO SAMPLE_POINTS (id, geometry)
VALUES
    (1100, ST_Point(10, 20, 1))

INSERT INTO sample_points(id, shape)
VALUES (2222,
  (SELECT  ST_AsShape(geometry)
   FROM    sample_points
   WHERE   id = 1100))

SELECT id, substr(ST_AsShape(geometry), 1, 20) AS shape
FROM   sample_points
WHERE  id = 1100
```

Returns:

```
ID     SHAPE

------ ----------------------------------------
  1100 x'0100000000000000000002440000000000000003440'
```

ST_AsText

ST_AsText takes a geometry as an input parameter and returns its well-known text representation.

If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes to be converted to the corresponding well-known text representation.

Return type

CLOB(2G)

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

After capturing and inserting the data into the SAMPLE_GEOMETRIES table, an analyst wants to verify that the values inserted are correct by looking at the well-known text representation of the geometries.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries(id SMALLINT, spatial_type varchar(18),
    geometry ST_GEOMETRY)

INSERT INTO sample_geometries(id, spatial_type, geometry)
VALUES
    (1, 'st_point', ST_Point(50, 50, 0)),
    (2, 'st_linestring', ST_LineString('linestring
        (200 100, 210 130, 220 140)',  0)),
    (3, 'st_polygon', ST_Polygon('polygon((110 120, 110 140,
        130 140, 130 120, 110 120))', 0))
```

The following SELECT statement lists the spatial type and the WKT representation of the geometries. The geometry is converted to text by the ST_AsText function. It is then cast to a varchar(120) because the default output of the ST_AsText function is CLOB(2G).

```
SELECT id, spatial_type, cast(geometry..ST_AsText
   AS varchar(150)) AS wkt
FROM   sample_geometries
```

Results:

```
ID     SPATIAL_TYPE       WKT
------ ------------------ ------------------------------------------------
     1 st_point           POINT ( 50.00000000 50.00000000)

     2 st_linestring      LINESTRING ( 200.00000000 100.00000000,
                            210.00000000 130.00000000, 220.00000000
                            140.00000000)

     3 st_polygon         POLYGON (( 110.00000000 120.00000000,
                            130.00000000 120.00000000, 130.00000000
                            140.00000000, 110.00000000140.00000000,
                            110.00000000 120.00000000))
```

ST_Boundary

ST_Boundary takes a geometry as an input parameter and returns its boundary as a new geometry. The resulting geometry is represented in the spatial reference system of the given geometry.

If the given geometry is a point, multipoint, closed curve, or closed multicurve, or if it is empty, then the result is an empty geometry of type ST_Point. For curves or multicurves that are not closed, the start points and end points of the curves are returned as an ST_MultiPoint value, unless such a point is the start or end point of an even number of curves. For surfaces and multisurfaces, the curve defining the boundary of the given geometry is returned, either as an ST_Curve or an ST_MultiCurve value. If the given geometry is null, then null is returned.

If possible, the specific type of the returned geometry will be ST_Point, ST_LineString, or ST_Polygon. For example, the boundary of a polygon with no holes is a single linestring, represented as ST_LineString. The boundary of a polygon with one or more holes consists of multiple linestrings, represented as ST_MultiLineString.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes. The boundary of this geometry is returned.

Return type

db2gse.ST_Geometry

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example creates several geometries and determines the boundary of each geometry.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Polygon('polygon((40 120, 90 120, 90 150, 40 150, 40 120))', 0))

INSERT INTO sample_geoms VALUES
       (2, ST_Polygon('polygon((40 120, 90 120, 90 150, 40 150, 40 120),
                               (70 130, 80 130, 80 140, 70 140, 70 130))' ,0))

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('linestring(60 60, 65 60, 65 70, 70 70)' ,0))

INSERT INTO sample_geoms VALUES
```

```
       (4, ST_Geometry('multilinestring((60 60, 65 60, 65 70, 70 70),
                                        (80 80, 85 80, 85 90, 90 90),
                                        (50 50, 55 50, 55 60, 60 60))' ,0))

INSERT INTO sample_geoms VALUES
       (5, ST_Geometry('point(30 30)' ,0))

SELECT id, CAST(ST_AsText(ST_Boundary(geometry)) as VARCHAR(320)) Boundary
FROM   sample_geoms

Results
ID      BOUNDARY
------- ------------------------------------------------------------------
      1 LINESTRING ( 40.00000000 120.00000000, 90.00000000 120.00000000,
          90.00000000 150.00000000, 40.00000000 150.00000000, 40.00000000
          120.00000000)

      2 MULTILINESTRING (( 40.00000000 120.00000000, 90.00000000 120.00000000,
          90.00000000 150.00000000, 40.00000000 150.00000000, 40.00000000
          120.00000000),( 70.00000000 130.00000000, 70.00000000 140.00000000,
          80.00000000 140.00000000, 80.00000000 130.00000000, 70.00000000
          130.00000000))

      3 MULTIPOINT ( 60.00000000 60.00000000, 70.00000000 70.00000000)

      4 MULTIPOINT ( 50.00000000 50.00000000, 70.00000000 70.00000000,
          80.00000000 80.00000000, 90.00000000 90.00000000)

      5 POINT EMPTY
```

ST_Buffer

ST_Buffer takes a geometry, a distance, and, optionally, a unit as input parameters and returns the geometry that surrounds the given geometry by the specified distance, measured in the given unit.

Each point on the boundary of the resulting geometry is the specified distance away from the given geometry. The resulting geometry is represented in the spatial reference system of the given geometry.

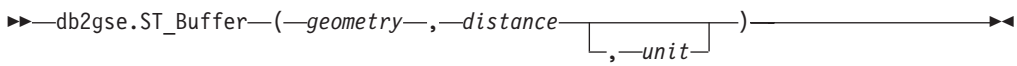
For geodetic data, if you specify a negative distance, ST_Buffer returns a region that is further than the specified distance away from all points of the input geometry. In other words, a negative distance returns the complementary region.

Any circular curve in the boundary of the resulting geometry is approximated by linear strings. For example, the buffer around a point, which would result in a circular region, is approximated by a polygon whose boundary is a linestring.

If the given geometry is null or is empty, null will be returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry to create the buffer around. For geodetic data, ST_Buffer supports only ST_Point and ST_MultiPoint data types.

distance
A DOUBLE PRECISION value that specifies the distance to be used for the buffer around *geometry*. For geodetic data, the distance must not be greater than the Earth's equatorial radius. For the WGS-84 ellipsoid, this length is 6378137.0 meters.

unit A VARCHAR(128) value that identifies the unit in which *distance* is measured. The supported units of measure are listed in the DB2GSE.ST_UNITS_OF_MEASURE catalog view.

If the *unit* parameter is omitted, the following rules are used to determine the unit of measure used for distance:

- If *geometry* is in a projected or geocentric coordinate system, the linear unit associated with this coordinate system is the default.
- If *geometry* is in a geographic coordinate system, but is not in a geodetic spatial reference system (SRS), the angular unit associated with this coordinate system is the default.
- If *geometry* is in a geodetic SRS, the default unit of measure is meters.

Restrictions on unit conversions: An error (SQLSTATE 38SU4) is returned if any of the following conditions occur:

- The geometry is in an unspecified coordinate system and the *unit* parameter is specified.
- The geometry is in a projected coordinate system and an angular unit is specified.
- The geometry is in a geographic coordinate system, but is not in a geodetic SRS, and a linear unit is specified.
- The geometry is in a geographic coordinate system, is in a geodetic SRS, and an angular unit is specified.

Return type

db2gse.ST_Geometry

Examples

In the following examples, the results have been reformatted for readability. The spacing in your results will vary according to your display.

Example 1

The following code creates a spatial reference system, creates the SAMPLE_GEOMETRIES table, and populates it.

```
db2se create_srs se_bank  -srsId 4000 -srsName new_york1983
    -xOffset 0 -yOffset 0 -xScale 1 -yScale 1
    -coordsysName NAD_1983_StatePlane_New_York_East_FIPS_3101_Feet

SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE
```

```
    sample_geometries (id INTEGER, spatial_type varchar(18),
    geometry ST_GEOMETRY)

INSERT INTO sample_geometries(id, spatial_type, geometry)
VALUES
    (1, 'st_point', ST_Point(50, 50, 4000)),
    (2, 'st_linestring',
         ST_LineString('linestring(200 100, 210 130,
         220 140)',  4000)),
    (3, 'st_polygon',
         ST_Polygon('polygon((110 120, 110 140, 130 140,
         130 120, 110 120))',4000)),
    (4, 'st_multipolygon',
         ST_MultiPolygon('multipolygon(((30 30, 30 40,
         35 40, 35 30, 30 30),(35 30, 35 40, 45 40,
         45 30, 35 30)))', 4000))
```

Example 2

The following SELECT statement uses the ST_Buffer function to apply a buffer of 10.

```
SELECT id, spatial_type,
       cast(geometry..ST_Buffer(10)..ST_AsText AS varchar(470)) AS buffer_10
FROM   sample_geometries
```

Results:

```
ID          SPATIAL_TYPE       BUFFER_10
----------- ------------------ ----------------------------------------
1           st_point           POLYGON (( 60.00000000 50.00000000,
   59.00000000 55.00000000, 54.00000000 59.00000000, 49.00000000
   60.00000000, 44.00000000 58.00000000, 41.00000000 53.00000000,
   40.00000000 48.00000000,42.00000000 43.00000000, 47.00000000
   41.00000000, 52.00000000 40.00000000, 57.00000000 42.00000000,
   60.00000000 50.00000000))

2             st_linestring    POLYGON (( 230.00000000
   140.00000000, 229.00000000 145.00000000, 224.00000000
   149.00000000, 219.00000000 150.00000000, 213.00000000 147.00000000,
   203.00000000 137.00000000, 201.00000000 133.00000000, 191.00000000
   103.00000000, 191.00000000 99.00000000, 192.00000000  95.00000000,
   196.00000000 91.00000000, 200.00000000 91.00000000,204.00000000
   91.00000000, 209.00000000 97.00000000, 218.00000000 124.00000000,
   227.00000000 133.00000000, 230.00000000 140.00000000))

3              st_polygon         POLYGON (( 140.00000000 120.00000000,
   140.00000000 140.00000000, 139.00000000  145.00000000, 130.00000000
   150.00000000, 110.00000000 150.00000000, 105.00000000 149.00000000,
   100.00000000 140.00000000,100.00000000 120.00000000, 101.00000000
   115.00000000, 110.00000000 110.00000000,130.00000000 110.00000000,
   135.00000000 111.00000000, 140.00000000 120.00000000))

4              st_multipolygon    POLYGON (( 55.00000000 30.00000000,
   55.00000000 40.00000000, 54.00000000 45.00000000, 45.00000000
   50.00000000, 30.00000000 50.00000000, 25.00000000 49.00000000,
   20.00000000 40.00000000, 20.00000000 30.00000000, 21.00000000
   25.00000000, 30.00000000 20.00000000, 45.00000000 20.00000000,
   50.00000000 21.00000000, 55.00000000 30.00000000))
```

Example 3

The following SELECT statement uses the ST_Buffer function to apply a negative buffer of 5.

```
SELECT id, spatial_type,
       cast(ST_AsText(ST_Buffer(geometry, -5)) AS varchar(150))
       AS buffer_negative_5
FROM   sample_geometries
WHERE  id = 3
```

Results:

```
ID          SPATIAL_TYPE       BUFFER_NEGATIVE_5
----------- ------------------ ------------------------------------
3           st_polygon         POLYGON (( 115.00000000 125.00000000,
   125.00000000 125.00000000, 125.00000000 135.00000000, 115.00000000
   135.00000000, 115.00000000 125.00000000))
```

Example 4

The following SELECT statement shows the result of applying a buffer with the unit parameter specified.

```
SELECT id, spatial_type,
    cast(ST_AsText(ST_Buffer(geometry, 10, 'METER')) AS varchar(680))
    AS buffer_10_meter
FROM   sample_geometries
WHERE  id = 3
```

Results:

```
ID          SPATIAL_TYPE       BUFFER_10_METER
----------- ------------------ ------------------------------------
3           st_polygon         POLYGON (( 163.00000000 120.00000000,
   163.00000000 140.00000000, 162.00000000 149.00000000, 159.00000000
   157.00000000, 152.00000000 165.00000000, 143.00000000 170.00000000,
   130.00000000 173.00000000, 110.00000000 173.00000000, 101.00000000
   172.00000000, 92.00000000 167.00000000, 84.00000000 160.00000000,
   79.00000000 151.00000000, 77.00000000 140.00000000, 77.00000000
   120.00000000, 78.00000000 111.00000000, 83.00000000 102.00000000,
   90.00000000 94.00000000, 99.00000000 89.00000000, 110.00000000
   87.00000000, 130.00000000 87.00000000, 139.00000000 88.00000000,
   147.00000000 91.00000000, 155.00000000 98.00000000, 160.00000000
   107.00000000, 163.00000000 120.00000000))
```

ST_Centroid

ST_Centroid takes a geometry as an input parameter and returns the geometric center, which is the center of the minimum bounding rectangle of the given geometry, as a point. The resulting point is represented in the spatial reference system of the given geometry.

If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry to determine the geometric center.

Return type

db2gse.ST_Point

Example

This example creates two geometries and finds the centroid of them.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
    (1, ST_Polygon('polygon
    ((40 120, 90 120, 90 150, 40 150, 40 120),
    (50 130, 80 130, 80 140, 50 140, 50 130))',0))

INSERT INTO sample_geoms VALUES
    (2, ST_MultiPoint('multipoint(10 10, 50 10, 10 30)' ,0))


SELECT id, CAST(ST_AsText(ST_Centroid(geometry))
   as VARCHAR(40)) Centroid
FROM sample_geoms
```

Results:

```
ID          CENTROID
----------- ----------------------------------------
          1 POINT ( 65.00000000 135.00000000)
          2 POINT ( 30.00000000 20.00000000)
```

ST_ChangePoint

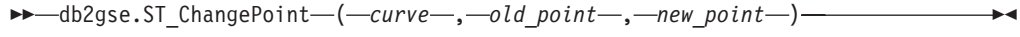
ST_ChangePoint takes a curve and two points as input parameters. It replaces all occurrences of the first point in the given curve with the second point and returns the resulting curve. The resulting geometry is represented in the spatial reference system of the given geometry.

If the two points are not represented in the same spatial reference system as the curve, they will be converted to the spatial reference system used for the curve.

If the given curve is empty, then an empty value is returned. If the given curve is null, or if any of the given points is null or empty, then null is returned.

This function can also be called as a method.

Syntax



Parameter

curve A value of type ST_Curve or one of its subtypes that represents the curve in which the points identified by *old_point* are changed to*new_point*.

old_point
A value of type ST_Point that identifies the points in the curve that are changed to *new_point*.

new_point
A value of type ST_Point that represents the new locations of the points in the curve identified by *old_point*.

Return type

db2gse.ST_Curve

Restrictions

The point to be changed in the curve must be one of the points used to define the curve.

If the curve has Z or M coordinates, then the given points also must have Z or M coordinates.

Examples

Example 1

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code creates and populates the SAMPLE_LINES table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines(id INTEGER, line ST_Linestring)


INSERT INTO sample_lines VALUES
    (1, ST_LineString('linestring (10 10, 5 5, 0 0, 10 0, 5 5, 0 10)', 0) )

INSERT INTO sample_lines VALUES
    (2, ST_LineString('linestring z (0 0 4, 5 5 5, 10 10 6, 5 5 7)', 0) )
```

Example 2

This example changes all occurrences of the point (5, 5) to the point (6, 6) in the linestring.

```
SELECT cast(ST_AsText(ST_ChangePoint(line, ST_Point(5, 5),
                                     ST_Point(6, 6))) as VARCHAR(160))
FROM   sample_lines
WHERE  id=1
```

Example 3

This example changes all occurrences of the point (5, 5, 5) to the point (6, 6, 6) in the linestring.

```
SELECT cast(ST_AsText(ST_ChangePoint(line, ST_Point(5.0, 5.0, 5.0),
       ST_Point(6.0, 6.0, 6.0) )) as VARCHAR(180))
FROM   sample_lines
WHERE  id=2
```

Results:

```
NEW
--------------------------------------------------------------------------------
LINESTRING Z ( 0.00000000 0.00000000 4.00000000, 6.00000000 6.00000000
6.00000000, 10.00000000 10.00000000 6.00000000, 5.00000000 5.00000000
7.00000000)
```

ST_Contains

ST_Contains takes two geometries as input parameter and returns 1 if the first geometry completely contains the second; otherwise it returns 0 (zero) to indicate that the first geometry does not completely contain the second.

If any of the given geometries is null or is empty, then null is returned.

For non–geodetic data, if the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system. For geodetic data, both geometries must be in the same geodetic spatial reference system (SRS).

Syntax

Parameter

geometry1
A value of type ST_Geometry or one of its subtypes that represents the geometry that is to be tested to completely contain *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the geometry that is to be tested to be completely within *geometry1*.

Restrictions: For geodetic data, both geometries must be geodetic and they both must be in the same geodetic SRS.

Return type

INTEGER

Examples

Example 1

The following code creates and populates these tables.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_points(id SMALLINT, geometry ST_POINT)

CREATE TABLE sample_lines(id SMALLINT, geometry ST_LINESTRING)

CREATE TABLE sample_polygons(id SMALLINT, geometry ST_POLYGON)

INSERT INTO sample_points (id, geometry)
VALUES
    (1, ST_Point(10, 20, 1)),
    (2, ST_Point('point(41 41)', 1))

INSERT INTO sample_lines (id, geometry)
VALUES
    (10, ST_LineString('linestring (1 10, 3 12, 10 10)', 1) ),
    (20, ST_LineString('linestring (50 10, 50 12, 45 10)', 1) )
INSERT INTO sample_polygons(id, geometry)
VALUES
      (100, ST_Polygon('polygon((0 0, 0 40, 40 40, 40 0, 0 0))',  1) )
```

Example 2

The following code fragment uses the ST_Contains function to determine which points are contained by a particular polygon.

```
SELECT poly.id AS polygon_id,
       CASE ST_Contains(poly.geometry, pts.geometry)
          WHEN 0 THEN 'does not contain'
          WHEN 1 THEN 'does contain'
       END AS contains,
       pts.id AS point_id
FROM   sample_points pts, sample_polygons poly
```

Results:

```
POLYGON_ID CONTAINS         POINT_ID
---------- ---------------- --------
       100 does contain            1
       100 does not contain        2
```

Example 3

The following code fragment uses the ST_Contains function to determine which lines are contained by a particular polygon.

```
SELECT poly.id AS polygon_id,
       CASE ST_Contains(poly.geometry, line.geometry)
          WHEN 0 THEN 'does not contain'
          WHEN 1 THEN 'does contain
       END AS contains,
       line.id AS line_id
FROM   sample_lines line, sample_polygons poly
```

Results:

```
POLYGON_ID CONTAINS         LINE_ID
---------- ---------------- -------
       100 does contain          10
       100 does not contain      20
```

ST_ConvexHull

ST_ConvexHull takes a geometry as an input parameter and returns the convex hull of it.

The resulting geometry is represented in the spatial reference system of the given geometry.

If possible, the specific type of the returned geometry will be ST_Point, ST_LineString, or ST_Polygon. For example, the boundary of a polygon with no holes is a single linestring, represented as ST_LineString. The boundary of a polygon with one or more holes consists of multiple linestrings, represented as ST_MultiLineString.

If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry to compute the convex hull.

Return type

db2gse.ST_Geometry

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code creates and populates the SAMPLE_GEOMETRIES table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries(id INTEGER, spatial_type varchar(18),
   geometry ST_GEOMETRY)

INSERT INTO sample_geometries(id, spatial_type, geometry)
VALUES
    (1, 'ST_LineString', ST_LineString
        ('linestring(20 20, 30 30, 20 40, 30 50)', 0)),
    (2, 'ST_Polygon', ST_Polygon('polygon
        ((110  120,  110 140, 120 130, 110 120))', 0) ),
    (3, 'ST_Polygon', ST_Polygon('polygon((30 30, 25 35, 15 50,
        35 80, 40 85, 80 90,70 75, 65 70, 55 50, 75 40, 60 30,
        30 30))', 0) ),
    (4, 'ST_MultiPoint', ST_MultiPoint('multipoint(20 20, 30 30,
        20 40, 30 50)', 1))
```

The following SELECT statement calculates the convex hull for all the geometries constructed above and displays the result.

```
SELECT id, spatial_type, cast(geometry..ST_ConvexHull..ST_AsText
   AS varchar(300)) AS convexhull
FROM   sample_geometries
```

Results:

```
ID     SPATIAL_TYPE       CONVEXHULL
------ ------------------ --------------------------------------------------
    1 ST_LineString      POLYGON (( 20.00000000 40.00000000,
                           20.00000000 20.00000000, 30.00000000
                           30.00000000, 30.00000000 50.00000000,
                           20.00000000 40.00000000))

    2 ST_Polygon         POLYGON (( 110.00000000 140.00000000,
                           110.00000000 120.00000000, 120.00000000
                           130.00000000,  110.00000000 140.00000000))

    3 ST_Polygon         POLYGON (( 15.00000000 50.00000000,
                           25.00000000 35.00000000, 30.00000000
                           30.00000000, 60.00000000 30.00000000,
                           75.00000000 40.00000000, 80.00000000
                           90.00000000, 40.00000000 85.00000000,
                           35.00000000 80.00000000, 15.00000000
                           50.00000000))

    4 ST_MultiPoint      POLYGON (( 20.00000000 40.00000000,
```

```
                                    20.00000000 20.00000000, 30.00000000
                                    30.00000000, 30.00000000 50.00000000,
                                    20.00000000 40.00000000))
```

ST_CoordDim

ST_CoordDim takes a geometry as an input parameter and returns the dimensionality of its coordinates.

If the given geometry does not have Z and M coordinates, the dimensionality is 2. If it has Z coordinates and no M coordinates, or if it has M coordinates and no Z coordinates, the dimensionality is 3. If it has Z and M coordinates, the dimensionality is 4. If the geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry to retrieve the dimensionality from.

Return type

INTEGER

Example

This example creates several geometries and then determines the dimensionality of their coordinates.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id CHARACTER(15), geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       ('Empty Point', ST_Geometry('point EMPTY',0))

INSERT INTO sample_geoms VALUES
       ('Linestring', ST_Geometry('linestring (10 10, 15 20)',0))

INSERT INTO sample_geoms VALUES
       ('Polygon', ST_Geometry('polygon((40 120, 90 120, 90 150,
         40 150, 40 120))' ,0))

INSERT INTO sample_geoms VALUES
       ('Multipoint M', ST_Geometry('multipoint m (10 10 5, 50 10
         6, 10 30 8)' ,0))

INSERT INTO sample_geoms VALUES
       ('Multipoint Z', ST_Geometry('multipoint z (47 34 295,
         23 45 678)' ,0))

INSERT INTO sample_geoms VALUES
       ('Point ZM',     ST_Geometry('point zm (10 10 16 30)' ,0))
```

```
SELECT id, ST_CoordDim(geometry)  COORDDIM
FROM sample_geoms
```

Results:

```
ID              COORDDIM
--------------- -----------
Empty Point               2
Linestring                2
Polygon                   2
Multipoint M              3
Multipoint Z              3
Point ZM                  4
```

ST_Crosses

ST_Crosses takes two geometries as input parameters and returns 1 if the first geometry crosses the second. Otherwise, 0 (zero) is returned.

If the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system.

If the first geometry is a polygon or a multipolygon, or if the second geometry is a point or multipoint, or if any of the geometries is null value or is empty, then null is returned. If the intersection of the two geometries results in a geometry that has a dimension that is one less than the maximum dimension of the two given geometries, and if the resulting geometry is not equal any of the two given geometries, then 1 is returned. Otherwise, the result is 0 (zero).

Syntax

Parameter

geometry1
A value of type ST_Geometry or one of its subtypes that represents the geometry that is to be tested for crossing *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the geometry that is to be tested to determine if it is crossed by *geometry1*.

Return Type

INTEGER

Example

This code determines if the constructed geometries cross each other.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('polygon((30 30, 30 50, 50 50, 50 30, 30 30))' ,0))

INSERT INTO sample_geoms VALUES
```

```
       (2, ST_Geometry('linestring(40 50, 50 40)' ,0))

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('linestring(20 20, 60 60)' ,0))

SELECT a.id, b.id, ST_Crosses(a.geometry, b.geometry) Crosses
FROM   sample_geoms a, sample_geoms b
```

Results:

```
ID          ID          CROSSES
----------- ----------- -----------
          1           1           -
          2           1           0
          3           1           1
          1           2           -
          2           2           0
          3           2           1
          1           3           -
          2           3           1
          3           3           0
```

ST_Difference

ST_Difference takes two geometries as input parameters and returns the part of the first geometry that does not intersect with the second geometry.

Both geometries must be of the same dimension. If either geometry is null, null is returned. If the first geometry is empty, an empty geometry of type ST_Point is returned. If the second geometry is empty, then the first geometry is returned unchanged.

For non–geodetic data, if the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system. For geodetic data, both geometries must be in the same geodetic spatial reference system (SRS).

This function can also be called as a method.

Syntax

Parameter

geometry1
A value of type ST_Geometry that represents the first geometry to use to compute the difference to *geometry2*.

geometry2
A value of type ST_Geometry that represents the second geometry that is used to compute the difference to *geometry1*.

Restrictions for geodetic data:

- Both geometries must be geodetic and they both must be in the same geodetic SRS.

- ST_Difference supports only ST_Point, ST_Polygon, ST_MultiPoint, and ST_MultiPolygon data types.

Return type

db2gse.ST_Geometry

The dimension of the returned geometry is the same as that of the input geometries.

Examples

In the following example, the results have been reformatted for readability. The spacing in your results will vary according to your display.

The following code creates and populates the SAMPLE_GEOMETRIES table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('polygon((10 10, 10 20, 20 20, 20 10, 10 10))' ,0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('polygon((30 30, 30 50, 50 50, 50 30, 30 30))' ,0))

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('polygon((40 40, 40 60, 60 60, 60 40, 40 40))' ,0))

INSERT INTO sample_geoms VALUES
       (4, ST_Geometry('linestring(70 70, 80 80)' ,0))

INSERT INTO sample_geoms VALUES
       (5, ST_Geometry('linestring(75 75, 90 90)' ,0))
```

Example 1

This example finds the difference between two disjoint polygons.

```
SELECT a.id, b.id, CAST(ST_AsText(ST_Difference(a.geometry, b.geometry))
   as VARCHAR(200))  Difference
FROM sample_geoms a, sample_geoms b
WHERE a.id = 1 and b.id = 2
```

Results:

```
ID        ID      DIFFERENCE
--------- -------- --------------------------------------------------
       1        2 POLYGON (( 10.00000000 10.00000000, 20.00000000
                     10.00000000, 20.00000000 20.00000000,
                     10.00000000 20.00000000, 10.00000000 10.00000000))
```

Example 2

This example finds the difference between two intersecting polygons.

```
SELECT a.id, b.id, CAST(ST_AsText(ST_Difference(a.geometry, b.geometry))
   as VARCHAR(200))  Difference
FROM sample_geoms a, sample_geoms b
WHERE a.id = 2 and b.id = 3
```

Results:

```
ID       ID       DIFFERENCE
-------- -------- --------------------------------------------------
       2        3 POLYGON (( 30.00000000 30.00000000, 50.00000000
                     30.00000000, 50.00000000 40.00000000, 40.00000000
                     40.00000000, 40.00000000 50.00000000, 30.00000000
                     50.00000000, 30.00000000 30.00000000))
```

Example 3

This example finds the difference between two overlapping linestrings.

```
SELECT a.id, b.id, CAST(ST_AsText(ST_Difference(a.geometry, b.geometry))
   as VARCHAR(100))  Difference
FROM sample_geoms a, sample_geoms b
WHERE a.id = 4 and b.id = 5
```

Results:

```
ID       ID       DIFFERENCE
-------- -------- --------------------------------------------------
       4        5 LINESTRING ( 70.00000000 70.00000000, 75.00000000
                     75.00000000)
```

ST_Dimension

ST_Dimension takes a geometry as an input parameter and returns its dimension.

If the given geometry is empty, then -1 is returned. For points and multipoints, the dimension is 0 (zero); for curves and multicurves, the dimension is 1; and for polygons and multipolygons, the dimension is 2. If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry that represents the geometry for which the dimension is returned.

Return type

INTEGER

Example

This example creates several different geometries and finds their dimensions.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id char(15), geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       ('Empty Point', ST_Geometry('point EMPTY',0))

INSERT INTO sample_geoms VALUES
       ('Point ZM', ST_Geometry('point zm (10 10 16 30)' ,0))
```

```
INSERT INTO sample_geoms VALUES
       ('MultiPoint M', ST_Geometry('multipoint m (10 10 5,
         50 10 6, 10 30 8)' ,0))

INSERT INTO sample_geoms VALUES
       ('LineString', ST_Geometry('linestring (10 10, 15 20)',0))

INSERT INTO sample_geoms VALUES
       ('Polygon', ST_Geometry('polygon((40 120, 90 120, 90 150,
         40 150, 40 120))' ,0))

SELECT id, ST_Dimension(geometry)  Dimension
FROM sample_geoms
```

Results:

```
ID              DIMENSION
--------------- -----------
Empty Point              -1
Point ZM                  0
MultiPoint M              0
LineString                1
Polygon                   2
```

ST_Disjoint

ST_Disjoint takes two geometries as input parameters and returns 1 if the given geometries do not intersect. If the geometries do intersect, then 0 (zero) is returned.

If the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system.

If any of the two geometries is null or is empty, then null value is returned.

This function can also be called as a method.

Syntax

Parameter

geometry1
A value of type ST_Geometry that represents the geometry that is tested to be disjoint with *geometry2*.

geometry2
A value of type ST_Geometry that represents the geometry that that is tested to be disjoint with *geometry1*.

Return type

INTEGER

Examples

Example 1

This code creates several geometries in the SAMPLE_GEOMETRIES table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('polygon((20 30, 30 30, 30 40, 20 40, 20 30))',0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('polygon((30 30, 30 50, 50 50, 50 30, 30 30))',0))

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('polygon((40 40, 40 60, 60 60, 60 40, 40 40))',0))

INSERT INTO sample_geoms VALUES
       (4, ST_Geometry('linestring(60 60, 70 70)' ,0))

INSERT INTO sample_geoms VALUES
       (5, ST_Geometry('linestring(30 30, 40 40)' ,0))
```

Example 2

This example determines if the first polygon is disjoint from any of the geometries.

```
SELECT a.id, b.id, ST_Disjoint(a.geometry, b.geometry) DisJoint
FROM sample_geoms a, sample_geoms b
WHERE a.id = 1
```

Results:

```
ID          ID          DISJOINT
----------- ----------- -----------
          1           1           0
          1           2           0
          1           3           1
          1           4           1
          1           5           0
```

Example 3

This example determines if the third polygon is disjoint from any of the geometries.

```
SELECT a.id, b.id, ST_Disjoint(a.geometry, b.geometry) DisJoint
FROM sample_geoms a, sample_geoms b
WHERE a.id = 3
```

Results:

```
ID          ID          DISJOINT
----------- ----------- -----------
          3           1           1
          3           2           0
          3           3           0
          3           4           0
          3           5           0
```

Example 4

This example determines if the second linestring is disjoint from any of the geometries.

```
SELECT a.id, b.id, ST_Disjoint(a.geometry, b.geometry) DisJoint
FROM sample_geoms a, sample_geoms b
WHERE a.id = 5
```

Results:

```
ID          ID          DISJOINT
----------- ----------- -----------
          5           1           0
          5           2           0
          5           3           0
          5           4           1
          5           5           0
```

ST_Distance

ST_Distance takes two geometries and, optionally, a unit as input parameters and returns the shortest distance between any point in the first geometry to any point in the second geometry, measured in the default or given units.

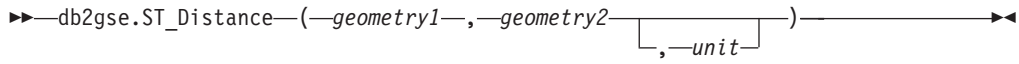
For geodetic data, ST_Distance returns the *geodesic distance* between any two geometries. The geodesic distance is the shortest distance on the surface of the ellipsoid.

If any of the two geometries is null or is empty, null is returned.

For non–geodetic data, if the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system. For geodetic data, both geometries must be in the same geodetic spatial reference system (SRS).

You can also call this function as a method when you provide a unit of measure.

Syntax



Parameter

geometry1
A value of type ST_Geometry that represents the geometry that is used to compute the distance to *geometry2*.

geometry2
A value of type ST_Geometry that represents the geometry that is used to compute the distance to *geometry1*.

unit VARCHAR(128) value that identifies the unit in which the result is measured. The supported units of measure are listed in the DB2GSE.ST_UNITS_OF_MEASURE catalog view.

For geodetic data, both geometries must be geodetic and they both must be in the same geodetic SRS.

If the *unit* parameter is omitted, the following rules are used to determine the unit of measure used for the result:

- If *geometry1* is in a projected or geocentric coordinate system, the linear unit associated with this coordinate system is the default.
- If *geometry1* is in a geographic coordinate system, but is not in a geodetic SRS, the angular unit associated with this coordinate system is the default.
- If *geometry1* is in a geodetic SRS, the default unit of measure is meters.

Restrictions on unit conversions: An error (SQLSTATE 38SU4) is returned if any of the following conditions occur:

- The geometry is in an unspecified coordinate system and the *unit* parameter is specified.
- The geometry is in a projected coordinate system and an angular unit is specified.
- The geometry is in a geographic coordinate system, is in a geodetic SRS, and an angular unit is specified.

Return type

DOUBLE

Examples

Example 1

The following SQL statements create and populate the SAMPLE_GEOMETRIES1 and SAMPLE_GEOMETRIES2 tables.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries1(id SMALLINT, spatial_type varchar(13),
   geometry ST_GEOMETRY)

CREATE TABLE sample_geometries2(id SMALLINT, spatial_type varchar(13),
   geometry ST_GEOMETRY)

INSERT INTO sample_geometries1(id, spatial_type, geometry)
VALUES
    ( 1, 'ST_Point', ST_Point('point(100 100)', 1) ),
    (10, 'ST_LineString', ST_LineString('linestring(125 125, 125 175)', 1) ),
    (20, 'ST_Polygon', ST_Polygon('polygon
                      ((50 50, 50 150, 150 150, 150 50, 50 50))', 1) )

INSERT INTO sample_geometries2(id, spatial_type, geometry)
VALUES
    (101, 'ST_Point', ST_Point('point(200 200)', 1) ),
    (102, 'ST_Point', ST_Point('point(200 300)', 1) ),
    (103, 'ST_Point', ST_Point('point(200 0)', 1) ),
    (110, 'ST_LineString', ST_LineString('linestring(200 100, 200 200)', 1) ),
    (120, 'ST_Polygon', ST_Polygon('polygon
                        ((200 0, 200 200, 300 200, 300 0, 200 0))', 1) )
```

Example 2

The following SELECT statement calculates the distance between the various geometries in the SAMPLE_GEOMTRIES1 and SAMPLE_GEOMTRIES2 tables.

```
SELECT   sg1.id AS sg1_id, sg1.spatial_type AS sg1_type,
         sg2.id AS sg1_id, sg2.spatial_type AS sg2_type,
         cast(ST_Distance(sg1.geometry, sg2.geometry)
         AS Decimal(8, 4)) AS distance
FROM     sample_geometries1 sg1, sample_geometries2 sg2
ORDER BY sg1.id
```

Results:

```
SG1_ID SG1_TYPE      SG1_ID SG2_TYPE      DISTANCE
------ ------------- ------ ------------- ----------
     1 ST_Point         101 ST_Point        141.4213
     1 ST_Point         102 ST_Point        223.6067
     1 ST_Point         103 ST_Point        141.4213
     1 ST_Point         110 ST_LineString   100.0000
     1 ST_Point         120 ST_Polygon      100.0000
    10 ST_LineString    101 ST_Point         79.0569
    10 ST_LineString    102 ST_Point        145.7737
    10 ST_LineString    103 ST_Point        145.7737
    10 ST_LineString    110 ST_LineString    75.0000
    10 ST_LineString    120 ST_Polygon       75.0000
    20 ST_Polygon       101 ST_Point         70.7106
    20 ST_Polygon       102 ST_Point        158.1138
    20 ST_Polygon       103 ST_Point         70.7106
    20 ST_Polygon       110 ST_LineString    50.0000
    20 ST_Polygon       120 ST_Polygon       50.0000
```

Example 3

The following SELECT statement illustrates how to find all the geometries that are within a distance of 100 of each other.

```
SELECT   sg1.id AS sg1_id, sg1.spatial_type AS sg1_type,
         sg2.id AS sg1_id, sg2.spatial_type AS sg2_type,
         cast(ST_Distance(sg1.geometry, sg2.geometry)
         AS Decimal(8, 4)) AS distance
FROM     sample_geometries1 sg1, sample_geometries2 sg2
WHERE    ST_Distance(sg1.geometry, sg2.geometry)  <= 100
```

Results:

```
SG1_ID SG1_TYPE      SG1_ID SG2_TYPE      DISTANCE
------ ------------- ------ ------------- ----------
     1 ST_Point         110 ST_LineString   100.0000
     1 ST_Point         120 ST_Polygon      100.0000
    10 ST_LineString    101 ST_Point         79.0569
    10 ST_LineString    110 ST_LineString    75.0000
    10 ST_LineString    120 ST_Polygon       75.0000
    20 ST_Polygon       101 ST_Point         70.7106
    20 ST_Polygon       103 ST_Point         70.7106
    20 ST_Polygon       110 ST_LineString    50.0000
    20 ST_Polygon       120 ST_Polygon       50.0000
```

Example 4

The following SELECT statement calculates the distance in kilometers between the various geometries.

```
SAMPLE_GEOMTRIES1 and SAMPLE_GEOMTRIES2 tables.
SELECT   sg1.id AS sg1_id, sg1.spatial_type AS sg1_type,
         sg2.id AS sg1_id, sg2.spatial_type AS sg2_type,
         cast(ST_Distance(sg1.geometry, sg2.geometry, 'KILOMETER')
         AS DECIMAL(10, 4)) AS distance
FROM     sample_geometries1 sg1, sample_geometries2 sg2
ORDER BY sg1.id
```

Results:

```
SG1_ID SG1_TYPE      SG1_ID SG2_TYPE      DISTANCE
------ ------------- ------ ------------- ------------
     1 ST_Point         101 ST_Point        12373.2168
     1 ST_Point         102 ST_Point        16311.3816
     1 ST_Point         103 ST_Point         9809.4713
     1 ST_Point         110 ST_LineString    1707.4463
```

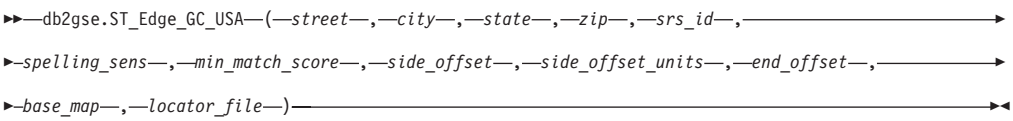
```
 1 ST_Point         120 ST_Polygon      12373.2168
10 ST_LineString    101 ST_Point         8648.2333
10 ST_LineString    102 ST_Point        11317.3934
10 ST_LineString    103 ST_Point        10959.7313
10 ST_LineString    110 ST_LineString    3753.5862
10 ST_LineString    120 ST_Polygon      10891.1254
20 ST_Polygon       101 ST_Point         7700.5333
20 ST_Polygon       102 ST_Point        15039.8109
20 ST_Polygon       103 ST_Point         7284.8552
20 ST_Polygon       110 ST_LineString    6001.8407
20 ST_Polygon       120 ST_Polygon      14515.8872
```

ST_Edge_GC_USA

ST_Edge_GC_USA is the function that implements the DB2SE_USA_GEOCODER which geocodes addresses located in the United States of America into points. The addresses are compared (matched) against EDGE files, which are provided on the geocoder data CD.

The function takes the street number and name, the city name, the state, the zip code, and the spatial reference system identifier for the resulting point as input parameters and returns an ST_Point value. Additionally, several configuration parameters that influence the geocoding process can be specified.

Syntax



Parameter

street A value of type VARCHAR(128) that contains the street number and name of the address to be geocoded.

This value must not be null.

city A value of type VARCHAR(128) that contains the name of the city of the address to be geocoded.

This value can be null if the *zip* parameter is specified.

state A value of type VARCHAR(128) that contains the name of the state of the address to be geocoded. The state can be abbreviated or spelled out.

This value can be null if the *zip* parameter is specified.

zip A value of type VARCHAR(10) that contains the zip code of the address to be geocoded. The zip code can be given as 5 digits or in the 5+4 notation.

This value can be null if the *city* and *state* parameters are specified.

srs_id A value of type INTEGER that contains the numeric identifier of the spatial reference system for the resulting point. The value must identify an existing spatial reference system, that uses a projected coordinate system based on the geographic coordinate system GCS_NORTH_AMERICAN_1983, or an existing spatial reference system that uses the geographic coordinate system itself, GCS_NORTH_AMERICAN_1983.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

spelling_sens
A value of type INTEGER that specifies the spelling sensitivity that should be applied to the given address. The value must be in the range from 0 (zero) to 100. The higher this value is, the more strict the geocoder will be regarding differences in the spelling of the given address. Deviations result in a higher penalty that will be applied to the final score of the match.

If the spelling sensitivity is set too high, fewer addresses might be geocoded successfully, and a null will be returned instead. If it the spelling sensitivity is set too low, a more unmatching addresses might be considered correct matches due to the accepted level of difference in the spelling of the addresses. **Recommendation:** Set this value to 60.

If this value is null, the spelling sensitivity will be derived from the locatior file. If it is not specified in the locator file, a spelling sensitivity of 60 is used.

min_match_score
A value of type INTEGER that contains the minimum score value that a point must have to be considered a match for the given address. The minimum score value must be in the range from 0 (zero) to 100. If the score of the point is lower than the *min_match_score* value, null is returned instead of the point, and the address is not geocoded.

Different factors like the quality of the base map, the spelling sensitivity, or the accuracy if the address influence the score of a point.
Recommendation: Set this value to 80.

If this value is null, the minimum match score will be derived from the locator file. If it is not specified in the locator file, a minimum score value of 80 is used.

side_offset
A value of type DOUBLE that specifies how far a resulting point is to be placed off the center of the street. The value must be larger than or equal to 0 (zero). The *side_offset_unit* parameter identifies the units that are used to measure the side offset.

If this value is null, the side offset will be derived from the locator file. If it is not specified in the locator file, a side offset of 0.0 is used.

side_offset_units
A value of type VARCHAR(128) that contains the units in which the *side_offset* parameter is measured. The value must be one of the following units:

- Inches
- Points
- Feet
- Yards
- Miles
- Nautical miles
- Millimeters
- Centimeters
- Meters

- Kilometers
- Decimal degrees
- Projected meters
- Reference data units

If this value is null, the side offset units will be derived from the locator file. If it is not specified in the locator file, the side offset will be measured in feet.

end_offset
A value of type INTEGER that indicates how far a point that would be exactly at the end of a street segment should be placed in the segment instead. The value must be larger than or equal to 0 (zero). This parameter is used to avoid placing resulting points in the middle of a street at intersections. The end offset is measured in points (the smallest possible resolution) on the base map.

If this value is null, the end offset will be derived from the locator file. If it is not specified in the locator file, an end offset of 3 is used.

base_map
A value of type VARCHAR(256) that contains the fully qualified path, including the base name, to the base map (.edg) file. The base map file is used by the geocoder to match the given addresses against. The base maps supplied by the DB2 Spatial Extender should be used. You can use this parameter if you placed the base maps in a different directory.

If this value is null, the path to the base map will be derived from the locator file. If it is not specified in the locator file, the base map will be searched for in the sqllib directory of the current instance, in the gse/refdata subdirectory. The base name of the file searched for is usa.edg.

locator_file
A value of type VARCHAR(256) that contains the fully qualified path, including the base name, to the locator file that contains additional configuration parameters for the geocoder. The locator file supplied by the DB2 Spatial Extender should be used.

If this value is null, the locator file will be searched for in the sqllib directory of the current instance, in the gse/cfg/geocoder subdirectory. The base name of the file searched for is EDGELocator.loc.

Return type

db2gse.ST_Point

Examples

Example 1

The following code creates a table SAMPLE_GEOCODING and inserts two addresses that are subsequently geocoded. The minimum match score will be set to 50 for the given addresses, and the spatial reference system for the resulting points is 1.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geocoding (
 street VARCHAR(128),
  city   VARCHAR(128),
```

```
 state  VARCHAR(128),
 zip    VARCHAR(5) )

INSERT INTO geocoding(street, city, state, zip)
 VALUES ('1212 New York Ave NW', 'Washington', 'DC', '20005'),
 ('100 First North Street', 'San Jose', 'CA', NULL)

SELECT VARCHAR(ST_AsText(ST_Edge_GC_USA(street, city, state, zip, 1,
    CAST(NULL AS INTEGER), 50, CAST(NULL AS DOUBLE),
    CAST(NULL AS VARCHAR(128)), CAST(NULL AS INTEGER),
     CAST(NULL AS VARCHAR(256)), CAST(NULL AS VARCHAR(256)))), 50)
FROM sample_geocoding
```

Results:

```
1
--------------------------------------------------
POINT ( -77.02829300 38.90049000)
POINT ( -121.94507200 37.28766700)
```

Example 2

In this example, a spatial reference system is created that uses a projected coordinate system. To simplify the interface of the geocoding function, a user-defined function is created to wrap the ST_Edge_GC_USA function.

```
db2se create_srs <db_name> -srsName CALIFORNIA -srsId 101 -xScale 1
  -coordsysName NAD_1983_STATEPLANE_CALIFORNIA_I_FIPS_0401

SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE FUNCTION California_GC (
  street VARCHAR(128), city VARCHAR(128), zip VARCHAR(10))
 RETURNS db2gse.ST_Point
   LANGUAGE SQL
   RETURN db2gse.ST_Edge_GC_USA(street, city, 'CA', zip, 101,
     CAST(NULL AS INTEGER), CAST(NULL AS INTEGER),
     CAST(NULL AS DOUBLE), CAST(NULL AS VARCHAR(128)),
       CAST(NULL AS INTEGER), CAST(NULL AS VARCHAR(256)))

CREATE TABLE sample_geocoding (
  street VARCHAR(128),
  city  VARCHAR(128),
  state  VARCHAR(128),
    zip    VARCHAR(5) )

INSERT INTO geocoding(street, city, state, zip)
VALUES ('100 First North Street', 'San Jose', 'CA', NULL)

SELECT VARCHAR(ST_AsText(California_GC(street, city, zip)), 50)
FROM sample_geocoding
```

Results:

```
1
--------------------------------------------------
POINT ( 2004879.00000000 272723.00000000)
```

The values of the X and Y coordinates of the point are different than in the first example because a different spatial reference system is used.

ST_Endpoint

ST_Endpoint takes a curve as an input parameter and returns the point that is the last point of the curve. The resulting point is represented in the spatial reference system of the given curve.

If the given curve is null or is empty, then null is returned.

This function can also be called as a method.

Syntax

Parameter

curve A value of type ST_Curve that represents the geometry from which the last point is returned.

Return type

db2gse.ST_Point

Example

The SELECT statement finds the endpoint of each of the geometries in the SAMPLE_LINES table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines(id INTEGER, line ST_Linestring)


INSERT INTO sample_lines VALUES
    (1, ST_LineString('linestring (10 10, 5 5, 0 0, 10 0, 5 5, 0 10)', 0) )

INSERT INTO sample_lines VALUES
    (2, ST_LineString('linestring z (0 0 4, 5 5 5, 10 10 6, 5 5 7)', 0) )


SELECT id, CAST(ST_AsText(ST_EndPoint(line)) as VARCHAR(50)) Endpoint
FROM   sample_lines
```

Results:

```
ID          ENDPOINT
----------- --------------------------------------------------
          1 POINT ( 0.00000000 10.00000000)
          2 POINT Z ( 5.00000000 5.00000000 7.00000000)
```

ST_Envelope

ST_Envelope takes a geometry as an input parameter and returns an envelope around the geometry. The envelope is a rectangle that is represented as a polygon.

If the given geometry is a point, a horizontal linestring, or a vertical linestring, then a rectangle, which is slightly larger than the given geometry, is returned. Otherwise, the minimum bounding rectangle of the geometry is returned as the

envelope. If the given geometry is null or is empty, then null is returned. To return the exact minimum bounding rectangle for all geometries, use the function ST_MBR.

For geodetic data, the envelope is a polygon that encloses the minimum bounding circle of the geometry.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry that represents the geometry to return the envelope for.

Return type

db2gse.ST_Polygon

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example creates several geometries and then determines their envelopes. For the non-empty point and the linestring (which is horizontal), the envelope is a rectangle that is slightly larger than the geometry.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
    (1, ST_Geometry('point EMPTY',0))

INSERT INTO sample_geoms VALUES
    (2, ST_Geometry('point zm (10 10 16 30)' ,0))

INSERT INTO sample_geoms VALUES
    (3, ST_Geometry('multipoint m (10 10 5, 50 10 6, 10 30 8)' ,0))

INSERT INTO sample_geoms VALUES
    (4, ST_Geometry('linestring (10 10, 20 10)',0))

INSERT INTO sample_geoms VALUES
    (5, ST_Geometry('polygon((40 120, 90 120, 90 150, 40 150, 40 120))',0))


SELECT id, CAST(ST_AsText(ST_Envelope(geometry)) as VARCHAR(160))  Envelope
FROM sample_geoms
```

Results:

```
ID          ENVELOPE
----------- ----------------------------------------------------------------
          1 -

          2 POLYGON (( 9.00000000 9.00000000, 11.00000000 9.00000000,
```

```
11.00000000 11.00000000, 9.00000000 11.00000000, 9.00000000 9.00000000))

       3 POLYGON (( 10.00000000 10.00000000, 50.00000000 10.00000000,
50.00000000 30.00000000, 10.00000000 30.00000000, 10.00000000
10.00000000))

       4 POLYGON (( 10.00000000 9.00000000, 20.00000000 9.00000000,
20.00000000  11.00000000, 10.00000000 11.00000000, 10.00000000
9.00000000))

       5 POLYGON (( 40.00000000 120.00000000, 90.00000000 120.00000000,
90.00000000 150.00000000, 40.00000000 150.00000000, 40.00000000
120.00000000))
```

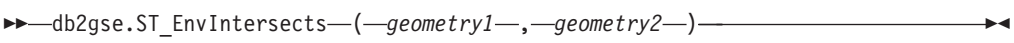
ST_EnvIntersects

ST_EnvIntersects takes two geometries as input parameters and returns 1 if the envelopes of two geometries intersect. Otherwise, 0 (zero) is returned.

If the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system.

If any of the given geometries is null or is empty, then null value is returned.

Syntax



Parameter

geometry1
A value of type ST_Geometry or one of its subtypes that represents the geometry whose envelope is to be tested for intersection with the envelope of *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the geometry whose envelope is to be tested for intersection with the envelope of *geometry1*.

Return type

INTEGER

Example

This example creates two parallel linestrings and checks them for intersection. The linestrings themselves do not intersect, but the envelopes for them do.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('linestring (10 10, 50 50)',0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('linestring (10 20, 50 60)',0))
```

```
SELECT a.id, b.id, ST_Intersects(a.geometry, b.geometry) Intersects,
                   ST_EnvIntersects(a.geometry, b.geometry) Envelope_Intersects
FROM   sample_geoms a , sample_geoms b
WHERE  a.id = 1 and b.id=2
```

Results:

```
ID          ID          INTERSECTS  ENVELOPE_INTERSECTS
----------- ----------- ----------- -------------------
          1           2           0                   1
```

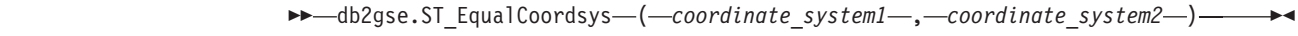
ST_EqualCoordsys

ST_EqualCoordsys takes two coordinate system definitions as input parameters and returns the integer value 1 (one) if the given definitions are identical. Otherwise, the integer value 0 (zero) is returned.

The coordinate system definitions are compared regardless of differences in spaces, parenthesis, uppercase and lowercase characters, and the representation of floating point numbers.

If any of the given coordinate system definitions is null, null is returned.

Syntax



Parameter

coordinate_system1
A value of type VARCHAR(2048) that defines the first coordinate system to be compared with *coordinate_system2*.

coordinate_system2
A value of type VARCHAR(2048) that defines the second coordinate system to be compared with *coordinate_system1*.

Return type

INTEGER

Example

This example compares two Australian coordinate systems to see if they are the same.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

VALUES ST_EqualCoordSys(
     (SELECT definition
      FROM   db2gse.ST_COORDINATE_SYSTEMS
      WHERE  coordsys_name='GCS_AUSTRALIAN') ,

     (SELECT definition
      FROM   db2gse.ST_COORDINATE_SYSTEMS
      WHERE  coordsys_name='GCS_AUSTRALIAN_1984')
      )
```

Results:

```
1
-----------
          0
```

ST_Equals

ST_Equals takes two geometries as input parameters and returns 1 if the geometries are equal. Otherwise 0 (zero) is returned. The order of the points used to define the geometry is not relevant for the test for equality.

If the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system.

If any of the two given geometries is null, then null is returned.

Syntax

Parameter

geometry1
A value of type ST_Geometry that represents the geometry that is to be compared with *geometry2*.

geometry2
A value of type ST_Geometry that represents the geometry that is to be compared with *geometry1*.

Return type

INTEGER

Examples

Example 1

This example creates two polygons that have their coordinates in a different order. ST_Equal is used to show that these polygons are considered equal.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('polygon((50 30, 30 30, 30 50, 50 50, 50 30))' ,0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('polygon((50 30, 50 50, 30 50, 30 30, 50 30))' ,0))


SELECT a.id, b.id, ST_Equals(a.geometry, b.geometry) Equals
FROM sample_geoms a, sample_geoms b
WHERE a.id = 1 and b.id = 2
```

Results:

```
ID          ID          EQUALS
----------- ----------- -----------
          1           2           1
```

Example 2

In this example, two geometries are created with the same X and Y coordinates, but different M coordinates (measures). When the geometries are compared with the ST_Equal function, a 0 (zero) is returned to indicate that these geometries are not equal.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('multipoint m(80 80 6, 90 90 7)' ,0))

INSERT INTO sample_geoms VALUES
       (4, ST_Geometry('multipoint m(80 80 6, 90 90 4)' ,0))


SELECT a.id, b.id, ST_Equals(a.geometry, b.geometry) Equals
FROM sample_geoms a, sample_geoms b
WHERE a.id = 3 and b.id = 4
```

Results:

```
ID          ID          EQUALS
----------- ----------- -----------
          3           4           0
```

Example 3

In this example, two geometries are created with a different set of coordinates, but both represent the same geometry. ST_Equal compares the geometries and indicates that both geometries are indeed equal.

```
SET current function path = current function path, db2gse
CREATE TABLE sample_geoms ( id INTEGER, geometry ST_Geometry )

INSERT INTO sample_geoms VALUES
   (5, ST_LineString('linestring ( 10 10, 40 40 )', 0)),
   (6, ST_LineString('linestring ( 10 10, 20 20, 40 40)', 0))

SELECT a.id, b.id, ST_Equals(a.geometry, b.geometry) Equals
FROM   sample_geoms a, sample_geoms b
WHERE  a.id = 5 AND b.id = 6
```

Results:

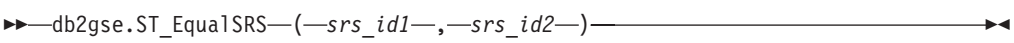
```
ID          ID          EQUALS
----------- ----------- -----------
          5           6           1
```

ST_EqualSRS

ST_EqualSRS takes two spatial reference system identifiers as input parameters and returns 1 if the given spatial reference systems are identical. Otherwise, 0 (zero) is returned. The offsets, scale factors, and the coordinate systems are compared.

If any of the given spatial reference system identifiers is null, null is returned.

Syntax



Parameter

srs_id1
A value of type INTEGER that identifies the first spatial reference system to be compared with the spatial reference system identified by *srs_id2*.

srs_id2
A value of type INTEGER that identifies the second spatial reference system to be compared with the spatial reference system identified by *srs_id1*.

Return type

INTEGER

Example

Two similar spatial reference systems are created with the following calls to db2se.

```
db2se create_srs SAMP_DB  -srsId 12 -srsName NYE_12 -xOffset 0 -yOffset 0
   -xScale 1 -yScale 1 -coordsysName
   NAD_1983_StatePlane_New_York_East_FIPS_3101_Feet

db2se create_srs SAMP_DB  -srsId 22 -srsName NYE_22 -xOffset 0 -yOffset 0
   -xScale 1 -yScale 1 -coordsysName
   NAD_1983_StatePlane_New_York_East_FIPS_3101_Feet
```

These SRSs have the same offset and scale values, and they refer to the same coordinate systems. The only difference is in the defined name and the SRS ID. Therefore, the comparison returns 1, which indicates that they are the same.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

VALUES ST_EqualSRS(12, 22)
```

Results:

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

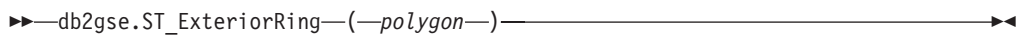
ST_ExteriorRing

ST_ExteriorRing takes a polygon as an input parameter and returns its exterior ring as a curve. The resulting curve is represented in the spatial reference system of the given polygon.

If the given polygon is null or is empty, then null is returned. If the polygon does not have any interior rings, the returned exterior ring is identical to the boundary of the polygon.

This function can also be called as a method.

Syntax



Parameter

polygon
A value of type ST_Polygon that represents the polygon for which the exterior ring is to be returned.

Return type

db2gse.ST_Curve

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example creates two polygons, one with two interior rings and one with no interior rings, then it determines their exterior rings.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys VALUES
       (1, ST_Polygon('polygon((40 120, 90 120, 90 150, 40 150, 40 120),
                      (50 130, 60 130, 60 140, 50 140, 50 130),
                      (70 130, 80 130, 80 140, 70 140, 70 130))' ,0))

INSERT INTO sample_polys VALUES
       (2, ST_Polygon('polygon((10 10, 50 10, 10 30, 10 10))' ,0))


SELECT id, CAST(ST_AsText(ST_ExteriorRing(geometry))
   AS VARCHAR(180)) Exterior_Ring
FROM sample_polys
```

Results:

```
ID          EXTERIOR_RING
----------- ----------------------------------------------------------------
          1 LINESTRING ( 40.00000000 120.00000000, 90.00000000
   120.00000000,  90.00000000 150.00000000, 40.00000000 150.00000000,
   40.00000000 120.00000000)

          2 LINESTRING ( 10.00000000 10.00000000, 50.00000000
   10.00000000, 10.00000000 30.00000000, 10.00000000 10.00000000)
```

ST_FindMeasure or ST_LocateAlong

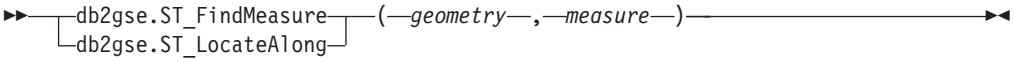
ST_FindMeasure or ST_LocateAlong takes a geometry and a measure as input parameters and returns a multipoint or multicurve of that part of the given geometry that has exactly the specified measure of the given geometry that contains the specified measure.

For points and multipoints, all the points with the specified measure are returned. For curves, multicurves, surfaces, and multisurfaces, interpolation is performed to compute the result. The computation for surfaces and multisurfaces is performed on the boundary of the geometry.

For points and multipoints, if the given measure is not found, then an empty geometry is returned. For all other geometries, if the given measure is lower than the lowest measure in the geometry or higher than the highest measure in the geometry, then an empty geometry is returned. If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry in which to search for parts whose M coordinates (measures) contain *measure*.

measure
A value of type DOUBLE that is the measure that the parts of *geometry* must be included in the result.

Return type

db2gse.ST_Geometry

Examples

Example 1

The following CREATE TABLE statement creates the SAMPLE_GEOMETRIES table. SAMPLE_GEOMETRIES has two columns: the ID column, which uniquely identifies each row, and the GEOMETRY ST_Geometry column, which stores sample geometry.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries(id SMALLINT, geometry ST_GEOMETRY)
```

The following INSERT statements insert two rows. The first is a linestring; the second is a multipoint.

```
INSERT INTO sample_geometries(id, geometry)
VALUES
  (1, ST_LineString('linestring m (2 2 3, 3 5 3, 3 3 6, 4 4 8)', 1)),
  (2, ST_MultiPoint('multipoint m
      (2 2 3, 3 5 3, 3 3 6, 4 4 6, 5 5 6, 6 6 8)', 1))
```

Example 2

In the following SELECT statement and the corresponding result set, the ST_FindMeasure function is directed to find points whose measure is 7. The first row returns a point. However, the second row returns an empty point. For linear features (geometry with a dimension greater than 0), ST_FindMeasure can interpolate the point; however, for multipoints, the target measure must match exactly.

```
SELECT id, cast(ST_AsText(ST_FindMeasure(geometry, 7))
   AS varchar(45)) AS measure_7
FROM   sample_geometries
```

Results:

```
ID     MEASURE_7
------ ---------------------------------------------
     1 POINT M ( 3.50000000 3.50000000 7.00000000)
     2 POINT EMPTY
```

Example 3

In the following SELECT statement and the corresponding result set, the ST_FindMeasure function returns a point and a multipoint. The target measure of 6 matches the measures in both the ST_FindMeasure and multipoint source data.

```
SELECT id, cast(ST_AsText(ST_FindMeasure(geometry, 6))
   AS varchar(120)) AS measure_6
FROM   sample_geometries
```

Results:

```
ID     MEASURE_6
------ ------------------------------------------------------------
1      POINT M ( 3.00000000 3.00000000 6.00000000)

2      MULTIPOINT M ( 3.00000000 3.00000000 6.00000000, 4.00000000
        4.00000000 6.00000000, 5.00000000 5.00000000 6.00000000)
```

ST_Generalize

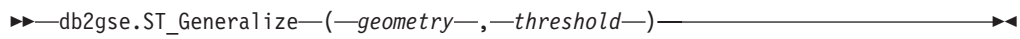
ST_Generalize takes a geometry and a threshold as input parameters and represents the given geometry with a reduced number of points, while preserving the general characteristics of the geometry.

The Douglas-Peucker line-simplification algorithm is used, by which the sequence of points that define the geometry is recursively subdivided until a run of the points can be replaced by a straight line segment. In this line segment, none of the defining points deviates from the straight line segment by more than the given threshold. Z and M coordinates are not considered for the simplification. The resulting geometry is in the spatial reference system of the given geometry.

If the given geometry is empty, an empty geometry of type ST_Point is returned. If the given geometry or the threshold is null, null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry for which the line-simplification is applied.

threshold
A value of type DOUBLE that identifies the threshold to be used for the

line-simplification algorithm. The threshold must be greater than or equal to 0 (zero). The larger the threshold, the smaller the number of points that will be used to represent the generalized geometry. For geodetic data, the unit for threshold is in meters.

Return type

db2gse.ST_Geometry

Examples

In the following examples, the results have been reformatted for readability. The spacing in your results will vary according to your display.

Example 1

A linestring is created with eight points that go from (10, 10) to (80, 80). The path is almost a straight line, but some of the points are slightly off of the line. The ST_Generalize function can be used to reduce the number of points in the line.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines (id INTEGER, geometry ST_LineString)

INSERT INTO sample_lines VALUES
       (1, ST_Linestring('linestring(10 10, 21 20, 34 26, 40 40,
                                     52 50, 59 63, 70 71, 80 80)' ,0))
```

Example 2

When a generalization factor of 3 is used, the linestring is reduced to four coordinates, and is still very close to the original representation of the linestring.

```
SELECT CAST(ST_AsText(ST_Generalize(geometry, 3)) as VARCHAR(115))
  Generalize_3
FROM sample_lines
```

Results:

```
GENERALIZE 3
------------------------------------------------------------------------
LINESTRING ( 10.00000000 10.00000000, 34.00000000 26.00000000,
  59.00000000  63.00000000, 80.00000000 80.00000000)
```

Example 3

When a generalization factor of 6 is used, the linestring is reduced to only two coordinates. This produces a simpler linestring than the previous example, however it deviates more from the original representation.

```
SELECT CAST(ST_AsText(ST_Generalize(geometry, 6)) as VARCHAR(65))
  Generalize_6
FROM sample_lines
```

Results:

```
GENERALIZE 6
-----------------------------------------------------------------
LINESTRING ( 10.00000000 10.00000000, 80.00000000 80.00000000)
```

ST_GeomCollection

Use ST_GeomCollection to construct a geometry collection.

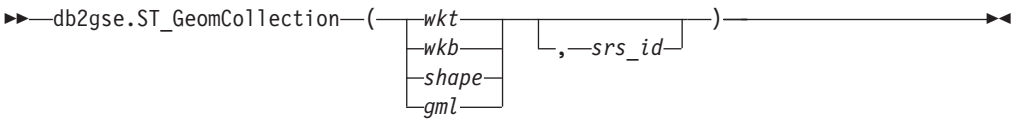
ST_GeomCollection constructs a geometry collection from one of the following inputs:

- A well-known text representation
- A well-known binary representation
- An ESRI shape representation
- A representation in the geography markup language (GML)

An optional spatial reference system identifier can be specified to identify the spatial reference system that the resulting geometry collection is in.

If the well-known text representation, the well-known binary representation, the ESRI shape representation, or the GML representation is null, then null is returned.

Syntax



Parameter

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting geometry collection.

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting geometry collection.

shape A value of type BLOB(2G) that represents the ESRI shape representation of the resulting geometry collection.

gml A value of type CLOB(2G) that represents the resulting geometry collection using the geography markup language (GML).

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting geometry collection.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used implicitly.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

Return type

db2gse.ST_GeomCollection

Notes

If the *srs_id* parameter is omitted, it might be necessary to cast *wkt* and *gml* explicitly to the CLOB data type. Otherwise, DB2 might resolve to the function used to cast values from the reference type REF(ST_GeomCollection) to the

ST_GeomCollection type. The following example ensures that DB2 resolves to the correct function:

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code illustrates how the ST_GeomCollection function can be used to create and insert a multipoint, multiline, and multipolygon from well-known text (WKT) representation and a multipoint from geographic markup language (GML) into a GeomCollection column.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geomcollections(id INTEGER,
   geometry ST_GEOMCOLLECTION)

INSERT INTO sample_geomcollections(id, geometry)
VALUES
    (4001, ST_GeomCollection('multipoint(1 2, 4 3, 5 6)', 1) ),
    (4002, ST_GeomCollection('multilinestring(
                              (33 2, 34 3, 35 6),
                              (28 4, 29 5, 31 8, 43 12),
                              (39 3, 37 4, 36 7))', 1) ),
    (4003, ST_GeomCollection('multipolygon(((3 3, 4 6, 5 3, 3 3),
                              (8 24, 9 25, 1 28, 8 24),
                              (13 33, 7 36, 1 40, 10 43, 13 33)))', 1)),
    (4004, ST_GeomCollection('<gml:MultiPoint srsName="EPSG:4269"
                              ><gml:PointMember><gml:Point>
                              <gml:coord><gml:X>10</gml:X>
                              <gml:Y>20</gml:Y></gml: coord></gml:Point>
                              </gml:PointMember><gml:PointMember>
                              <gml:Point><gml:coord><gml:X>30</gml:X>
                              <gml:Y>40</gml:Y></gml:coord></gml:Point>
                              </gml:PointMember></gml:MultiPoint>', 1))

SELECT id, cast(geometry..ST_AsText AS varchar(350)) AS geomcollection
FROM   sample_geomcollections
```

Results:

```
ID          GEOMCOLLECTION
----------- ------------------------------------------------------------------
4001         MULTIPOINT ( 1.00000000 2.00000000, 4.00000000 3.00000000,
    5.00000000 6.00000000)

4002         MULTILINESTRING (( 33.00000000 2.00000000, 34.00000000
   3.00000000, 35.00000000 6.00000000),( 28.00000000 4.00000000,
   29.00000000 5.00000000, 31.00000000 8.00000000, 43.00000000
   12.00000000),(39.00000000 3.00000000, 37.00000000 4.00000000,
   36.00000000 7.00000000))

4003         MULTIPOLYGON ((( 13.00000000 33.00000000, 10.00000000
    43.00000000, 1.00000000 40.00000000, 7.00000000 36.00000000,
    13.00000000 33.00000000)),(( 8.00000000 24.00000000, 9.00000000
    25.00000000, 1.00000000 28.00000000, 8.00000000 24.00000000)),
    (( 3.00000000 3.00000000,5.00000000 3.00000000, 4.00000000
    6.00000000,3.00000000 3.00000000)))

4004         MULTIPOINT ( 10.00000000 20.00000000, 30.00000000
    40.00000000)
```

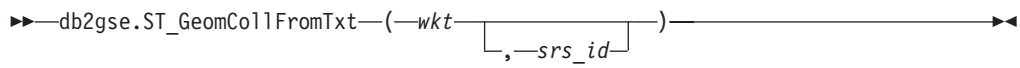
ST_GeomCollFromTxt

ST_GeomCollFromTxt takes a well-known text representation of a geometry collection and, optionally, a spatial reference system identifier as input parameters and returns the corresponding geometry collection.

If the given well-known text representation is null, then null is returned.

The recommended function for achieving the same result is ST_GeomCollection. It is recommended because of its flexibility: ST_GeomCollection takes additional forms of input as well as the well-known binary representation.

Syntax



Parameter

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting geometry collection.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting geometry collection.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used implicitly.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

Return type

db2gse.ST_GeomCollection

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code illustrates how the ST_GeomCollFromTxt function can be used to create and insert a multipoint, multiline, and multipolygon from a well-known text (WKT) representation into a GeomCollection column.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geomcollections(id INTEGER, geometry ST_GEOMCOLLECTION)

INSERT INTO sample_geomcollections(id, geometry)
VALUES
    (4011, ST_GeomCollFromTxt('multipoint(1 2, 4 3, 5 6)', 1) ),
    (4012, ST_GeomCollFromTxt('multilinestring(
                            (33 2, 34 3, 35 6),
                            (28 4, 29 5, 31 8, 43 12),
                            (39 3, 37 4, 36 7))', 1) ),
    (4013, ST_GeomCollFromTxt('multipolygon(((3 3, 4 6, 5 3, 3 3),
                            (8 24, 9 25, 1 28, 8 24),
                            (13 33, 7 36, 1 40, 10 43, 13 33)))', 1))
```

```
SELECT id, cast(geometry..ST_AsText AS varchar(340))
   AS geomcollection
FROM   sample_geomcollections
```

Results:

```
ID          GEOMCOLLECTION
----------- ----------------------------------------------------------------
4011        MULTIPOINT ( 1.00000000 2.00000000, 4.00000000 3.00000000,
   5.00000000 6.00000000)

4012        MULTILINESTRING (( 33.00000000 2.00000000, 34.00000000
   3.00000000, 35.00000000 6.00000000),( 28.00000000 4.00000000, 29.00000000
   5.00000000, 31.00000000 8.00000000, 43.00000000 12.00000000),( 39.00000000
   3.00000000, 37.00000000 4.00000000, 36.00000000 7.00000000))

4013        MULTIPOLYGON ((( 13.00000000 33.00000000, 10.00000000 43.00000000,
   1.00000000 40.00000000, 7.00000000 36.00000000, 13.00000000 33.00000000)),
   (( 8.00000000 24.00000000, 9.00000000 25.00000000, 1.00000000 28.00000000,
   8.00000000 24.00000000)),(( 3.00000000 3.00000000, 5.00000000 3.00000000,
   4.00000000 6.00000000, 3.00000000 3.00000000)))
```

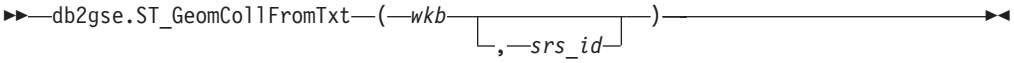
ST_GeomCollFromWKB

ST_GeomCollFromWKB takes a well-known binary representation of a geometry collection and, optionally, a spatial reference system identifier as input parameters and returns the corresponding geometry collection.

If the given well-known binary representation is null, then null is returned.

The preferred version for this functionality is ST_GeomCollection.

Syntax



Parameter

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting geometry collection.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting geometry collection.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used implicitly.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

Return type

db2gse.ST_GeomCollection

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code illustrates how the ST_GeomCollFromWKB function can be used to create and query the coordinates of a geometry collection in a well-known binary representation. The rows are inserted into the SAMPLE_GEOMCOLLECTION table with IDs 4021 and 4022 and geometry collections in spatial reference system 1.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geomcollections(id INTEGER,
  geometry ST_GEOMCOLLECTION, wkb BLOB(32k))

INSERT INTO sample_geomcollections(id, geometry)
VALUES
  (4021, ST_GeomCollFromTxt('multipoint(1 2, 4 3, 5 6)', 1)),
  (4022, ST_GeomCollFromTxt('multilinestring(
                            (33 2, 34 3, 35 6),
                            (28 4, 29 5, 31 8, 43 12))', 1))

UPDATE sample_geomcollections AS temp_correlated
SET    wkb = geometry..ST_AsBinary
WHERE  id = temp_correlated.id

SELECT id, cast(ST_GeomCollFromWKB(wkb)..ST_AsText
   AS varchar(190)) AS GeomCollection
FROM   sample_geomcollections
```

Results:

```
ID          GEOMCOLLECTION
----------- ------------------------------------------------------
       4021 MULTIPOINT ( 1.00000000 2.00000000, 4.00000000
  3.00000000, 5.00000000 6.00000000)

       4022 MULTILINESTRING (( 33.00000000 2.00000000,
 34.00000000 3.00000000, 35.00000000 6.00000000),( 28.00000000
 4.00000000, 29.00000000 5.00000000, 31.00000000 8.00000000,
 43.00000000 12.00000000))
```

ST_Geometry

ST_Geometry constructs a geometry from one of the following inputs:

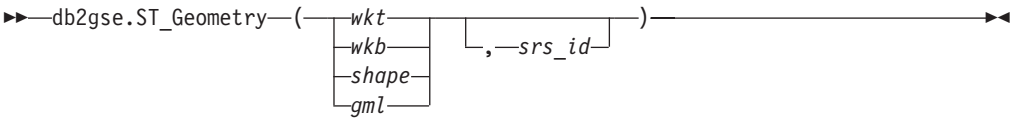
- A well-known text representation
- A well-known binary representation
- An ESRI shape representation
- A representation in the geography markup language (GML)

An optional spatial reference system identifier can be specified to identify the spatial reference system that the resulting geometry is in.

The dynamic type of the resulting geometry is one of the instantiable subtypes of ST_Geometry.

If the well-known text representation, the well-known binary representation, the ESRI shape representation, or the GML representation is null, then null is returned.

Syntax



Parameter

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting geometry.

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting geometry.

shape A value of type BLOB(2G) that represents the ESRI shape representation of the resulting geometry.

gml A value of type CLOB(2G) that represents the resulting geometry using the geography markup language (GML).

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting geometry.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used implicitly.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

Return type

db2gse.ST_Geometry

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code illustrates how the ST_Geometry function can be used to create and insert a point from a well-known text (WKT) point representation or line from Geographic Markup Language (GML) line representation.

The ST_Geometry function is the most flexible of the spatial type constructor functions because it can create any spatial type from various geometry representations. ST_LineFromText can create only a line from WKT line representation. ST_WKTToSql can construct any type, but only from WKT representation.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries(id INTEGER, geometry ST_GEOMETRY)

INSERT INTO sample_geometries(id, geometry)
VALUES
    (7001, ST_Geometry('point(1 2)', 1) ),
    (7002, ST_Geometry('linestring(33 2, 34 3, 35 6)', 1) ),
    (7003, ST_Geometry('polygon((3 3, 4 6, 5 3, 3 3))', 1)),
    (7004, ST_Geometry('<gml:Point srsName=";EPSG:4269";><gml:coord>
         <gml:X>50</gml:X><gml:Y>60</gml:Y></gml:coord>
```

```
          </gml:Point>', 1))

SELECT id, cast(geometry..ST_AsText AS varchar(120)) AS geometry
FROM   sample_geometries
```

Results:

```
ID          GEOMETRY
----------- ------------------------------------------------------------
7001        POINT ( 1.00000000 2.00000000)

7002        LINESTRING ( 33.00000000 2.00000000, 34.00000000 3.00000000,
  35.00000000 6.00000000)

7003        POLYGON (( 3.00000000 3.00000000, 5.00000000 3.00000000,
  4.00000000 6.00000000, 3.00000000 3.00000000))

7004        POINT ( 50.00000000 60.00000000)
```

ST_GeometryN

ST_GeometryN takes a geometry collection and an index as input parameters and returns the geometry in the collection that is identified by the index. The resulting geometry is represented in the spatial reference system of the given geometry collection.

If the given geometry collection is null or is empty, or if the index is smaller than 1 or larger than the number of geometries in the collection, then null is returned and a warning condition is raised (01HS0).

This function can also be called as a method.

Syntax

Parameter

collection
A value of type ST_GeomCollection or one of its subtypes that represents the geometry collection to locate the *n*th geometry within.

index A value of type INTEGER that identifies the *n*th geometry that is to be returned from *collection*.

If *index* is smaller than 1 or larger than the number of geometries in the collection, then null is returned and a warning is returned (SQLSTATE 01HS0).

Return type

db2gse.ST_Geometry

Example

The following code illustrates how to choose the second geometry inside a geometry collection.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geomcollections (id INTEGER,
```

```
  geometry ST_GEOMCOLLECTION)

INSERT INTO sample_geomcollections(id, geometry)
VALUES
    (4001, ST_GeomCollection('multipoint(1 2, 4 3)', 1) ),
    (4002, ST_GeomCollection('multilinestring(
                           (33 2, 34 3, 35 6),
                           (28 4, 29 5, 31 8, 43 12),
                           (39 3, 37 4, 36 7))', 1) ),
    (4003, ST_GeomCollection('multipolygon(((3 3, 4 6, 5 3, 3 3),
                              (8 24, 9 25, 1 28, 8 24),
                              (13 33, 7 36, 1 40, 10 43, 13 33)))', 1))

SELECT id, cast(ST_GeometryN(geometry, 2)..ST_AsText AS varchar(110))
    AS second_geometry
FROM   sample_geomcollections
```

Results:

```
ID          SECOND_GEOMETRY
----------- ------------------------------------------------------------
       4001 POINT ( 4.00000000 3.00000000)

       4002 LINESTRING ( 28.00000000 4.00000000, 29.00000000 5.00000000,
   31.00000000 8.00000000, 43.00000000 12.00000000)

       4003 POLYGON (( 8.00000000 24.00000000, 9.00000000 25.00000000,
   1.00000000 28.00000000, 8.00000000 24.00000000))
```

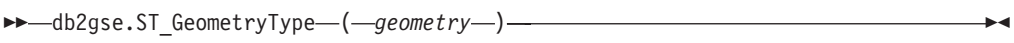
ST_GeometryType

ST_GeometryType takes a geometry as input parameter and returns the fully qualified type name of the dynamic type of that geometry.

The DB2 functions TYPE_SCHEMA and TYPE_NAME have the same effect.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry for which the geometry type is to be returned.

Return type

VARCHAR(128)

Examples

The following code illustrates how to determine the type of a geometry.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries (id INTEGER, geometry ST_GEOMETRY)

INSERT INTO sample_geometries(id, geometry)
VALUES
```

```
    (7101, ST_Geometry('point(1 2)', 1) ),
    (7102, ST_Geometry('linestring(33 2, 34 3, 35 6)', 1) ),
    (7103, ST_Geometry('polygon((3 3, 4 6, 5 3, 3 3))', 1)),
    (7104, ST_Geometry('multipoint(1 2, 4 3)', 1) )

SELECT id, geometry..ST_GeometryType AS geometry_type
FROM   sample_geometries
```

Results:

```
ID          GEOMETRY_TYPE
----------- ------------------------------
       7101 "DB2GSE  "."ST_POINT"
       7102 "DB2GSE  "."ST_LINESTRING"
       7103 "DB2GSE  "."ST_POLYGON"
       7104 "DB2GSE  "."ST_MULTIPOINT"
```

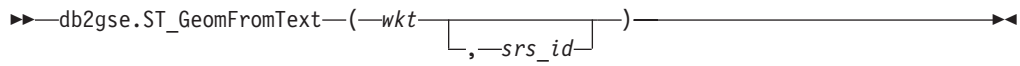
ST_GeomFromText

ST_GeomFromText takes a well-known text representation of a geometry and, optionally, a spatial reference system identifier as input parameters and returns the corresponding geometry.

If the given well-known text representation is null, then null is returned.

The preferred version for this functionality is ST_Geometry.

Syntax



Parameter

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting geometry.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting geometry.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used implicitly.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

Return type

db2gse.ST_Geometry

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

In this example the ST_GeomFromText function is used to create and insert a point from a well known text (WKT) point representation.

The following code inserts rows into the SAMPLE_POINTS table with IDs and geometries in spatial reference system 1 using WKT representation.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries(id INTEGER, geometry ST_GEOMETRY)

INSERT INTO sample_geometries(id, geometry)
VALUES
    (1251, ST_GeomFromText('point(1 2)', 1) ),
    (1252, ST_GeomFromText('linestring(33 2, 34 3, 35 6)', 1) ),
    (1253, ST_GeomFromText('polygon((3 3, 4 6, 5 3, 3 3))', 1))
```

The following SELECT statement will return the ID and GEOMETRIES from the SAMPLE_GEOMETRIES table.

```
SELECT id, cast(geometry..ST_AsText AS varchar(105))
   AS geometry
FROM   sample_geometries
```

Results:

```
ID          GEOMETRY
----------- ----------------------------------------------------------------
       1251 POINT ( 1.00000000 2.00000000)

       1252 LINESTRING ( 33.00000000 2.00000000, 34.00000000 3.00000000,
              35.00000000 6.00000000)

       1253 POLYGON (( 3.00000000 3.00000000, 5.00000000 3.00000000,
              4.00000000 6.00000000, 3.00000000 3.00000000))
```

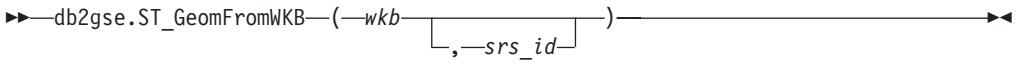
ST_GeomFromWKB

ST_GeomFromWKB takes a well-known binary representation of a geometry and, optionally, a spatial reference system identifier as input parameters and returns the corresponding geometry.

If the given well-known binary representation is null, then null is returned.

The preferred version for this functionality is ST_Geometry.

Syntax



Parameter

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting geometry.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting geometry.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used implicitly.

If the specified srs_id parameter does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

Return type

db2gse.ST_Geometry

Examples

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code illustrates how the ST_GeomFromWKB function can be used to create and insert a line from a well-known binary (WKB) line representation.

The following example inserts a record into the SAMPLE_GEOMETRIES table with an ID and a geometry in spatial reference system 1 in a WKB representation.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries (id INTEGER, geometry ST_GEOMETRY,
    wkb BLOB(32K))

INSERT INTO sample_geometries(id, geometry)
VALUES
    (1901, ST_GeomFromText('point(1 2)', 1) ),
    (1902, ST_GeomFromText('linestring(33 2, 34 3, 35 6)', 1) ),
    (1903, ST_GeomFromText('polygon((3 3, 4 6, 5 3, 3 3))', 1))

UPDATE sample_geometries AS temp_correlated
SET    wkb = geometry..ST_AsBinary
WHERE  id = temp_correlated.id

SELECT id, cast(ST_GeomFromWKB(wkb)..ST_AsText AS varchar(190))
   AS geometry
FROM   sample_geometries
```

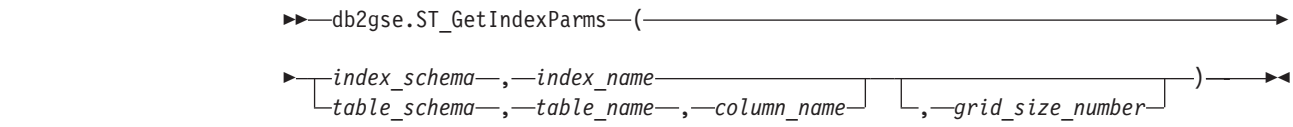
Results:

```
 ID          GEOMETRY
 ----------- ------------------------------------------------------------
1901         POINT ( 1.00000000 2.00000000)

1902         LINESTRING ( 33.00000000 2.00000000, 34.00000000
   3.00000000, 35.00000000 6.00000000)

1903         POLYGON (( 3.00000000 3.00000000, 5.00000000 3.00000000,
   4.00000000 6.00000000, 3.00000000 3.00000000))
```

ST_GetIndexParms

ST_GetIndexParms takes either the identifier for a spatial index or for a spatial column as an input parameter and returns the parameters used to define the index or the index on the spatial column. If an additional parameter number is specified, only the grid size identified by the number is returned.

Syntax



Parameter

index_schema
A value of type VARCHAR(128) that identifies the schema in which the spatial index with the unqualified name *index_name* is in. The schema name is case-sensitive and must be listed in the SYSCAT.SCHEMATA catalog view.

If this parameter is null, then the value of the CURRENT SCHEMA special register is used as the schema name for the spatial index.

index_name
A value of type VARCHAR(128) that contains the unqualified name of the spatial index for which the index parameters are returned. The index name is case-sensitive and must be listed in the SYSCAT.INDEXES catalog view for the schema *index_schema*.

table_schema
A value of type VARCHAR(128) that identifies the schema in which the table with the unqualified name *table_name* is in. The schema name is case-sensitive and must be listed in the SYSCAT.SCHEMATA catalog view.

If this is parameter null, then the value of the CURRENT SCHEMA special register is used as the schema name for the spatial index.

table_name
A value of type VARCHAR(128) that contains the unqualified name of the table with the spatial column *column_name*. The table name is case-sensitive and must be listed in the SYSCAT.TABLES catalog view for the schema *table_schema*.

column_name
A value of type VARCHAR(128) that identifies the column in the table *table_schema.table_name* for which the index parameters of the spatial index on that column are returned. The column name is case-sensitive and must be listed in the SYSCAT.COLUMNS catalog view for the table *table_schema.table_name*.

If there is no spatial index defined in the column, then an error is raised (SQLSTATE 38SQ0).

grid_size_number
A DOUBLE value that identifies the parameter whose value or values are to be returned.

If this value is smaller than 1 or larger than 3, then an error is raised (SQLSTATE 38SQ1).

Return type

DOUBLE (if *grid_size_number* is specified)

If *grid_size_number* is not specified, then a table with the two columns ORDINAL and VALUE is returned. The column ORDINAL is of type INTEGER, and the column VALUE is of type DOUBLE.

If the parameters are returned for a grid index, the ORDINAL column contains the values 1, 2, and 3 for the first, second, and third grid size, respectively. The column VALUE contains the grid sizes.

The VALUE column contains the respective values for each of the parameters.

Examples

Example 1

This code creates a table with a spatial column and a spatial index.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sch.offices (name VARCHAR(30), location ST_Point )

 CREATE INDEX sch.idx ON sch.offices(location)
      EXTEND USING db2gse.spatial_index(1e0, 10e0, 1000e0)
```

The ST_GetIndexParms function can be used to retrieve the values for the parameters that were used when the spatial index was created.

Example 2

This example shows how to retrieve the three grid sizes for a spatial grid index separately by explicitly specifying which parameter, identified by its number, is to be returned.

```
VALUES ST_GetIndexParms('SCH', 'OFFICES', 'LOCATION', 1)
```

Results:

```
1
------------------------
  +1.00000000000000E+000
```

```
VALUES ST_GetIndexParms('SCH', 'OFFICES', 'LOCATION', 2)
```

Results:

```
1
------------------------
  +1.00000000000000E+001
```

```
VALUES ST_GetIndexParms('SCH', 'IDX', 3)
```

Results:

```
1
------------------------
  +1.00000000000000E+003
```

Example 3

This example shows how to retrieve all the parameters of a spatial grid index. The ST_GetIndexParms function returns a table that indicates the parameter number and the corresponding grid size.

```
SELECT * FROM TABLE ( ST_GetIndexParms('SCH', 'OFFICES', 'LOCATION') ) AS t
```

Results:

```
ORDINAL     VALUE
----------- ------------------------
          1   +1.00000000000000E+000
          2   +1.00000000000000E+001
          3   +1.00000000000000E+003
```

```
SELECT * FROM TABLE ( ST_GetIndexParms('SCH', 'IDX') ) AS t
```

Results:

```
ORDINAL     VALUE
----------- ------------------------
          1   +1.00000000000000E+000
          2   +1.00000000000000E+001
          3   +1.00000000000000E+003
```

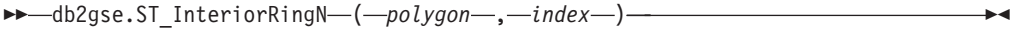
ST_InteriorRingN

ST_InteriorRingN takes a polygon and an index as input parameters and returns the interior ring identified by the given index as a linestring. The interior rings are organized according to the rules defined by the internal geometry verification routines.

If the given polygon is null or is empty, or if it does not have any interior rings, then null is returned. If the index is smaller than 1 or larger than the number of interior rings in the polygon, then null is returned and a warning condition is raised (1HS1).

This function can also be called as a method.

Syntax



Parameter

polygon
A value of type ST_Polygon that represents the geometry from which the interior ring identified by *index* is returned.

index A value of type INTEGER that identifies the *n*the interior ring that is returned. If there is no interior ring identified by *index*, then a warning condition is raised (01HS1).

Return type

db2gse.ST_Curve

Example

In this example, a polygon is created with two interior rings. The ST_InteriorRingN call is then used to retrieve the second interior ring.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys VALUES
       (1, ST_Polygon('polygon((40 120, 90 120, 90 150, 40 150, 40 120),
                      (50 130, 60 130, 60 140, 50 140, 50 130),
                      (70 130, 80 130, 80 140, 70 140, 70 130))' ,0))


SELECT id, CAST(ST_AsText(ST_InteriorRingN(geometry, 2)) as VARCHAR(180))
       Interior_Ring
FROM sample_polys
```

Results:

```
ID          INTERIOR_RING
----------- ----------------------------------------------------------------
      1 LINESTRING ( 70.00000000 130.00000000, 70.00000000 140.00000000,
80.00000000 140.00000000, 80.00000000 130.00000000, 70.00000000 130.00000000)
```

ST_Intersection

ST_Intersection takes two geometries as input parameters and returns the geometry that is the intersection of the two given geometries. The intersection is the common part of the first geometry and the second geometry. The resulting geometry is represented in the spatial reference system of the first geometry.

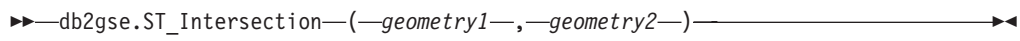
If possible, the specific type of the returned geometry will be ST_Point, ST_LineString, or ST_Polygon. For example, the intersection of a point and a polygon is either empty or a single point, represented as ST_MultiPoint.

If any of the two geometries is null, null is returned.

For non–geodetic data, if the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system. For geodetic data, both geometries must be in the same geodetic spatial reference system (SRS).

This function can also be called as a method.

Syntax



Parameter

geometry1
A value of type ST_Geometry or one of its subtypes that represents the first geometry to compute the intersection with *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the second geometry to compute the intersection with *geometry1*.

For geodetic data, both geometries must be geodetic and they both must be in the same geodetic SRS.

Return type

db2gse.ST_Geometry

The dimension of the returned geometry is that of the input with the lower dimension, except for linestrings in geodetic data. For geodetic data, the dimension of the intersection of two linestrings is 0 (in other words, the intersection is a point or multipoint).

Example

In the following examples, the results have been reformatted for readability. The spacing in your results will vary according to your display.

This example creates several different geometries and then determines the intersection (if any) with the first one.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('polygon((30 30, 30 50, 50 50, 50 30, 30 30))' ,0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('polygon((20 30, 30 30, 30 40, 20 40, 20 30))' ,0))

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('polygon((40 40, 40 60, 60 60, 60 40, 40 40))' ,0))

INSERT INTO sample_geoms VALUES
       (4, ST_Geometry('linestring(60 60, 70 70)' ,0))

INSERT INTO sample_geoms VALUES
       (5, ST_Geometry('linestring(30 30, 60 60)' ,0))

SELECT a.id, b.id, CAST(ST_AsText(ST_Intersection(a.geometry, b.geometry))
   as VARCHAR(150)) Intersection
FROM sample_geoms a, sample_geoms b
WHERE a.id = 1
```

Results:

```
ID          ID          INTERSECTION
----------- ----------- ------------------------------------------------
          1           1 POLYGON (( 30.00000000 30.00000000, 50.00000000
30.00000000, 50.00000000 50.00000000, 30.00000000 50.00000000, 30.00000000
30.00000000))

          1           2 LINESTRING ( 30.00000000 40.00000000, 30.00000000
30.00000000)

          1           3 POLYGON (( 40.00000000 40.00000000, 50.00000000
40.00000000, 50.00000000 50.00000000, 40.00000000 50.00000000, 40.00000000
40.00000000))

          1           4 POINT EMPTY

          1           5 LINESTRING ( 30.00000000 30.00000000, 50.00000000
50.00000000)

  5 record(s) selected.
```

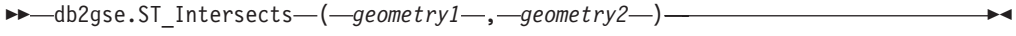
ST_Intersects

ST_Intersects takes two geometries as input parameters and returns 1 if the given geometries intersect. If the geometries do not intersect, 0 (zero) is returned.

If any of the two geometries is null or is empty, null is returned.

For non–geodetic data, if the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system. For geodetic data, both geometries must be in the same geodetic spatial reference system (SRS).

Syntax



Parameter

geometry1
A value of type ST_Geometry or one of its subtypes that represents the geometry to test for intersection with *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the geometry to test for intersection with *geometry1*.

Restrictions: For geodetic data, both geometries must be geodetic, and they both must be in the same geodetic SRS.

Return type

INTEGER

Example

The following statements create and populate the SAMPLE_GEOMETRIES1 and SAMPLE_GEOMETRIES2 tables.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries1(id SMALLINT, spatial_type varchar(13),
    geometry ST_GEOMETRY);
CREATE TABLE sample_geometries2(id SMALLINT, spatial_type varchar(13),
    geometry ST_GEOMETRY);

INSERT INTO sample_geometries1(id, spatial_type, geometry)
VALUES
    ( 1, 'ST_Point', ST_Point('point(550 150)', 1) ),
    (10, 'ST_LineString', ST_LineString('linestring(800 800, 900 800)', 1)),
    (20, 'ST_Polygon', ST_Polygon('polygon((500 100, 500 200, 700 200,
          700 100, 500 100))', 1) )

INSERT INTO sample_geometries2(id, spatial_type, geometry)
VALUES
    (101, 'ST_Point', ST_Point('point(550 150)', 1) ),
    (102, 'ST_Point', ST_Point('point(650 200)', 1) ),
    (103, 'ST_Point', ST_Point('point(800 800)', 1) ),
    (110, 'ST_LineString', ST_LineString('linestring(850 250, 850 850)', 1)),
    (120, 'ST_Polygon', ST_Polygon('polygon((650 50, 650 150, 800 150,
           800 50, 650 50))', 1)),
    (121, 'ST_Polygon', ST_Polygon('polygon((20 20, 20 40, 40 40, 40 20,
           20 20))', 1) )
```

The following SELECT statement determines whether the various geometries in the SAMPLE_GEOMTRIES1 and SAMPLE_GEOMTRIES2 tables intersect.

```
SELECT   sg1.id AS sg1_id, sg1.spatial_type AS sg1_type,
         sg2.id AS sg2_id, sg2.spatial_type AS sg2_type,
         CASE ST_Intersects(sg1.geometry, sg2.geometry)
            WHEN 0 THEN 'Geometries do not intersect'
            WHEN 1 THEN 'Geometries intersect'
         END AS intersects
FROM     sample_geometries1 sg1, sample_geometries2 sg2
ORDER BY sg1.id
```

Results:

```
SG1_ID SG1_TYPE      SG2_ID SG2_TYPE      INTERSECTS
------ ------------- ------ ------------- --------------------------
     1 ST_Point         101 ST_Point      Geometries intersect
     1 ST_Point         102 ST_Point      Geometries do not intersect
```

```
 1 ST_Point         103 ST_Point      Geometries do not intersect
 1 ST_Point         110 ST_LineString Geometries do not intersect
 1 ST_Point         120 ST_Polygon    Geometries do not intersect
 1 ST_Point         121 ST_Polygon    Geometries do not intersect
10 ST_LineString    101 ST_Point      Geometries do not intersect
10 ST_LineString    102 ST_Point      Geometries do not intersect
10 ST_LineString    103 ST_Point      Geometries intersect
10 ST_LineString    110 ST_LineString Geometries intersect
10 ST_LineString    120 ST_Polygon    Geometries do not intersect
10 ST_LineString    121 ST_Polygon    Geometries do not intersect
20 ST_Polygon       101 ST_Point      Geometries intersect
20 ST_Polygon       102 ST_Point      Geometries intersect
20 ST_Polygon       103 ST_Point      Geometries do not intersect
20 ST_Polygon       110 ST_LineString Geometries do not intersect
20 ST_Polygon       120 ST_Polygon    Geometries intersect
20 ST_Polygon       121 ST_Polygon    Geometries do not intersect
```

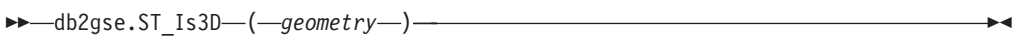
ST_Is3d

ST_Is3d takes a geometry as an input parameter and returns 1 if the given geometry has Z coordinates. Otherwise, 0 (zero) is returned.

If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that is to be tested for the existence of Z coordinates.

Return type

INTEGER

Example

In this example, several geometries are created with and without Z coordinates and M coordinates (measures). ST_Is3d is then used to determine which of them contain Z coordinates.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('point EMPTY',0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('polygon((40 120, 90 120, 90 150, 40 150, 40 120))' ,0))

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('multipoint m (10 10 5, 50 10 6, 10 30 8)' ,0))

INSERT INTO sample_geoms VALUES
       (4, ST_Geometry('linestring z (10 10 166, 20 10 168)',0))
```

```
INSERT INTO sample_geoms VALUES
       (5, ST_Geometry('point zm (10 10 16 30)' ,0))


SELECT id, ST_Is3d(geometry)  Is_3D
FROM sample_geoms
```

Results:

```
ID          IS_3D
----------- -----------
          1           0
          2           0
          3           0
          4           1
          5           1
```

ST_IsClosed

ST_IsClosed takes a curve or multicurve as an input parameter and returns 1 if the given curve or multicurve is closed. Otherwise, 0 (zero) is returned.

A curve is closed if the start point and end point are equal. If the curve has Z coordinates, the Z coordinates of the start and end point must be equal. Otherwise, the points are not considered equal, and the curve is not closed. A multicurve is closed if each of its curves are closed.

If the given curve or multicurve is empty, then 0 (zero) is returned. If it is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

curve A value of type ST_Curve or ST_MultiCurve or one of their subtypes that represent the curve or multicurve that is to be tested.

Return type

INTEGER

Examples

Example 1

This example creates several linestrings. The last two linestrings have the same X and Y coordinates, but one linestring contains varying Z coordinates that cause the linestring to not be closed, and the other linestring contains varying M coordinates (measures) that do not affect whether the linestring is closed.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines (id INTEGER, geometry ST_Linestring)

INSERT INTO sample_lines VALUES
```

```
       (1, ST_Linestring('linestring EMPTY',0))

INSERT INTO sample_lines VALUES
       (2, ST_Linestring('linestring(10 10, 20 10, 20 20)' ,0))

INSERT INTO sample_lines VALUES
       (3, ST_Linestring('linestring(10 10, 20 10, 20 20, 10 10)' ,0))

INSERT INTO sample_lines VALUES
       (4, ST_Linestring('linestring m(10 10 1, 20 10 2, 20 20 3,
        10 10 4)' ,0))

INSERT INTO sample_lines VALUES
       (5, ST_Linestring('linestring z(10 10 5, 20 10 6, 20 20 7,
        10 10 8)' ,0))

SELECT id, ST_IsClosed(geometry)  Is_Closed
FROM sample_lines
```

Results:

```
ID          IS_CLOSED
----------- -----------
          1           0
          2           0
          3           1
          4           1
          5           0
```

Example 2

In this example, two multilinestrings are created. ST_IsClosed is used to determine if the multilinestrings are closed. The first one is not closed, even though all of the curves together form a complete closed loop. This is because each curve itself is not closed.

The second multilinestring is closed because each curve itself is closed.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mlines (id INTEGER, geometry ST_MultiLinestring)
INSERT INTO sample_mlines VALUES
       (6, ST_MultiLinestring('multilinestring((10 10, 20 10, 20 20),
                                               (20 20, 30 20, 30 30),
                                               (30 30, 10 30, 10 10))',0))

INSERT INTO sample_mlines VALUES
       (7, ST_MultiLinestring('multilinestring((10 10, 20 10, 20 20, 10 10 ),
                                                (30 30, 50 30, 50 50,
                                                 30 30 ))',0))

SELECT id, ST_IsClosed(geometry)  Is_Closed
FROM sample_mlines
```

Results:

```
ID          IS_CLOSED
----------- -----------
          6           0
          7           1
```

ST_IsEmpty

ST_IsEmpty takes a geometry as an input parameter and returns 1 if the given geometry is empty. Otherwise 0 (zero) is returned.

If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that is to be tested.

Return type

INTEGER

Example

The following code creates three geometries and then determines if they are empty.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('point EMPTY',0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('polygon((40 120, 90 120, 90 150, 40 150, 40 120))' ,0))

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('multipoint m (10 10 5, 50 10 6, 10 30 8)' ,0))

INSERT INTO sample_geoms VALUES
       (4, ST_Geometry('linestring z (10 10 166, 20 10 168)',0))

INSERT INTO sample_geoms VALUES
       (5, ST_Geometry('point zm (10 10 16 30)' ,0))

SELECT id, ST_IsEmpty(geometry)  Is_Empty
FROM sample_geoms
```

Results:

```
ID          IS_EMPTY
----------- -----------
          1           1
          2           0
          3           0
          4           0
          5           0
```

ST_IsMeasured

ST_IsMeasured takes a geometry as an input parameter and returns 1 if the given geometry has M coordinates (measures). Otherwise 0 (zero) is returned.

If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry to be tested for the existence of M coordinates (measures).

Return type

INTEGER

Example

In this example, several geometries are created with and without Z coordinates and M coordinates (measures). ST_IsMeasured is then used to determine which of them contained measures.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('point EMPTY',0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('polygon((40 120, 90 120, 90 150, 40 150, 40 120))' ,0))

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('multipoint m (10 10 5, 50 10 6, 10 30 8)' ,0))

INSERT INTO sample_geoms VALUES
       (4, ST_Geometry('linestring z (10 10 166, 20 10 168)',0))

INSERT INTO sample_geoms VALUES
       (5, ST_Geometry('point zm (10 10 16 30)' ,0))


SELECT id, ST_IsMeasured(geometry)  Is_Measured
FROM sample_geoms
```

Results:

```
ID          IS_MEASURED
----------- -----------
          1           0
          2           0
          3           1
          4           0
          5           1
```

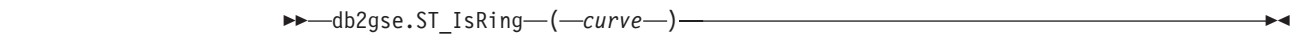
ST_IsRing

ST_IsRing takes a curve as an input parameter and returns 1 if it is a ring. Otherwise, 0 (zero) is returned. A curve is a ring if it is simple and closed.

If the given curve is empty, then 0 (zero) is returned. If it is null, then null is returned.

This function can also be called as a method.

Syntax



Parameter

curve A value of type ST_Curve or one of its subtypes that represents the curve to be tested.

Return type

INTEGER

Examples

In this example, four linestrings are created. ST_IsRing is used to check if they are rings. The last one is not considered a ring even though it is closed because the path crosses over itself.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines (id INTEGER, geometry ST_Linestring)

INSERT INTO sample_lines VALUES
       (1, ST_Linestring('linestring EMPTY',0))

INSERT INTO sample_lines VALUES
       (2, ST_Linestring('linestring(10 10, 20 10, 20 20)' ,0))

INSERT INTO sample_lines VALUES
       (3, ST_Linestring('linestring(10 10, 20 10, 20 20, 10 10)' ,0))

INSERT INTO sample_lines VALUES
       (4, ST_Linestring('linestring(10 10, 20 10, 10 20, 20 20, 10 10)' ,0))


SELECT id, ST_IsClosed(geometry) Is_Closed, ST_IsRing(geometry)  Is_Ring
FROM sample_lines
```

Results:

```
ID          IS_CLOSED   IS_RING
----------- ----------- -----------
          1           1           0
          2           0           0
          3           1           1
          4           1           0
```

ST_IsSimple

ST_IsSimple takes a geometry as an input parameter and returns 1 if the given geometry is simple. Otherwise, 0 (zero) is returned.

Points, surfaces, and multisurfaces are always simple. A curve is simple if it does not pass through the same point twice; a multipoint is simple if it does not contain two equal points; and a multicurve is simple if all of its curves are simple and the only intersections occur at points that are on the boundary of the curves in the multicurve.

If the given geometry is empty, then 1 is returned. If it is null, null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry to be tested.

Return type

INTEGER

Examples

In this example, several geometries are created and checked if they are simple. The geometry with an ID of 4 is not considered simple because it contains more than one point that is the same. The geometry with an ID of 6 is not considered simple because the linestring crosses over itself.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('point EMPTY' ,0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('point (21 33)' ,0))

INSERT INTO sample_geoms VALUES
       (3, ST_Geometry('multipoint(10 10, 20 20, 30 30)' ,0))

INSERT INTO sample_geoms VALUES
       (4, ST_Geometry('multipoint(10 10, 20 20, 30 30, 20 20)' ,0))

INSERT INTO sample_geoms VALUES
       (5, ST_Geometry('linestring(60 60, 70 60, 70 70)' ,0))

INSERT INTO sample_geoms VALUES
       (6, ST_Geometry('linestring(20 20, 30 30, 30 20, 20 30  )' ,0))

INSERT INTO sample_geoms VALUES
```

```
       (7, ST_Geometry('polygon((40 40, 50 40, 50 50, 40 40  ))' ,0))

SELECT id, ST_IsSimple(geometry) Is_Simple
FROM sample_geoms
```

Results:

```
ID          IS_SIMPLE
----------- -----------
          1           1
          2           1
          3           1
          4           0
          5           1
          6           0
          7           1
```

ST_IsValid

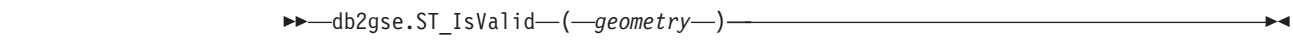
ST_IsValid takes a geometry as an input parameter and returns 1 if it is valid. Otherwise 0 (zero) is returned.

A geometry is valid only if all of the attributes in the structured type are consistent with the internal representation of geometry data, and if the internal representation is not corrupted.

If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes.

Return type

INTEGER

Example

This example creates several geometries and uses ST_IsValid to check if they are valid. All of the geometries are valid because the constructor routines, such as ST_Geometry, do not allow invalid geometries to be constructed.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms VALUES
       (1, ST_Geometry('point EMPTY',0))

INSERT INTO sample_geoms VALUES
       (2, ST_Geometry('polygon((40 120, 90 120, 90 150, 40 150, 40 120))' ,0))

INSERT INTO sample_geoms VALUES
```

```
       (3, ST_Geometry('multipoint m (10 10 5, 50 10 6, 10 30 8)' ,0))

INSERT INTO sample_geoms VALUES
       (4, ST_Geometry('linestring z (10 10 166, 20 10 168)',0))

INSERT INTO sample_geoms VALUES
       (5, ST_Geometry('point zm (10 10 16 30)' ,0))


SELECT id, ST_IsValid(geometry)  Is_Valid
FROM sample_geoms
```

Results:

```
ID          IS_VALID
----------- -----------
          1           1
          2           1
          3           1
          4           1
          5           1
```

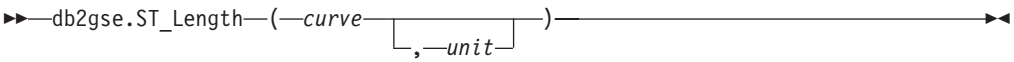
ST_Length

ST_Length takes a curve or multicurve and, optionally, a unit as input parameters and returns the length of the given curve or multicurve in the default or given unit of measure.

If the given curve or multicurve is null or is empty, null is returned.

This function can also be called as a method.

Syntax



Parameter

curve A value of type ST_Curve or ST_MultiCurve that represents the curves for which the length is returned.

unit A VARCHAR(128) value that identifies the units in which the length of the curve is measured. The supported units of measure are listed in the DB2GSE.ST_UNITS_OF_MEASURE catalog view.

If the *unit* parameter is omitted, the following rules are used to determine the unit in which the length is measured:

- If *curve* is in a projected or geocentric coordinate system, the linear unit associated with this coordinate system is the default.
- If *curve* is in a geographic coordinate system, but is not in a geodetic spatial reference system (SRS), the angular unit associated with this coordinate system is the default.
- If *curve* is in a geodetic SRS, the default unit of measure is meters.

Restrictions on unit conversions: An error (SQLSTATE 38SU4) is returned if any of the following conditions occur:

- The *curve* is in an unspecified coordinate system and the *unit* parameter is specified.
- The *curve* is in a projected coordinate system and an angular unit is specified.
- The *curve* is in a geographic coordinate system, but is not in a geodetic SRS, and a linear unit is specified.
- The *curve* is in a geodetic SRS and an angular unit is specified.

Return type

DOUBLE

Examples

Example 1

The following SQL statements create a table SAMPLE_GEOMETRIES and insert a line and a multiline into the table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_geometries(id SMALLINT, spatial_type varchar(20),
    geometry ST_GEOMETRY)

INSERT INTO sample_geometries(id, spatial_type, geometry)
VALUES
    (1110, 'ST_LineString', ST_LineString('linestring(50 10, 50 20)', 1)),
    (1111, 'ST_MultiLineString', ST_MultiLineString('multilinestring
                            ((33 2, 34 3, 35 6),
                            (28 4, 29 5, 31 8, 43 12),
                            (39 3, 37 4, 36 7))', 1))
```

Example 2

The following SELECT statement calculates the length of the line in the SAMPLE_GEOMTRIES table.

```
SELECT id, spatial_type, cast(ST_Length(geometry..ST_ToLineString)
   AS DECIMAL(7, 2)) AS "Line Length"
FROM   sample_geometries
WHERE  id = 1110
```

Results:

```
ID     SPATIAL_TYPE         Line Length
------ -------------------- -----------
  1110 ST_LineString              10.00
```

Example 3

The following SELECT statement calculates the length of the multiline in the SAMPLE_GEOMTRIES table.

```
SELECT id, spatial_type, ST_Length(ST_ToMultiLine(geometry))
   AS multiline_length
FROM   sample_geometries
WHERE  id = 1111
```

Results:

```
ID     SPATIAL_TYPE         MULTILINE_LENGTH
 ------ -------------------- ------------------------
   1111 ST_MultiLineString     +2.76437123387202E+001
```

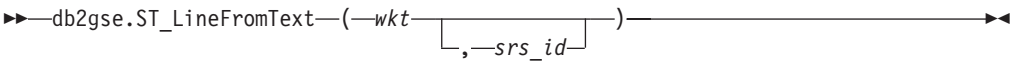
ST_LineFromText

ST_LineFromText takes a well-known text representation of a linestring and, optionally, a spatial reference system identifier as input parameters and returns the corresponding linestring.

If the given well-known text representation is null, then null is returned.

The preferred version for this functionality is ST_LineString.

Syntax



Parameter

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting linestring.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting linestring.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

Return type

db2gse.ST_LineString

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code uses the ST_LineFromText function to create and insert a line from a well-known text (WKT) line representation. The rows are inserted into the SAMPLE_LINES table with an ID and a line value in spatial reference system 1 in WKT representation.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_lines(id SMALLINT, geometry ST_LineString)

INSERT INTO sample_lines(id, geometry)
VALUES
    (1110, ST_LineFromText('linestring(850 250, 850 850)', 1) ),
    (1111, ST_LineFromText('linestring empty', 1) )

SELECT id, cast(geometry..ST_AsText AS varchar(75)) AS linestring
FROM   sample_lines
```

Results:

```
ID     LINESTRING
------ ------------------------------------------------------------------
  1110 LINESTRING ( 850.00000000 250.00000000, 850.00000000 850.00000000)
  1111 LINESTRING EMPTY
```

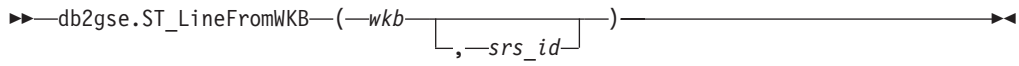
ST_LineFromWKB

ST_LineFromWKB takes a well-known binary representation of a linestring and, optionally, a spatial reference system identifier as input parameters and returns the corresponding linestring.

If the given well-known binary representation is null, then null is returned.

The preferred version for this functionality is ST_LineString.

Syntax



Parameter

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting linestring.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting linestring.

If the ***srs_id*** parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

Return type

db2gse.ST_LineString

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The following code uses the ST_LineFromWKB function to create and insert a line from a well-known binary representation. The row is inserted into the SAMPLE_LINES table with an ID and a line in spatial reference system 1 in WKB representation.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_lines(id SMALLINT, geometry ST_LineString, wkb BLOB(32k))

INSERT INTO sample_lines(id, geometry)
VALUES
    (1901, ST_LineString('linestring(850 250, 850 850)', 1) ),
    (1902, ST_LineString('linestring(33 2, 34 3, 35 6)', 1) )

UPDATE sample_lines AS temp_correlated
SET    wkb = geometry..ST_AsBinary
```

```
WHERE  id = temp_correlated.id

SELECT id, cast(ST_LineFromWKB(wkb)..ST_AsText AS varchar(90)) AS line
FROM   sample_lines
```

Results:

```
ID     LINE
------ ------------------------------------------------------------------
  1901 LINESTRING ( 850.00000000 250.00000000, 850.00000000 850.00000000)

  1902 LINESTRING ( 33.00000000 2.00000000, 34.00000000 3.00000000,
35.00000000 6.00000000)
```

ST_LineString

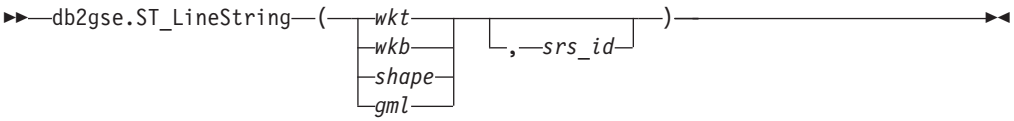
ST_LineString constructs a linestring from one of the following inputs:

- A well-known text representation
- A well-known binary representation
- An ESRI shape representation
- A representation in the geography markup language (GML)

A spatial reference system identifier can be provided optionally to identify the spatial reference system that the resulting linestring is in.

If the well-known text representation, the well-known binary representation, the ESRI shape representation, or the GML representation is null, then null is returned.

Syntax



Parameter

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting polygon.

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting polygon.

shape A value of type BLOB(2G) that represents the ESRI shape representation of the resulting polygon.

gml A value of type CLOB(2G) that represents the resulting polygon using the geography markup language (GML).

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting polygon.

If the *srs_id* parameter is omitted, then the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an error is returned (SQLSTATE 38SU1).

Return type

db2gse.ST_LineString

Examples

The following code uses the ST_LineString function to create and insert a line from a well-known text (WKT) line representation or from a well-known binary (WKB) representation.

The following example inserts a row into the SAMPLE_LINES table with an ID and line in spatial reference system 1 in WKT and GML representation

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_lines(id SMALLINT, geometry ST_LineString)

INSERT INTO sample_lines(id, geometry)
VALUES
    (1110, ST_LineString('linestring(850 250, 850 850)', 1) ),
    (1111, ST_LineString('<gml:LineString srsName=";EPSG:4269";><gml:coord>
                          <gml:X>90</gml:X><gml:Y>90</gml:Y>
                          </gml:coord><gml:coord><gml:X>100</gml:X>
                          <gml:Y>100</gml:Y></gml:coord>
                          </gml:LineString>', 1) )

SELECT id, cast(geometry..ST_AsText AS varchar(75)) AS linestring
FROM   sample_lines
```

Results:

```
ID     LINESTRING
------ ---------------------------------------------------------------------
  1110 LINESTRING ( 850.00000000 250.00000000, 850.00000000 850.00000000)
  1111 LINESTRING ( 90.00000000 90.00000000, 100.00000000 100.00000000)
```

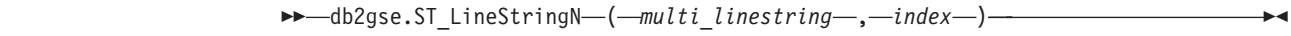
ST_LineStringN

ST_LineStringN takes a multilinestring and an index as input parameters and returns the linestring that is identified by the index. The resulting linestring is represented in the spatial reference system of the given multilinestring.

If the given multilinestring is null or is empty, or if the index is smaller than 1 or larger than the number of linestrings, then null is returned.

This function can also be called as a method.

Syntax



Parameter

multi_linestring
A value of type ST_MultiLineString that represents the multilinestring from which the linestring that is identified by *index* is returned.

index A value of type INTEGER that identifies the *n*th linestring, which is to be returned from *multi_linestring*.

If *index* is smaller than 1 or larger than the number of linestrings in *multi_linestring*, then null is returned and a warning condition is returned (SQLSTATE 01HS0).

Return type

db2gse.ST_LineString

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The SELECT statement illustrates how to choose the second geometry inside a multilinestring in the SAMPLE_MLINES table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

CREATE TABLE sample_mlines (id INTEGER,
  geometry ST_MULTILINESTRING)

INSERT INTO sample_mlines(id, geometry)
VALUES
    (1110, ST_MultiLineString('multilinestring
                              ((33 2, 34 3, 35 6),
                              (28 4, 29 5, 31 8, 43 12),
                              (39 3, 37 4, 36 7))', 1) ),
    (1111, ST_MLineFromText('multilinestring(
                            (61 2, 64 3, 65 6),
                            (58 4, 59 5, 61 8),
                            (69 3, 67 4, 66 7, 68 9))', 1) )

SELECT id, cast(ST_LineStringN(geometry, 2)..ST_AsText
  AS varchar(110)) AS second_linestring
FROM   sample_mlines
```

Results:

```
ID          SECOND_LINESTRING
----------- ----------------------------------------------------------------
1110         LINESTRING ( 28.00000000 4.00000000, 29.00000000
   5.00000000, 31.00000000 8.00000000, 43.00000000 12.00000000)

1111         LINESTRING ( 58.00000000 4.00000000, 59.00000000
   5.00000000, 61.00000000 8.00000000)
```

ST_M

ST_M can either:

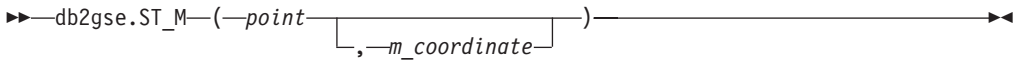
- Take a point as an input parameter and return its M (measure) coordinate
- Take a point and an M coordinate and return the point itself with its M coordinate set to the given measure, even if the specified point has no existing M coordinate.

If the specified M coordinate is null, then the M coordinate of the point is removed.

If the specified point is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameters

point A value of type ST_Point for which the M coordinate is returned or modified.

m_coordinate
A value of type DOUBLE that represents the new M coordinate for *point*.

If *m_coordinate* is null, then the M coordinate is removed from *point*.

Return types

- DOUBLE, if *m_coordinate* is not specified
- db2gse.ST_Point, if *m_coordinate* is specified

Examples

Example 1

This example illustrates the use of the ST_M function. Three points are created and inserted into the SAMPLE_POINTS table. They are all in the spatial reference system that has an ID of 1.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point)

INSERT INTO sample_points
  VALUES (1, ST_Point (2, 3, 32, 5, 1))

INSERT INTO sample_points
  VALUES (2, ST_Point (4, 5, 20, 4, 1))

INSERT INTO sample_points
  VALUES (3, ST_Point (3, 8, 23, 7, 1))
```

Example 2

This example finds the M coordinate of the points in the SAMPLE_POINTS table.

```
SELECT id, ST_M (geometry) M_COORD
  FROM sample_points
```

Results:

```
ID          M_COORD
----------- ------------------------
          1 +5.00000000000000E+000
          2 +4.00000000000000E+000
          3 +7.00000000000000E+000
```

Example 3

This example returns one of the points with its M coordinate set to 40.

```
SELECT id, CAST (ST_AsText (ST_M (geometry, 40) )
  AS VARCHAR(60) ) M_COORD_40
  FROM sample_points
  WHERE id=3
```

Results:

```
ID         M_COORD_40
---------- ----------------------------------------------------
         3 POINT ZM (3.00000000 8.00000000 23.00000000 40.00000000)
```

ST_MaxM

ST_MaxM takes a geometry as an input parameter and returns its maximum M coordinate.

If the given geometry is null or is empty, or if it does not have M coordinates, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes for which the maximum M coordinate is returned.

Return type

DOUBLE

Examples

Example 1

This example illustrates the use of the ST_MaxM function. Three polygons are created and inserted into the SAMPLE_POLYS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon('polygon zm ((110 120 20 3,
                                      110 140 22 3,
                                      120 130 26 4,
                                      110 120 20 3))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon('polygon zm ((0 0 40 7,
                                      0 4 35 9,
                                      5 4 32 12,
                                      5 0 31 5,
                                      0 0 40 7))', 0) )

INSERT INTO sample_polys
  VALUES (3, ST_Polygon('polygon zm ((12 13 10 16,
                                      8 4 10 12,
                                      9 4 12 11,
                                      12 13 10 16))', 0) )
```

Example 2

This example finds the maximum M coordinate of each polygon in SAMPLE_POLYS.

```
SELECT id, CAST ( ST_MaxM(geometry) AS INTEGER) MAX_M
  FROM sample_polys
```

Results:

```
ID          MAX_M
----------- ------------
          1            4
          2           12
          3           16
```

Example 3

This example finds the maximum M coordinate that exists for all polygons in the GEOMETRY column.

```
SELECT CAST ( MAX ( ST_MaxM(geometry) ) AS INTEGER) OVERALL_MAX_M
  FROM sample_polys
```

Results:

```
OVERALL_MAX_M
-------------
           16
```

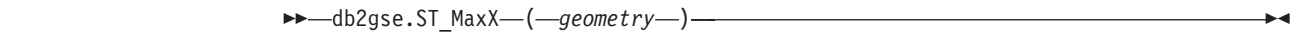
ST_MaxX

ST_MaxX takes a geometry as an input parameter and returns its maximum X coordinate.

If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes for which the maximum X coordinate is returned.

Return type

DOUBLE

Examples

Example 1

This example illustrats the use of the ST_MaxX function. Three polygons are created and inserted into the SAMPLE_POLYS table. The third example illustrates

how you can use all of the functions that return the maximum and minimum coordinate values to assess the spatial range of the geometries that are stored in a particular spatial column.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon('polygon zm ((110 120 20 3,
                                      110 140 22 3,
                                      120 130 26 4,
                                      110 120 20 3))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon('polygon zm ((0 0 40 7,
                                      0 4 35 9,
                                      5 4 32 12,
                                      5 0 31 5,
                                      0 0 40 7))', 0) )

INSERT INTO sample_polys
  VALUES (3, ST_Polygon('polygon zm ((12 13 10 16,
                                      8 4 10 12,
                                      9 4 12 11,
                                      12 13 10 16))', 0) )
```

Example 2

This example finds the maximum X coordinate of each polygon in SAMPLE_POLYS.

```
SELECT id, CAST ( ST_MaxX(geometry) AS INTEGER) MAX_X_COORD
  FROM sample_polys
```

Results:

```
ID          MAX_X_COORD
----------- ------------
          1          120
          2            5
          3           12
```

Example 3

This example finds the maximum X coordinate that exists for all polygons in the GEOMETRY column.

```
SELECT CAST ( MAX ( ST_MaxX(geometry) ) AS INTEGER) OVERALL_MAX_X
  FROM sample_polys
```

Results:

```
OVERALL_MAX_X
-------------
          120
```

Example 4

This example finds the spatial extent (overall minimum to overall maximum) of all the polygons in the SAMPLE_POLYS table. This calculation is typically used to compare the actual spatial extent of the geometries to the spatial extent of the spatial reference system associated with the data to determine if the data has room to grow.

```
SELECT CAST ( MIN (ST_MinX (geometry)) AS INTEGER) MIN_X,
       CAST ( MIN (ST_MinY (geometry)) AS INTEGER) MIN_Y,
       CAST ( MIN (ST_MinZ (geometry)) AS INTEGER) MIN_Z,
       CAST ( MIN (ST_MinM (geometry)) AS INTEGER) MIN_M,
       CAST ( MAX (ST_MaxX (geometry)) AS INTEGER) MAX_X,
       CAST ( MAX (ST_MaxY (geometry)) AS INTEGER) MAX_Y,
       CAST ( MAX (ST_MaxZ (geometry)) AS INTEGER) MAX_Z,
       CAST ( MAX (ST_MaxmM(geometry)) AS INTEGER) MAX_M,
  FROM sample_polys
```

Results:

```
MIN_X     MIN_Y     MIN_Z     MIN_M     MAX_X     MAX_Y     MAX_Z     MAX_M
--------- --------- --------- --------- --------- --------- --------- ----------
        0         0        10         3       120       140        40         16
```

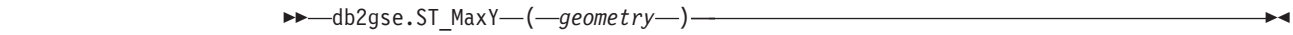
ST_MaxY

ST_MaxY takes a geometry as an input parameter and returns its maximum Y coordinate.

If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes for which the maximum Y coordinate is returned.

Return type

DOUBLE

Examples

Example 1

This example illustrates the use of the ST_MaxY function. Three polygons are created and inserted into the SAMPLE_POLYS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon('polygon zm ((110 120 20 3,
                                      110 140 22 3,
                                      120 130 26 4,
                                      110 120 20 3))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon('polygon zm ((0 0 40 7,
                                      0 4 35 9,
                                      5 4 32 12,
                                      5 0 31 5,
                                      0 0 40 7))', 0) )
```

```
INSERT INTO sample_polys
  VALUES (3, ST_Polygon('polygon zm ((12 13 10 16,
                                      8 4 10 12,
                                      9 4 12 11,
                                      12 13 10 16))', 0) )
```

Example 2

This example finds the maximum Y coordinate of each polygon in SAMPLE_POLYS.

```
SELECT id, CAST ( ST_MaxY(geometry) AS INTEGER) MAX_Y
  FROM sample_polys
```

Results:

```
ID          MAX_Y
----------- ------------
          1          140
          2            4
          3           13
```

Example 3

This example finds the maximum Y coordinate that exists for all polygons in the GEOMETRY column.

```
SELECT CAST ( MAX ( ST_MaxY(geometry) ) AS INTEGER) OVERALL_MAX_Y
  FROM sample_polys
```

Results:

```
OVERALL_MAX_Y
--------------
           140
```

ST_MaxZ

ST_MaxZ takes a geometry as an input parameter and returns its maximum Z coordinate.

If the given geometry is null or is empty, or if it does not have Z coordinates, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes for which the maximum Z coordinate is returned.

Return type

DOUBLE

Examples

Example 1

This example illustrates the use of the ST_MaxZ function. Three polygons are created and inserted into the SAMPLE_POLYS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon('polygon zm ((110 120 20 3,
                                      110 140 22 3,
                                      120 130 26 4,
                                      110 120 20 3))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon('polygon zm ((0 0 40 7,
                                      0 4 35 9,
                                      5 4 32 12,
                                      5 0 31 5,
                                      0 0 40 7))', 0) )

INSERT INTO sample_polys
  VALUES (3, ST_Polygon('polygon zm ((12 13 10 16,
                                      8 4 10 12,
                                      9 4 12 11,
                                      12 13 10 16))', 0) )
```

Example 2

This example finds the maximum Z coordinate of each polygon in SAMPLE_POLYS.

```
SELECT id, CAST ( ST_MaxZ(geometry) AS INTEGER) MAX_Z
  FROM sample_polys
```

Results:

```
ID          MAX_Z
----------- -----------
          1          26
          2          40
          3          12
```

Example 3

This example finds the maximum Z coordinate that exists for all polygons in the GEOMETRY column.

```
SELECT CAST ( MAX ( ST_MaxZ(geometry) ) AS INTEGER) OVERALL_MAX_Z
  FROM sample_polys
```

Results:

```
OVERALL_MAX_Z
-------------
           40
```

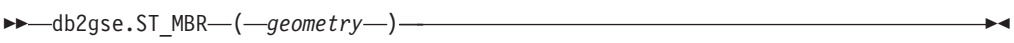
ST_MBR

ST_MBR takes a geometry as an input parameter and returns its minimum bounding rectangle.

If the given geometry is a point, then the point itself is returned. If the geometry is a horizontal linestring or a vertical linestring and the spatial reference system is non-geodetic, the horizontal or vertical linestring itself is returned. Otherwise, the minimum bounding rectangle of the geometry is returned as a polygon. If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry for which the minimum bounding rectangle is returned.

Return type

db2gse.ST_Geometry

Example

This example illustrates how the ST_MBR function can be used to return the minimum bounding rectangle of a polygon. Because the specified geometry is a polygon, the minimum bounding rectangle is returned as a polygon.

In the following examples, the lines of results have been reformatted here for readability. The spacing in your results will vary according to your online display.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon ('polygon (( 5 5, 7 7, 5 9, 7 9, 9 11, 13 9,
                                     15 9, 13 7, 15 5, 9 6, 5 5))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon ('polygon (( 20 30, 25 35, 30 30, 20 30))', 0) )

SELECT id, CAST (ST_AsText ( ST_MBR(geometry)) AS VARCHAR(150) ) MBR
  FROM sample_polys
```

Results:

```
ID        MBR
--------- ------------------------------------------------------------
        1 POLYGON (( 5.00000000 5.00000000, 15.00000000 5.00000000,
             15.00000000 11.00000000, 5.00000000 11.00000000,
              5.00000000 5.00000000))
        2 POLYGON (( 20.00000000 30.00000000, 30.00000000 30.00000000,
             30.00000000 35.00000000, 20.00000000 35.00000000,
             20.00000000 30.00000000 ))
```

ST_MBRIntersects

ST_MBRIntersects takes two geometries as input parameters and returns 1 if the minimum bounding rectangles of the two geometries intersect. Otherwise, 0 (zero) is returned. The minimum bounding rectangle of a point and a horizontal or vertical linestring is the geometry itself.

If the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system.

If either of the given geometries is null or is empty, then null is returned.

Syntax

Parameters

geometry1
A value of type ST_Geometry or one of its subtypes that represents the geometry whose minimum bounding rectangle is to be tested for intersection with the minimum bounding rectangle of *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the geometry whose minimum bounding rectangle is to be tested for intersection with the minimum bounding rectangle of *geometry1*.

Return type

INTEGER

Examples

Example 1

This example illustrates the use of ST_MBRIntersects to get an approximation of whether two nonintersecting polygons are close to each other by seeing if their minimum bounding rectangles intersect. The first example uses the SQL CASE expression. The second example uses a single SELECT statement to find those polygons that intersect the minimum bounding rectangle of the polygon with ID = 2.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon ('polygon (( 0 0, 30 0, 40 30, 40 35,
                                     5 35, 5 10, 20 10, 20 5, 0 0 ))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon ('polygon (( 15 15, 15 20, 60 20, 60 15,
                                     15 15 ))', 0) )

INSERT INTO sample_polys
  VALUES (3, ST_Polygon ('polygon (( 115 15, 115 20, 160 20, 160 15,
                                     115 15 ))', 0) )
```

Example 2

The following SELECT statement uses a CASE expression to find the IDs of the polygons that have minimum bounding rectangles that intersect.

```
SELECT a.id, b.id,
    CASE ST_MBRIntersects (a.geometry, b.geometry)
      WHEN 0 THEN 'MBRs do not intersect'
      WHEN 1 THEN 'MBRs intersect'
    END AS MBR_INTERSECTS
  FROM  sample_polys a, sample_polys b
  WHERE a.id <= b.id
```

Results:

```
ID        ID        MBR_INTERSECTS
--------- --------- --------------
        1         1 MBRs intersect
        1         2 MBRs intersect
        2         2 MBRs intersect
        1         3 MBRs do not intersect
        2         3 MBRs do not intersect
        3         3 MBRs intersect
```

Example 3

The following SELECT statement determines whether the minimum bounding rectangles for the geometries intersect that for the polygon with ID = 2.

```
SELECT a.id, b.id, ST_MBRIntersects (a.geometry, b.geometry) MBR_INTERSECTS
  FROM sample_polys a, sample_polys b
  WHERE a.id = 2
```

Results

```
ID         ID           MBR_INTERSECTS
---------- ------------ ---------------
         2            1               1
         2            2               1
         2            3               0
```

ST_MeasureBetween, ST_LocateBetween

ST_MeasureBetween or ST_LocateBetween takes a geometry and two M coordinates (measures) as input parameters and returns that part of the given geometry that represents the set of disconnected paths or points between the two M coordinates.

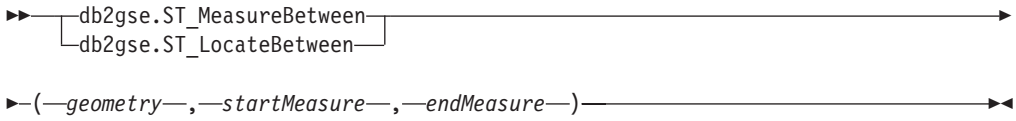
For curves, multicurves, surfaces, and multisurfaces, interpolation is performed to compute the result. The resulting geometry is represented in the spatial reference system of the given geometry.

If the given geometry is a surface or multisurface, then ST_MeasureBetween or ST_LocateBetween will be applied to the exterior and interior rings of the geometry. If none of the parts of the given geometry are in the interval defined by the given M coordinates, then an empty geometry is returned. If the given geometry is null , then null is returned.

If the resulting geometry is not empty, a multipoint or multilinestring type is returned.

Both functions can also be called as methods.

Syntax



Parameters

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry in which those parts with measure values between *startMeasure* to *endMeasure* are to be found.

startMeasure
A value of type DOUBLE that represents the lower bound of the measure interval. If this value is null, no lower bound is applied.

endMeasure
A value of type DOUBLE that represents the upper bound of the measure interval. If this value is null, no upper bound is applied.

Return type

db2gse.ST_Geometry

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

The M coordinate (measure) of a geometry is defined by the user. It is very versatile because it can represent anything that you want to measure; for example, distance along a highway, temperature, pressure, or pH measurements.

This example illustrates the use of the M coordinate to record collected data of pH measurements. A researcher collects the pH of the soil along a highway at specific places. Following his standard operating procedures, he writes down the values that he needs at every place at which he takes a soil sample: the X and Y coordinates of that place and the pH that he measures.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines (id INTEGER, geometry ST_LineString)

INSERT INTO sample_lines
  VALUES (1, ST_LineString ('linestring m (2 2 3, 3 5 3,
                                           3 3 6, 4 4 6,
                                           5 5 6, 6 6 8)', 1 ) )
```

To find the path where the acidity of the soil varies between 4 and 6, the researcher would use this SELECT statement:

```
SELECT id, CAST( ST_AsText( ST_MeasureBetween( 4, 6) )
  AS VARCHAR(150) ) MEAS_BETWEEN_4_AND_6
  FROM sample_lines
```

Results:

```
ID         MEAS_BETWEEN_4_AND_6
---------- ------------------------------------------------------
         1 LINESTRING M (3.00000000 4.33333300 4.00000000,
```

```
                                3.00000000 3.00000000 6.00000000,
                                4.00000000 4.00000000 6.00000000,
                                5.00000000 5.00000000 6.00000000)
```

ST_MidPoint

ST_MidPoint takes a curve as an input parameter and returns the point on the curve that is equidistant from both end points of the curve, measured along the curve. The resulting point is represented in the spatial reference system of the given curve.

If the given curve is empty, then an empty point is returned. If the given curve is null, then null is returned.

If the curve contains Z coordinates or M coordinates (measures), the midpoint is determined solely by the values of the X and Y coordinates in the curve. The Z coordinate and measure in the returned point are interpolated.

This function can also be called as a method.

Syntax

Parameter

curve A value of type ST_Curve or one of its subtypes that represents the curve for which the point in the middle is returned.

Return type

db2gse.ST_Point

Example

This example illustrates the use of ST_MidPoint for returning the midpoint of curves.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines (id INTEGER, geometry ST_LineString)

INSERT INTO sample_lines (id, geometry)
  VALUES (1, ST_LineString ('linestring (0 0, 0 10, 0 20, 0 30, 0 40)', 1 ) )

INSERT INTO sample_lines (id, geometry)
  VALUES (2, ST_LineString ('linestring (2 2, 3 5, 3 3, 4 4, 5 5, 6 6)', 1 ) )

INSERT INTO sample_lines (id, geometry)
  VALUES (3, ST_LineString ('linestring (0 10, 0 0, 10 0, 10 10)', 1 ) )

INSERT INTO sample_lines (id, geometry)
  VALUES (4, ST_LineString ('linestring (0 20, 5 20, 10 20, 15 20)', 1 ) )

SELECT id, CAST( ST_AsText( ST_MidPoint(geometry) ) AS VARCHAR(60) ) MID_POINT
  FROM sample_lines
```

Results:

```
ID         MID_POINT
---------- -----------------------------------
         1 POINT ( 0.00000000 20.00000000)
         2 POINT ( 3.00000000 3.45981800)
         3 POINT ( 5.00000000 0.00000000)
         4 POINT ( 7.50000000 20.00000000)
```

ST_MinM

ST_MinM takes a geometry as an input parameter and returns its minimum M coordinate.

If the given geometry is null or is empty, or if it does not have M coordinates, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes for which the minimum M coordinate is returned.

Return type

DOUBLE

Examples

Example 1

This example illustrates the use of the ST_MinM function. Three polygons are created and inserted into the SAMPLE_POLYS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon('polygon zm ((110 120 20 3,
                                      110 140 22 3,
                                      120 130 26 4,
                                      110 120 20 3))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon('polygon zm ((0 0 40 7,
                                      0 4 35 9,
                                      5 4 32 12,
                                      5 0 31 5,
                                      0 0 40 7))', 0) )

INSERT INTO sample_polys
  VALUES (3, ST_Polygon('polygon zm ((12 13 10 16,
                                      8 4 10 12,
                                      9 4 12 11,
                                      12 13 10 16))', 0) )
```

Example 2

This example finds the minimum M coordinate of each polygon in SAMPLE_POLYS.

```
SELECT id, CAST ( ST_MinM(geometry) AS INTEGER) MIN_M
  FROM sample_polys
```

Results:

```
ID          MIN_M
----------- ------------
          1            3
          2            5
          3           11
```

Example 3

This example finds the minimum M coordinate that exists for all polygons in the GEOMETRY column.

```
SELECT CAST ( MIN ( ST_MinM(geometry) ) AS INTEGER) OVERALL_MIN_M
  FROM sample_polys
```

Results:

```
OVERALL_MIN_M
--------------
            3
```

ST_MinX

ST_MinX takes a geometry as an input parameter and returns its minimum X coordinate.

If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes for which the minimum X coordinate is returned.

Return type

DOUBLE

Examples

Example 1

This example illustrates the use of the ST_MinX function. Three polygons are created and inserted into the SAMPLE_POLYS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon('polygon zm ((110 120 20 3,
                                      110 140 22 3,
                                      120 130 26 4,
                                      110 120 20 3))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon('polygon zm ((0 0 40 7,
                                      0 4 35 9,
                                      5 4 32 12,
                                      5 0 31 5,
                                      0 0 40 7))', 0) )

INSERT INTO sample_polys
  VALUES (3, ST_Polygon('polygon zm ((12 13 10 16,
                                      8 4 10 12,
                                      9 4 12 11,
                                      12 13 10 16))', 0) )
```

Example 2

This example finds the minimum X coordinate of each polygon in SAMPLE_POLYS.

```
SELECT id, CAST ( ST_MinX(geometry) AS INTEGER) MIN_X
  FROM sample_polys
```

Results:

```
ID          MIN_X
----------- -----------
          1         110
          2           0
          3           8
```

Example 3

This example finds the minimum X coordinate that exists for all polygons in the GEOMETRY column.

```
SELECT CAST ( MIN ( ST_MinX(geometry) ) AS INTEGER) OVERALL_MIN_X
  FROM sample_polys
```

Results:

```
OVERALL_MIN_X
-------------
            0
```

ST_MinY

ST_MinY takes a geometry as an input parameter and returns its minimum Y coordinate.

If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes for which the minimum Y coordinate is returned.

Return type

DOUBLE

Examples

Example 1

This example illustrates the use of the ST_MinY function. Three polygons are created and inserted into the SAMPLE_POLYS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon('polygon zm ((110 120 20 3,
                                      110 140 22 3,
                                      120 130 26 4,
                                      110 120 20 3))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon('polygon zm ((0 0 40 7,
                                      0 4 35 9,
                                      5 4 32 12,
                                      5 0 31 5,
                                      0 0 40 7))', 0) )

INSERT INTO sample_polys
  VALUES (3, ST_Polygon('polygon zm ((12 13 10 16,
                                      8 4 10 12,
                                      9 4 12 11,
                                      12 13 10 16))', 0) )
```

Example 2

This example finds the minimum Y coordinate of each polygon in SAMPLE_POLYS.

```
SELECT id, CAST ( ST_MinY(geometry) AS INTEGER) MIN_Y
  FROM sample_polys
```

Results:

```
ID          MIN_Y
----------- ------------
          1          120
          2            0
          3            4
```

Example 3

This example finds the minimum Y coordinate that exists for all polygons in the GEOMETRY column.

```
SELECT CAST ( MIN ( ST_MinY(geometry) ) AS INTEGER) OVERALL_MIN_Y
  FROM sample_polys
```

Results:

```
OVERALL_MIN_Y
-------------
            0
```

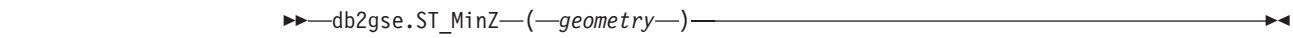
ST_MinZ

ST_MinZ takes a geometry as an input parameter and returns its minimum Z coordinate.

If the given geometry is null or is empty, or if it does not have Z coordinates, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes for which the minimum Z coordinate is returned.

Return type

DOUBLE

Examples

Example 1

This example illustrates the use of the ST_MinZ function. Three polygons are created and inserted into the SAMPLE_POLYS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon('polygon zm ((110 120 20 3,
                                      110 140 22 3,
                                      120 130 26 4,
                                      110 120 20 3))', 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon('polygon zm ((0 0 40 7,
                                      0 4 35 9,
                                      5 4 32 12,
                                      5 0 31 5,
                                      0 0 40 7))', 0) )

INSERT INTO sample_polys
  VALUES (3, ST_Polygon('polygon zm ((12 13 10 16,
```

```
 8 4 10 12,
 9 4 12 11,
12 13 10 16))', 0) )
```

Example 2

This example finds the minimum Z coordinate of each polygon in SAMPLE_POLYS.

```
SELECT id, CAST ( ST_MinZ(geometry) AS INTEGER) MIN_Z
  FROM sample_polys
```

Results:

```
ID          MIN_Z
----------- ------------
          1           20
          2           31
          3           10
```

Example 3

This example finds the minimum Z coordinate that exists for all polygons in the GEOMETRY column.

```
SELECT CAST ( MIN ( ST_MinZ(geometry) ) AS INTEGER) OVERALL_MIN_Z
  FROM sample_polys
```

Results:

```
OVERALL_MIN_Z
--------------
             10
```

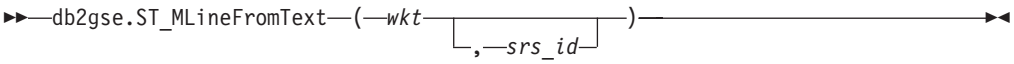
ST_MLineFromText

ST_MLineFromText takes a well-known text representation of a multilinestring and, optionally, a spatial reference system identifier as input parameters and returns the corresponding multilinestring.

If the given well-known text representation is null, then null is returned.

The recommended function for achieving the same result is the ST_MultiLineString function. It is recommended because of its flexibility: ST_MultiLineString takes additional forms of input as well as the well-known text representation.

Syntax



Parameters

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting multilinestring.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting multilinestring.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If the specified *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_MultiLineString

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_MLineFromText can be used to create and insert a multilinestring from its well-known text representation. The record that is inserted has ID = 1110, and the geometry is a multilinestring in spatial reference system 1. The multilinestring is in the well-known text representation of a multilinestring. The X and Y coordinates for this geometry are:

- Line 1: (33, 2) (34, 3) (35, 6)
- Line 2: (28, 4) (29, 5) (31, 8) (43, 12)
- Line 3: (39, 3) (37, 4) (36, 7)

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mlines (id INTEGER, geometry ST_MultiLineString)

INSERT INTO sample_mlines
  VALUES (1110, ST_MLineFromText ('multilinestring ( (33 2, 34 3, 35 6),
                                                     (28 4, 29 5, 31 8, 43 12),
                                                     (39 3, 37 4, 36 7) )', 1) )
```

The following SELECT statement returns the multilinestring that was recorded in the table:

```
SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(280) ) MULTI_LINE_STRING
  FROM sample_mlines
  WHERE id = 1110
```

Results:

```
ID         MULTI_LINE_STRING
---------- ------------------------------------------------------------------
      1110 MULTILINESTRING (( 33.00000000 2.00000000, 34.00000000 3.00000000,
             35.00000000 6.00000000),
                           ( 28.00000000 4.00000000, 29.00000000 5.00000000,
             31.00000000 8.0000000, 43.00000000 12.00000000),
                           ( 39.00000000 3.00000000, 37.00000000 4.00000000,
             36.00000000 7.00000000 ))
```

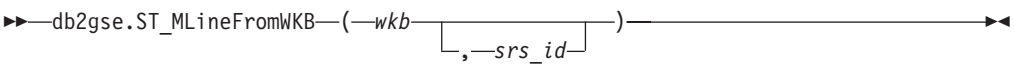
ST_MLineFromWKB

ST_MLineFromWKB takes a well-known binary representation of a multilinestring and, optionally, a spatial reference system identifier as input parameters and returns the corresponding multilinestring.

If the given well-known binary representation is null, then null is returned.

The recommended function for achieving the same result is the ST_MultiLineString function. It is recommended because of its flexibility: ST_MultiLineString takes additional forms of input as well as the well-known binary representation.

Syntax



Parameters

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting multilinestring.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting multilinestring.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If the specified *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_MultiLineString

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_MLineFromWKB can be used to create a multilinestring from its well-known binary representation. The geometry is a multilinestring in spatial reference system 1. In this example, the multilinestring gets stored with ID = 10 in the GEOMETRY column of the SAMPLE_MLINES table, and then the WKB column is updated with its well-known binary representation (using the ST_AsBinary function). Finally, the ST_MLineFromWKB function is used to return the multilinestring from the WKB column. The X and Y coordinates for this geometry are:

- Line 1: (61, 2) (64, 3) (65, 6)
- Line 2: (58, 4) (59, 5) (61, 8)
- Line 3: (69, 3) (67, 4) (66, 7) (68, 9)

The SAMPLE_MLINES table has a GEOMETRY column, where the multilinestring is stored, and a WKB column, where the multilinestring's well-known binary representation is stored.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mlines (id INTEGER, geometry ST_MultiLineString,
       wkb BLOB(32K))

INSERT INTO sample_mlines
  VALUES (10, ST_MultiLineString ('multilinestring
       ( (61 2, 64 3, 65 6),
         (58 4, 59 5, 61 8),
         (69 3, 67 4, 66 7, 68 9) )', 1) )

UPDATE sample_mlines AS temporary_correlated
  SET wkb = ST_AsBinary( geometry )
  WHERE id = temporary_correlated.id
```

In the following SELECT statement, the ST_MLineFromWKB function is used to retrieve the multilinestring from the WKB column.

```
SELECT id, CAST( ST_AsText( ST_MLineFromWKB (wkb) )
       AS VARCHAR(280) ) MULTI_LINE_STRING
  FROM sample_mlines
  WHERE id = 10
```

Results:

```
ID         MULTI_LINE_STRING
---------- ------------------------------------------------------------------
        10 MULTILINESTRING (( 61.00000000 2.00000000, 64.00000000 3.00000000,
              65.00000000 6.00000000),
                           ( 58.00000000 4.00000000, 59.00000000 5.00000000,
              61.00000000 8.0000000),
                           ( 69.00000000 3.00000000, 67.00000000 4.00000000,
              66.00000000 7.00000000, 68.00000000 9.00000000 ))
```

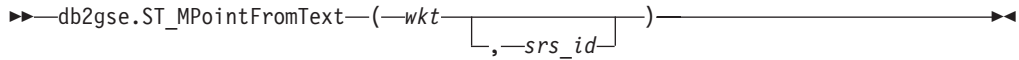
ST_MPointFromText

ST_MPointFromText takes a well-known text representation of a multipoint and, optionally, a spatial reference system identifier as input parameters and returns the corresponding multipoint.

If the given well-known text representation is null, then null is returned.

The recommended function for achieving the same result is the ST_MultiPoint function. It is recommended because of its flexibility: ST_MultiPoint takes additional forms of input as well as the well-known text representation.

Syntax



Parameters

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting multipoint.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting multipoint.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If the specified *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_MultiPoint

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_MPointFromText can be used to create and insert a multipoint from its well-known text representation. The record that is inserted has ID = 1110, and the geometry is a multipoint in spatial reference system 1. The multipoint is in the well-known text representation of a multipoint. The X and Y coordinates for this geometry are: (1, 2) (4, 3) (5, 6).

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mpoints (id INTEGER, geometry ST_MultiPoint)

INSERT INTO sample_mpoints
  VALUES (1110, ST_MPointFromText ('multipoint (1 2, 4 3, 5 6) )', 1) )
```

The following SELECT statement returns the multipoint that was recorded in the table:

```
SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(280) ) MULTIPOINT
  FROM sample_mpoints
  WHERE id = 1110
```

Results:

```
ID         MULTIPOINT
---------- ------------------------------------------------------------------
      1110 MULTIPOINT (1.00000000 2.00000000, 4.00000000 3.00000000,
                       5.00000000 6.00000000)
```

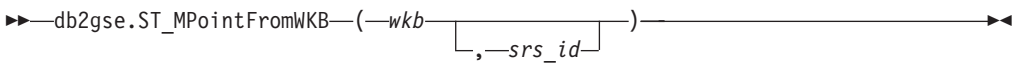
ST_MPointFromWKB

ST_MPointFromWKB takes a well-known binary representation of a multipoint and, optionally, a spatial reference system identifier as input parameters and returns the corresponding multipoint.

If the given well-known binary representation is null, then null is returned.

The recommended function for achieving the same result is the ST_MultiPoint function. It is recommended because of its flexibility: ST_MultiPoint takes additional forms of input as well as the well-known binary representation.

Syntax



Parameters

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting multipoint.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting multipoint.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If the specified *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_MultiPoint

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_MPointFromWKB can be used to create a multipoint from its well-known binary representation. The geometry is a multipoint in spatial reference system 1. In this example, the multipoint gets stored with ID = 10 in the GEOMETRY column of the SAMPLE_MPOINTS table, and then the WKB column is updated with its well-known binary representation (using the ST_AsBinary function). Finally, the ST_MPointFromWKB function is used to return the multipoint from the WKB column. The X and Y coordinates for this geometry are: (44, 14) (35, 16) (24, 13).

The SAMPLE_MPOINTS table has a GEOMETRY column, where the multipoint is stored, and a WKB column, where the multipoint's well-known binary representation is stored.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mpoints (id INTEGER, geometry ST_MultiPoint,
    wkb BLOB(32K))

INSERT INTO sample_mpoints
  VALUES (10, ST_MultiPoint ('multipoint ( 4 14, 35 16, 24 13)', 1))

UPDATE sample_mpoints AS temporary_correlated
  SET wkb = ST_AsBinary( geometry )
  WHERE id = temporary_correlated.id
```

In the following SELECT statement, the ST_MPointFromWKB function is used to retrieve the multipoint from the WKB column.

```
SELECT id, CAST( ST_AsText( ST_MLineFromWKB (wkb)) AS VARCHAR(100)) MULTIPOINT
  FROM sample_mpoints
  WHERE id = 10
```

Results:

```
ID         MULTIPOINT
---------- ----------------------------------------------------------------
        10 MULTIPOINT (44.00000000 14.00000000, 35.00000000
             16.00000000 24.00000000 13.00000000)
```

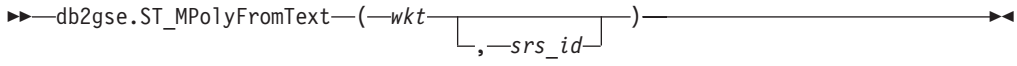
ST_MPolyFromText

ST_MPolyFromText takes a well-known text representation of a multipolygon and, optionally, a spatial reference system identifier as input parameters and returns the corresponding multipolygon.

If the given well-known text representation is null, then null is returned.

The recommended function for achieving the same result is the ST_MultiPolygon function. It is recommended because of its flexibility: ST_MultiPolygon takes additional forms of input as well as the well-known text representation.

Syntax



Parameters

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting multipolygon.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting multipolygon.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If the specified *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_MultiPolygon

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_MPolyFromText can be used to create and insert a multipolygon from its well-known text representation. The record that is inserted has ID = 1110, and the geometry is a multipolygon in spatial reference system 1. The multipolygon is in the well-known text representation of a multipolygon. The X and Y coordinates for this geometry are:

- Polygon 1: (3, 3) (4, 6) (5, 3) (3, 3)
- Polygon 2: (8, 24) (9, 25) (1, 28) (8, 24)
- Polygon 3: (13, 33) (7, 36) (1, 40) (10, 43) (13, 33)

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mpolys (id INTEGER, geometry ST_MultiPolygon)

INSERT INTO sample_mpolys
  VALUES (1110,
          ST_MPolyFromText ('multipolygon (( (3 3, 4 6, 5 3, 3 3),
                                (8 24, 9 25, 1 28, 8 24),
                                (13 33, 7 36, 1 40, 10 43 13 33) ))', 1) )
```

The following SELECT statement returns the multipolygon that was recorded in the table:

```
SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(350) ) MULTI_POLYGON
  FROM sample_mpolys
  WHERE id = 1110
```

Results:

```
ID         MULTI_POLYGON
------- ------------------------------------------------------------------
   1110 MULTIPOLYGON ((( 13.00000000 33.00000000, 10.00000000 43.00000000,
           1.00000000 40.00000000, 7.00000000 36.00000000,
           13.00000000 33.00000000)),
                      (( 8.00000000 24.00000000, 9.00000000 25.00000000,
           1.00000000 28.0000000, 8.00000000 24.00000000)),
                       ( 3.00000000 3.00000000, 5.00000000 3.00000000,
           4.00000000 6.00000000, 3.00000000 3.00000000)))
```

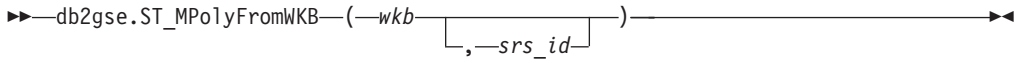
ST_MPolyFromWKB

ST_MPolyFromWKB takes a well-known binary representation of a multipolygon and, optionally, a spatial reference system identifier as input parameters and returns the corresponding multipolygon.

If the given well-known binary representation is null, then null is returned.

The recommended function for achieving the same result is the ST_MultiPolygon function. It is recommended because of its flexibility: ST_MultiPolygon takes additional forms of input as well as the well-known binary representation.

Syntax



Parameters

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting multipolygon.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting multipolygon.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If the specified *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_MultiPolygon

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_MPolyFromWKB can be used to create a multipolygon from its well-known binary representation. The geometry is a multipolygon in spatial reference system 1. In this example, the multipolygon gets stored with ID = 10 in the GEOMETRY column of the SAMPLE_MPOLYS table, and then the WKB column is updated with its well-known binary representation (using the ST_AsBinary function). Finally, the ST_MPolyFromWKB function is used to return the multipolygon from the WKB column. The X and Y coordinates for this geometry are:

- Polygon 1: (1, 72) (4, 79) (5, 76) (1, 72)
- Polygon 2: (10, 20) (10, 40) (30, 41) (10, 20)
- Polygon 3: (9, 43) (7, 44) (6, 47) (9, 43)

The SAMPLE_MPOLYS table has a GEOMETRY column, where the multipolygon is stored, and a WKB column, where the multipolygon's well-known binary representation is stored.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mpolys (id INTEGER,
    geometry ST_MultiPolygon, wkb BLOB(32K))

INSERT INTO sample_mpolys
  VALUES (10, ST_MultiPolygon ('multipolygon
        (( (1 72, 4 79, 5 76, 1 72),
         (10 20, 10 40, 30 41, 10 20),
         (9 43, 7 44, 6 47, 9 43) ))', 1))

UPDATE sample_mpolys AS temporary_correlated
  SET wkb = ST_AsBinary( geometry )
  WHERE id = temporary_correlated.id
```

In the following SELECT statement, the ST_MPolyFromWKB function is used to retrieve the multipolygon from the WKB column.

```
SELECT id, CAST( ST_AsText( ST_MPolyFromWKB (wkb) )
    AS VARCHAR(320) ) MULTIPOLYGON
  FROM sample_mpolys
  WHERE id = 10
```

Results:

```
ID         MULTIPOLYGON
---------- ------------------------------------------------------------------------
        10 MULTIPOLYGON ((( 10.00000000 20.00000000, 30.00000000
              41.00000000, 10.00000000 40.00000000, 10.00000000
              20.00000000)),
                          ( 1.00000000 72.00000000, 5.00000000
              76.00000000, 4.00000000 79.0000000, 1.00000000
              72,00000000)),
                           ( 9.00000000 43.00000000, 6.00000000
               47.00000000, 7.00000000 44.00000000, 9.00000000
               43.00000000 )))
```

ST_MultiLineString

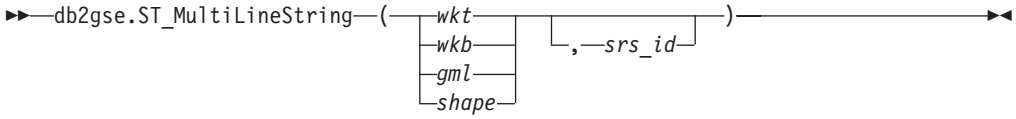
ST_MultiLineString constructs a multilinestring from one of the following inputs:

- A well-known text representation
- A well-known binary representation
- A shape representation
- A representation in the geography markup language (GML)

An optional spatial reference system identifier can be specified to identify the spatial reference system that the resulting multilinestring is in.

If the well-known text representation, the well-known binary representation, the shape representation, or the GML representation is null, then null is returned.

Syntax



Parameters

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting multilinestring.

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting multilinestring.

gml A value of type CLOB(2G) that represents the resulting multilinestring using the geography markup language.

shape A value of type BLOB(2G) that represents the shape representation of the resulting multilinestring.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting multilinestring.

If the *srs_id* parameter is omitted, then the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_MultiLineString

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_MultiLineString can be used to create and insert a multilinestring from its well-known text representation. The record that is inserted has ID = 1110, and the geometry is a multilinestring in spatial reference system 1. The multilinestring is in the well-known text representation of a multilinestring. The X and Y coordinates for this geometry are:

- Line 1: (33, 2) (34, 3) (35, 6)
- Line 2: (28, 4) (29, 5) (31, 8) (43, 12)
- Line 3: (39, 3) (37, 4) (36, 7)

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mlines (id INTEGER,
                            geometry ST_MultiLineString)

INSERT INTO sample_mlines
  VALUES (1110,
          ST_MultiLineString ('multilinestring ( (33 2, 34 3, 35 6),
                                      (28 4, 29 5, 31 8, 43 12),
                                      (39 3, 37 4, 36 7) )', 1) )
```

The following SELECT statement returns the multilinestring that was recorded in the table:

```
SELECT id,
       CAST( ST_AsText( geometry ) AS VARCHAR(280) )
  MULTI_LINE_STRING
  FROM sample_mlines
  WHERE id = 1110
```

Results:

```
ID         MULTI_LINE_STRING
------- ------------------------------------------------------------------
   1110 MULTILINESTRING (( 33.00000000 2.00000000, 34.00000000 3.00000000,
              35.00000000 6.00000000),
                         ( 28.00000000 4.00000000, 29.00000000 5.00000000,
              31.00000000 8.0000000, 43.00000000 12.00000000),
                         ( 39.00000000 3.00000000, 37.00000000 4.00000000,
              36.00000000 7.00000000 ))
```

ST_MultiPoint

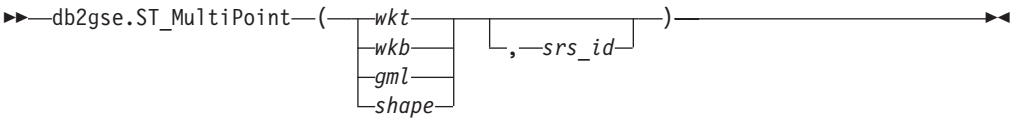
ST_MultiPoint constructs a multipoint from one of the following inputs:

- A well-known text representation
- A well-known binary representation
- A shape representation
- A representation in the geography markup language (GML)

An optional spatial reference system identifier can be specified to indicate the spatial reference system the resulting multipoint is in.

If the well-known text representation, the well-known binary representation, the shape representation, or the GML representation is null, then null is returned.

Syntax



Parameters

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting multipoint.

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting multipoint.

gml A value of type CLOB(2G) that represents the resulting multipoint using the geography markup language.

shape A value of type BLOB(2G) that represents the shape representation of the resulting multipoint.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting multipoint.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_Point

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_MultiPoint can be used to create and insert a multipoint from its well-known text representation. The record that is inserted has ID = 1110, and the geometry is a multipoint in spatial reference system 1. The multipoint is in the well-known text representation of a multipoint. The X and Y coordinates for this geometry are: (1, 2) (4, 3) (5, 6).

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mpoints (id INTEGER, geometry ST_MultiPoint)

INSERT INTO sample_mpoints
  VALUES (1110, ST_MultiPoint ('multipoint (1 2, 4 3, 5 6) )', 1))
```

The following SELECT statement returns the multipoint that was recorded in the table:

```
SELECT id, CAST( ST_AsText(geometry) AS VARCHAR(90)) MULTIPOINT
  FROM sample_mpoints
  WHERE id = 1110
```

Results:

```
ID         MULTIPOINT
---------- ----------------------------------------------------
      1110 MULTIPOINT (1.00000000 2.00000000, 4.00000000
           3.00000000, 5.00000000 6.00000000)
```

ST_MultiPolygon

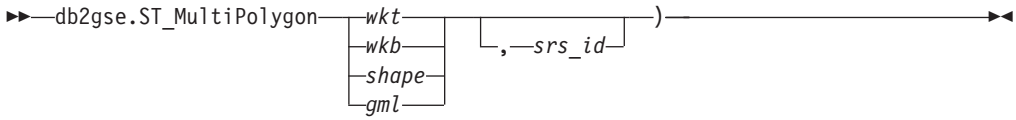
ST_MultiPolygon constructs a multipolygon from one of the following inputs:

- A well-known text representation
- A well-known binary representation
- A shape representation
- A representation in the geography markup language (GML)

An optional spatial reference system identifier can be specified to identify the spatial reference system that the resulting multipolygon is in.

If the well-known text representation, the well-known binary representation, the shape representation, or the GML representation is null, then null is returned.

Syntax



Parameters

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting multipolygon.

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting multipolygon.

gml A value of type CLOB(2G) that represents the resulting multipolygon using the geography markup language.

shape A value of type BLOB(2G) that represents the shape representation of the resulting multipolygon.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting multipolygon.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_MultiPolygon

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_MultiPolygon can be used to create and insert a multipolygon from its well-known text representation. The record that is inserted has ID = 1110, and the geometry is a multipolygon in spatial reference system 1. The multipolygon is in the well-known text representation of a multipolygon. The X and Y coordinates for this geometry are:

- Polygon 1: (3, 3) (4, 6) (5, 3) (3, 3)
- Polygon 2: (8, 24) (9, 25) (1, 28) (8, 24)
- Polygon 3: (13, 33) (7, 36) (1, 40) (10, 43) (13, 33)

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mpolys (id INTEGER, geometry ST_MultiPolygon)

INSERT INTO sample_mpolys
  VALUES (1110,
          ST_MultiPolygon ('multipolygon (( (3 3, 4 6, 5 3, 3 3),
                                    (8 24, 9 25, 1 28, 8 24),
                                    (13 33, 7 36, 1 40, 10 43 13 33) ))', 1) )
```

The following SELECT statement returns the multipolygon that was recorded in the table:

```
SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(350) ) MULTI_POLYGON
  FROM sample_mpolys
  WHERE id = 1110
```

Results:

```
ID          MULTI_POLYGON
------- ------------------------------------------------------------------
   1110 MULTIPOLYGON ((( 13.00000000 33.00000000, 10.00000000 43.00000000,
           1.00000000 40.00000000, 7.00000000 36.00000000,
          13.00000000 33.00000000)),
                      (( 8.00000000 24.00000000, 9.00000000 25.00000000,
           1.00000000 28.0000000, 8.00000000 24.00000000)),
                      (( 3.00000000 3.00000000, 5.00000000 3.00000000,
           4.00000000 6.00000000, 3.00000000 3.00000000)))
```

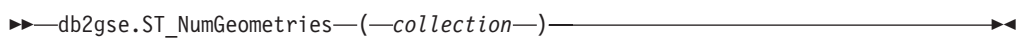
ST_NumGeometries

ST_NumGeometries takes a geometry collection as an input parameter and returns the number of geometries in the collection.

If the given geometry collection is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameter

collection
A value of type ST_GeomCollection or one of its subtypes that represents the geometry collection for which the number of geometries is returned.

Return Type

INTEGER

Example

Two geometry collections are stored in the SAMPLE_GEOMCOLL table. One is a multipolygon, and the other is a multipoint. The ST_NumGeometries function determines how many individual geometries are within each geometry collection.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geomcoll (id INTEGER, geometry ST_GeomCollection)

INSERT INTO sample_geomcoll
  VALUES (1,
          ST_MultiPolygon ('multipolygon (( (3 3, 4 6, 5 3, 3 3),
                                (8 24, 9 25, 1 28, 8 24),
                                (13 33, 7 36, 1 40, 10 43, 13 33) ))', 1) )

INSERT INTO sample_geomcoll
  VALUES (2, ST_MultiPoint ('multipoint (1 2, 4 3, 5 6, 7 6, 8 8)', 1) )

SELECT id, ST_NumGeometries (geometry) NUM_GEOMS_IN_COLL
  FROM sample_geomcoll
```

Results:

```
ID          NUM_GEOMS_IN_COLL
----------- -----------------
          1                 3
          2                 5
```

ST_NumInteriorRing

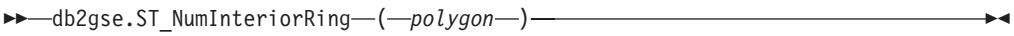
ST_NumInteriorRing takes a polygon as an input parameter and returns the number of its interior rings.

If the given polygon is null or is empty, then null is returned.

If the polygon has no interior rings, then 0 (zero) is returned.

This function can also be called as a method.

Syntax



Parameter

polygon
A value of type ST_Polygon that represents the polygon for which the number of interior rings is returned.

Return type

INTEGER

Example

The following example creates two polygons:

- One with two interior rings
- One without any interior rings

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon('polygon
        ((40 120, 90 120, 90 150, 40 150, 40 120),
         (50 130, 60 130, 60 140, 50 140, 50 130),
         (70 130, 80 130, 80 140, 70 140, 70 130))' , 0) )

INSERT INTO sample_polys
  VALUES (2, ST_Polygon('polygon ((5 15, 50 15, 50 105, 5 15))' , 0) )
```

The ST_NumInteriorRing function is used to return the number of rings in the geometries in the table:

```
SELECT id, ST_NumInteriorRing(geometry) NUM_RINGS
FROM sample_polys
```

Results:

```
ID         NUM_RINGS
---------- --------------
         1              2
         2              0
```

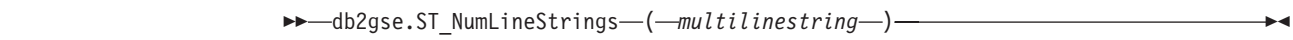
ST_NumLineStrings

ST_NumLineStrings takes a multilinestring as an input parameter and returns the number of linestrings that it contains.

If the given multilinestring is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameter

multilinestring
A value of type ST_MultiLineString that represents the multilinestring for which the number of linestrings is returned.

Return type

INTEGER

Example

Multilinestrings are stored in the SAMPLE_MLINES table. The ST_NumLineStrings function determines how many individual geometries are within each multilinestring.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mlines (id INTEGER, geometry ST_MultiLineString)

INSERT INTO sample_mlines
  VALUES (110, ST_MultiLineString ('multilinestring
       ( (33 2, 34 3, 35 6),
         (28 4, 29 5, 31 8, 43 12),
         (39 3, 37 4, 36 7))', 1) )
INSERT INTO sample_mlines
  VALUES (111, ST_MultiLineString ('multilinestring
       ( (3 2, 4 3, 5 6),
         (8 4, 9 5, 3 8, 4 12))', 1) )

SELECT id, ST_NumLineStrings (geometry) NUM_WITHIN
  FROM sample_mlines
```

Results:

```
ID          NUM_WITHIN
----------- ----------
        110          3
        111          2
```

ST_NumPoints

ST_NumPoints takes a geometry as an input parameter and returns the number of points that were used to define that geometry. For example, if the geometry is a polygon and five points were used to define that polygon, then the returned number is 5.

If the given geometry is null or is empty, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry for which the number of points is returned.

Return type

INTEGER

Example

A variety of geometries are stored in the table. The ST_NumPoints function determines how many points are within each geometry in the SAMPLE_GEOMETRIES table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (spatial_type VARCHAR(18), geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES ('st_point',
           ST_Point (2, 3, 0) )

INSERT INTO sample_geometries
  VALUES ('st_linestring',
           ST_LineString ('linestring (2 5, 21 3, 23 10)', 0) )

INSERT INTO sample_geometries
  VALUES ('st_polygon',
           ST_Polygon ('polygon ((110 120, 110 140, 120 130, 110 120))', 0) )

SELECT spatial_type, ST_NumPoints (geometry) NUM_POINTS
  FROM sample_geometries
```

Results:

```
SPATIAL_TYPE    NUM_POINTS
--------------- ----------
st_point                 1
st_linestring            3
st_polygon               4
```

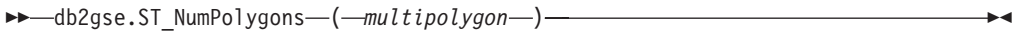
ST_NumPolygons

ST_NumPolygons takes a multipolygon as an input parameter and returns the number of polygons that it contains.

If the given multipolygon is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameter

multipolygon
A value of type ST_MultiPolygon that represents the multipolygon for which the number of polygons is returned.

Return type

INTEGER

Example

Multipolygons are stored in the SAMPLE_MPOLYS table. The ST_NumPolygons function determines how many individual geometries are within each multipolygon.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mpolys (id INTEGER, geometry ST_MultiPolygon)

INSERT INTO sample_mpolys
  VALUES (1,
          ST_MultiPolygon ('multipolygon (( (3 3, 4 6, 5 3, 3 3),
                                (8 24, 9 25, 1 28, 8 24),
                                (13 33, 7 36, 1 40, 10 43, 13 33) ))', 1) )

INSERT INTO sample_polys
  VALUES (2,
          ST_MultiPolygon ('multipolygon empty', 1) )

INSERT INTO sample_polys
  VALUES (3,
          ST_MultiPolygon ('multipolygon (( (3 3, 4 6, 5 3, 3 3),
                                (13 33, 7 36, 1 40, 10 43, 13 33) ))', 1) )

SELECT id, ST_NumPolygons (geometry) NUM_WITHIN
  FROM sample_mpolys
```

Results:

```
ID          NUM_WITHIN
----------- ----------
          1          3
          2          0
          3          2
```

ST_Overlaps

ST_Overlaps takes two geometries as input parameters and returns 1 if the intersection of the geometries results in a geometry of the same dimension but is not equal to either of the given geometries. Otherwise, 0 (zero) is returned.

If any of the two geometries is null or is empty, then null is returned.

If the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system.

Syntax

Parameters

geometry1
A value of type ST_Geometry or one of its subtypes that represents the geometry that is tested to overlap with *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the geometry that is tested to overlap with *geometry1*.

Return type

INTEGER

Examples

Example 1

This example illustrates the use of ST_Overlaps. Various geometries are created and inserted into the SAMPLE_GEOMETRIES table

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES (1, ST_Point (10, 20, 1)),
         (2, ST_Point ('point (41 41)', 1) ),
         (10, ST_LineString ('linestring (1 10, 3 12, 10 10)', 1) ),
         (20, ST_LineString ('linestring (50 10, 50 12, 45 10)', 1) ),
         (30, ST_LineString ('linestring (50 12, 50 10, 60 8)', 1) ),
         (100, ST_Polygon ('polygon ((0 0, 0 40, 40 40, 40 0, 0 0))', 1) ),
         (110, ST_Polygon ('polygon ((30 10, 30 30, 50 30, 50 10, 30 10))', 1) ),
         (120, ST_Polygon ('polygon ((0 50, 0 60, 40 60, 40 60, 0 50))', 1) )
```

Example 2

This example finds the IDs of points that overlap.

```
SELECT sg1.id, sg2.id
  CASE ST_Overlaps (sg1.geometry, sg2.geometry)
    WHEN 0 THEN 'Points_do_not_overlap'
    WHEN 1 THEN 'Points_overlap'
    END
  AS OVERLAP
  FROM sample_geometries sg1, sample_geometries sg2
  WHERE sg1.id < 10 AND sg2.id < 10 AND sg1.id >= sg2.id
```

Results:

```
ID          ID         OVERLAP
----------- ---------- ------------------------
          1          1 Points_do_not_overlap
          2          1 Points_do_not_overlap
          2          2 Points_do_not_overlap
```

Example 3

This example finds the IDs of lines that overlap.

```
SELECT sg1.id, sg2.id
  CASE ST_Overlaps (sg1.geometry, sg2.geometry)
    WHEN 0 THEN 'Lines_do_not_overlap'
    WHEN 1 THEN 'Lines_overlap'
    END
  AS OVERLAP
  FROM sample_geometries sg1, sample_geometries sg2
  WHERE sg1.id >= 10 AND sg1.id < 100
    AND sg2.id >= 10 AND sg2.id < 100
    AND sg1.id >= sg2.id
```

Results:

```
ID          ID         OVERLAP
----------- ---------- ------------------------
         10         10 Lines_do_not_overlap
         20         10 Lines_do_not_overlap
         30         10 Lines_do_not_overlap
         20         20 Lines_do_not_overlap
         30         20 Lines_overlap
         30         30 Lines_do_not_overlap
```

Example 4

This example finds the IDs of polygons that overlap.

```
SELECT sg1.id, sg2.id
  CASE ST_Overlaps (sg1.geometry, sg2.geometry)
    WHEN 0 THEN 'Polygons_do_not_overlap'
    WHEN 1 THEN 'Polygons_overlap'
    END
  AS OVERLAP
  FROM sample_geometries sg1, sample_geometries sg2
  WHERE sg1.id >= 100 AND sg2.id >= 100 AND sg1.id >= sg2.id
```

Results:

```
ID          ID         OVERLAP
----------- ---------- ------------------------
        100        100 Polygons_do_not_overlap
        110        100 Polygons_overlap
        120        100 Polygons_do_not_overlap
        110        110 Polygons_do_not_overlap
        120        110 Polygons_do_not_overlap
        120        120 Polygons_do_not_overlap
```

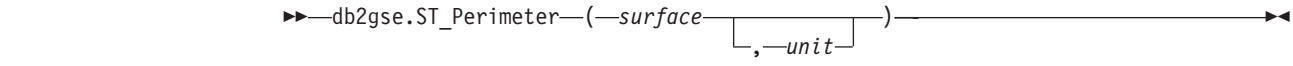
ST_Perimeter

ST_Perimeter takes a surface or multisurface and, optionally, a unit as input parameters and returns the perimeter of the surface or multisurface, that is the length of its boundary, measured in the default or given units.

If the given surface or multisurface is null or is empty, null is returned.

This function can also be called as a method.

Syntax



Parameters

surface
A value of type ST_Surface, ST_MultiSurface, or one of their subtypes for which the perimeter is returned.

unit A VARCHAR(128) value that identifies the units in which the perimeter is measured. The supported units of measure are listed in the DB2GSE.ST_UNITS_OF_MEASURE catalog view.

If the *unit* parameter is omitted, the following rules are used to determine the unit in which the perimeter is measured:

- If *surface* is in a projected or geocentric coordinate system, the linear unit associated with this coordinate system is the default.
- If *surface* is in a geographic coordinate system, but is not in a geodetic spatial reference system (SRS), the angular unit associated with this coordinate system is the default.
- If *surface* is in a geodetic SRS, the default unit of measure is meters.

Restrictions on unit conversions: An error (SQLSTATE 38SU4) is returned if any of the following conditions occur:

- The geometry is in an unspecified coordinate system and the *unit* parameter is specified.
- The geometry is in a projected coordinate system and an angular unit is specified.
- The geometry is in a geographic coordinate system, but is not in a geodetic SRS, and a linear unit is specified.
- The geometry is in a geographic coordinate system, is in a geodetic SRS, and an angular unit is specified.

Return type

DOUBLE

Examples

Example 1

This example illustrates the use of the ST_Perimeter function. A spatial reference system with an ID of 4000 is created using a call to db2se, and a polygon is created in that spatial reference system.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse

db2se create_srs se_bank -srsId 4000 -srsName new_york1983
  -xOffset 0 -yOffset 0 -xScale 1 -yScale 1
  -coordsysName NAD_1983_StatePlane_New_York_East_FIPS_3101_Feet
```

The SAMPLE_POLYS table is created to hold a geometry with a perimeter of 18.

```
CREATE TABLE sample_polys (id SMALLINT, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1, ST_Polygon ('polygon ((0 0, 0 4, 5 4, 5 0, 0 0))', 4000))
```

Example 2

This example lists the ID and perimeter of the polygon.

```
SELECT id, ST_Perimeter (geometry) AS PERIMETER
  FROM sample_polys
```

Results:

```
ID          PERIMETER
----------- ------------------------
          1 +1.80000000000000E+001
```

Example 3

This example lists the ID and perimeter of the polygon with the perimeter measured in meters.

```
SELECT id, ST_Perimeter (geometry, 'METER') AS PERIMETER_METER
  FROM sample_polys
```

Results:

```
ID          PERIMETER_METER
----------- ----------------------
          1 +5.48641097282195E+000
```

ST_PerpPoints

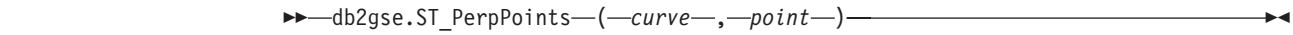
ST_PerpPoints takes a curve or multicurve and a point as input parameters and returns the perpendicular projection of the given point on the curve or multicurve. The point with the smallest distance between the given point and the perpendicular point is returned. If two or more such perpendicular projected points are equidistant from the given point, they are all returned. If no perpendicular point can be constructed, then an empty point is returned.

If the given curve or multicurve has Z or M coordinates, the Z or M coordinate of the resulting points are computed by interpolation on the given curve or multicurve.

If the given curve or point is empty, then an empty point is returned. If the given curve or point is null , then null is returned.

This function can also be called as a method.

Syntax



Parameters

curve A value of type ST_Curve, ST_MultiCurve, or one of their subtypes that represents the curve or multicurve in which the perpendicular projection of the *point* is returned.

point A value of type ST_Point that represents the point that is perpendicular projected onto *curve*.

Return type

db2gse.ST_MultiPoint

Examples

Example 1

This example illustrates the use of the ST_PerpPoints function to find points that are perpendicular to the linestring stored in the following table. The ST_LineString function is used in the INSERT statement to create the linestring.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines (id INTEGER, line ST_LineString)

INSERT INTO sample_lines (id, line)
  VALUES (1, ST_LineString('linestring (0 10, 0 0, 10 0, 10 10)' , 0) )
```

Example 2

This example finds the perpendicular projection on the linestring of a point with coordinates (5, 0). The ST_AsText function is used to convert the returned value (a multipoint) to its well-known text representation.

```
SELECT CAST ( ST_AsText( ST_PerpPoints( line, ST_Point(5, 0) ) )
  AS VARCHAR(50) ) PERP
  FROM sample_lines
```

Results:

```
PERP
----------------------------------------
MULTIPOINT ( 5.00000000 0.00000000)
```

Example 3

This example finds the perpendicular projections on the linestring of a point with coordinates (5, 5). In this case, there are three points on the linestring that are equidistant to the given location. Therefore, a multipoint that consists of all three points is returned.

```
SELECT  CAST ( ST_AsText( ST_PerpPoints( line, ST_Point(5, 5) ) )
  AS VARCHAR160) ) PERP
  FROM sample_lines
```

Results:

```
PERP
--------------------------------------------------------------------------------
MULTIPOINT ( 0.00000000 5.00000000, 5.00000000 0.00000000, 10.00000000 5.00000000)
```

Example 4

This example finds the perpendicular projections on the linestring of a point with coordinates (5, 10). In this case there are three different perpendicular points that can be found. However, the ST_PerpPoints function only returns those points that are closest to the given point. Thus, a multipoint that consists of only the two closest points is returned. The third point is not included.

```
SELECT CAST ( ST_AsText( ST_PerpPoints( line, ST_Point(5, 10) ) )
  AS VARCHAR(80) ) PERP
  FROM sample_lines
```

Results:

```
PERP
------------------------------------------------------------
MULTIPOINT ( 0.00000000 10.00000000, 10.00000000 10.00000000 )
```

Example 5

This example finds the perpendicular projection on the linestring of a point with coordinates (5, 15).

```
SELECT CAST ( ST_AsText( ST_PerpPoints( line, ST_Point('point(5 15)', 0 ) ) )
  AS VARCHAR(80) ) PERP
  FROM sample_lines
```

Results:

```
PERP
-----------------------------------
MULTIPOINT ( 5.00000000 0.00000000 )
```

Example 6

In this example, the specified point with coordinates (15 15) has no perpendicular projection on the linestring. Therefore, an empty geometry is returned.

```
SELECT CAST ( ST_AsText( ST_PerpPoints( line, ST_Point(15, 15) ) )
  AS VARCHAR(80) ) PERP
  FROM sample_lines
```

Results:

```
PERP
--------------------------------------------
MULTIPOINT EMPTY
```

ST_Point

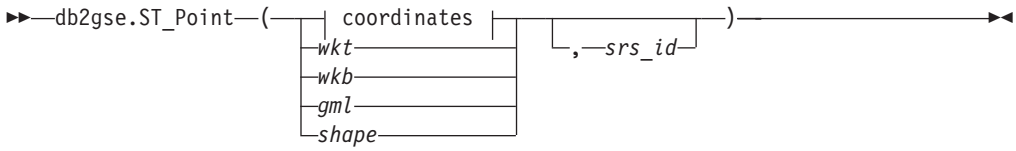
ST_Point constructs a point from one of the following sets of input:

- X and Y coordinates only
- X, Y, and Z coordinates
- X, Y, Z, and M coordinates
- A well-known text representation
- A well-known binary representation
- A shape representation
- A representation in the geography markup language (GML)

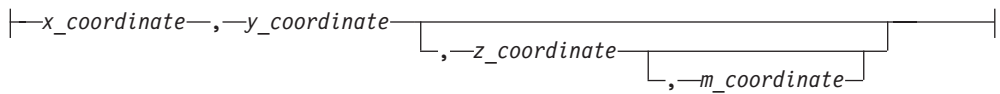
An optional spatial reference system identifier can be specified to indicate the spatial reference system that the resulting point is in.

If the point is constructed from coordinates, and if the X or Y coordinate is null, then an exception condition is raised (SQLSTATE 38SUP). If the Z or M coordinate is null, then the resulting point will not have a Z or M coordinate, respectively. If the point is constructed from its well-known text representation, its well-known binary representation, its shape representation, or its GML representation, and if the representation is null, then null is returned.

Syntax



coordinates:



Parameters

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting point.

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting point.

gml A value of type CLOB(2G) that represents the resulting point using the geography markup language.

shape A value of type BLOB(2G) that represents the shape representation of the resulting point.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting point.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

x_coordinate
A value of type DOUBLE that specifies the X coordinate for the resulting point.

y_coordinate
A value of type DOUBLE that specifies the Y coordinate for the resulting point.

z_coordinate
A value of type DOUBLE that specifies the Z coordinate for the resulting point.

If the *z_coordinate* parameter is omitted, the resulting point will not have a Z coordinate. The result of ST_Is3D is 0 (zero) for such a point.

m_coordinate
A value of type DOUBLE that specifies the M coordinate for the resulting point.

If the *m_coordinate* parameter is omitted, the resulting point will not have a measure. The result of ST_IsMeasured is 0 (zero) for such a point.

Return type

db2gse.ST_Point

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

Example 1

This example illustrates how ST_Point can be used to create and insert points. The first point is created using a set of X and Y coordinates. The second point is created using its well-known text representation. Both points are geometries in spatial reference system 1.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point)

INSERT INTO sample_points
  VALUES (1100, ST_Point (10, 20, 1) )

INSERT INTO sample_points
  VALUES (1101, ST_Point ('point (30 40)', 1) )
```

The following SELECT statement returns the points that were recorded in the table:

```
SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(90)) POINTS
  FROM sample_points
```

Results:

```
ID         POINTS
---------- ----------------------------------
      1110 POINT ( 10.00000000 20.00000000)
      1101 POINT ( 30.00000000 40.00000000)
```

Example 2

This example inserts a record into the SAMPLE_POINTS table with ID 1103 and a point value with an X coordinate of 120, a Y coordinate of 358, an M coordinate of 34, but no Z coordinate.

```
INSERT INTO SAMPLE_POINTS(ID, GEOMETRY)
 VALUES(1103, db2gse.ST_Point(120, 358, CAST(NULL AS DOUBLE), 34, 1))
 SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(90) ) POINTS
 FROM sample_points
```

Results:

```
ID         POINTS
 ---------- -----------------------------------------------
       1103 POINT M ( 120.0000000 358.0000000 34.00000000)
```

Example 3

This example inserts a row into the SAMPLE_POINTS table with ID 1104 and a point value with an X coordinate of 1003, a Y coordinate of 9876, a Z coordinate of 20, and in spatial reference system 0, using the geography markup language for its representation.

```
INSERT INTO SAMPLE_POINTS(ID, GEOMETRY)
 VALUES(1104, db2gse.ST_Point('<gml:Point><gml:coord>
    <gml:x>1003</gml:X><gml:Y>9876</gml:Y><gml:Z>20</gml:Z>
    </gml:coord></gml:Point>', 1))
 SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(90) ) POINTS
 FROM sample_points
```

Results:

```
ID         POINTS
 ---------- ------------------------------------------------
       1104 POINT Z ( 1003.000000 9876.000000 20.00000000)
```

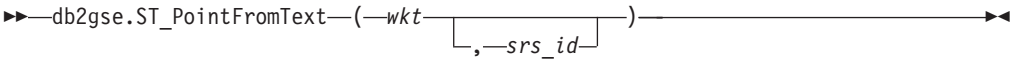
ST_PointFromText

ST_PointFromText takes a well-known text representation of a point and, optionally, a spatial reference system identifier as input parameters and returns the corresponding point.

If the given well-known text representation is null, then null is returned.

The recommended function for achieving the same result is the ST_Point function. It is recommended because of its flexibility: ST_Point takes additional forms of input as well as the well-known text representation.

Syntax



Parameters

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting point.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting point.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_Point

Example

This example illustrates how ST_PointFromText can be used to create and insert a point from its well-known text representation. The record that is inserted has ID = 1110, and the geometry is a point in spatial reference system 1. The point is in the well-known text representation of a point. The X and Y coordinates for this geometry are: (10, 20).

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point)

INSERT INTO sample_points
  VALUES (1110, ST_PointFromText ('point (30 40)', 1) )
```

The following SELECT statement returns the polygon that was recorded in the table:

```
SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(35) ) POINTS
  FROM sample_points
  WHERE id = 1110
```

Results:

```
ID         POINTS
---------- --------------------------------------
      1110 POINTS ( 30.00000000 40.00000000)
```

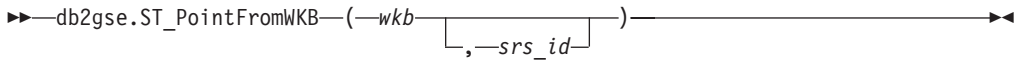
ST_PointFromWKB

ST_PointFromWKB takes a well-known binary representation of a point and, optionally, a spatial reference system identifier as input parameters and returns the corresponding point.

If the given well-known binary representation is null, then null is returned.

The recommended function for achieving the same result is the ST_Point function. It is recommended because of its flexibility: ST_Point takes additional forms of input as well as the well-known binary representation.

Syntax



Parameters

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting point.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting point.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used implicitly.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_Point

Example

This example illustrates how ST_PointFromWKB can be used to create a point from its well-known binary representation. The geometries are points in spatial reference system 1. In this example, the points get stored in the GEOMETRY column of the SAMPLE_POLYS table, and then the WKB column is updated with their well-known binary representations (using the ST_AsBinary function). Finally, the ST_PointFromWKB function is used to return the points from the WKB column.

The SAMPLE_POINTS table has a GEOMETRY column, where the points are stored, and a WKB column, where the points' well-known binary representations are stored.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point, wkb BLOB(32K))

INSERT INTO sample_points
  VALUES (10, ST_Point ('point (44 14)', 1) ),
```

```
  VALUES (11, ST_Point ('point (24 13)', 1))

UPDATE sample_points AS temporary_correlated
  SET wkb = ST_AsBinary( geometry )
  WHERE id = temporary_correlated.id
```

In the following SELECT statement, the ST_PointFromWKB function is used to retrieve the points from the WKB column.

```
SELECT id, CAST( ST_AsText( ST_PolyFromWKB (wkb) ) AS VARCHAR(35) ) POINTS
  FROM sample_points
```

Results:

```
ID         POINTS
---------- -----------------------------------
        10 POINT ( 44.00000000 14.00000000)
        11 POINT ( 24.00000000 13.00000000)
```

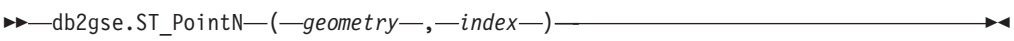
ST_PointN

ST_PointN takes a linestring or a multipoint and an index as input parameters and returns that point in the linestring or multipoint that is identified by the index. The resulting point is represented in the spatial reference system of the given linestring or multipoint.

If the given linestring or multipoint is null or is empty, then null is returned. If the index is smaller than 1 or larger than the number of points in the linestring or multipoint, then null is returned and a warning condition is returned (SQLSTATE 01HS2).

This function can also be called as a method.

Syntax



Parameters

geometry
A value of type ST_LineString or ST_MultiPoint that represents the geometry from which the point that is identified by *index* is returned.

index A value of type INTEGER that identifies the *n*th point which is to be returned from *geometry*.

Return type

db2gse.ST_Point

Example

The following example illustrates the use of ST_PointN.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines (id INTEGER, line ST_LineString)

INSERT INTO sample_lines
```

```
  VALUES (1, ST_LineString ('linestring (10 10, 5 5, 0 0, 10 0, 5 5, 0 10)', 0) )

SELECT id, CAST ( ST_AsText (ST_PointN (line, 2) ) AS VARCHAR(60) ) SECOND_INDEX
  FROM sample_lines
```

Results:

```
ID        SECOND_INDEX
--------- --------------------------------
        1 POINT (5.00000000 5.00000000)
```

ST_PointOnSurface

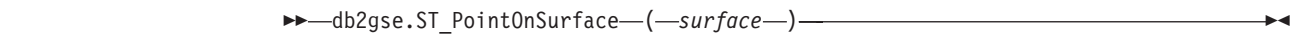
ST_PointOnSurface takes a surface or a multisurface as an input parameter and returns a point that is guaranteed to be in the interior of the surface or multisurface. This point is the paracentroid of the surface.

The resulting point is represented in the spatial reference system of the given surface or multisurface.

If the given surface or multisurface is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameter

surface
A value of type ST_Surface, ST_MultiSurface, or one of their subtypes that represents the geometry for which a point on the surface is returned.

Return type

db2gse.ST_Point

Example

In the following example, two polygons are created and then ST_PointOnSurface is used. One of the polygons has a hole in its center. The returned points are on the surface of the polygons. They are not necessarily at the exact center of the polygons.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1,
          ST_Polygon ('polygon ( (40 120, 90 120, 90 150, 40 150, 40 120) ,
                        (50 130, 80 130, 80 140, 50 140, 50 130) )' ,0) )
INSERT INTO sample_polys
  VALUES (2,
          ST_Polygon ('polygon ( (10 10, 50 10, 10 30, 10 10) )', 0) )

SELECT id, CAST (ST_AsText (ST_PointOnSurface (geometry) ) AS VARCHAR(80) )
  POINT_ON_SURFACE
  FROM sample_polys
```

Results:

```
ID          POINT_ON_SURFACE
----------- ----------------------------------
          1 POINT ( 65.00000000 125.00000000)
          2 POINT ( 30.00000000 15.00000000)
```

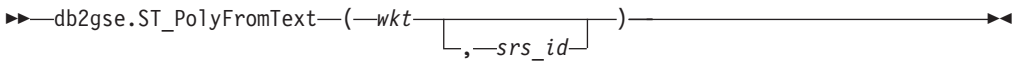
ST_PolyFromText

ST_PolyFromText takes a well-known text representation of a polygon and, optionally, a spatial reference system identifier as input parameters and returns the corresponding polygon.

If the given well-known text representation is null, then null is returned.

The recommended function for achieving the same result is the ST_Polygon function. It is recommended because of its flexibility: ST_Polygon takes additional forms of input as well as the well-known text representation.

Syntax



Parameters

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting polygon.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting polygon.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_Polygon

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_PolyFromText can be used to create and insert a polygon from its well-known text representation. The record that is inserted has ID = 1110, and the geometry is a polygon in spatial reference system 1. The polygon is in the well-known text representation of a polygon. The X and Y coordinates for this geometry are: (50, 20) (50, 40) (70, 30).

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1110, ST_PolyFromText ('polygon ((50 20, 50 40, 70 30, 50 20))', 1) )
```

The following SELECT statement returns the polygon that was recorded in the table:

```
SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(120) ) POLYGON
  FROM sample_polys
  WHERE id = 1110
```

Results:

```
ID         POLYGON
---------- ----------------------------------------------------------------
      1110 POLYGON (( 50.00000000 20.00000000, 70.00000000 30.00000000,
                      50.00000000 40.00000000, 50.00000000 20.00000000))
```

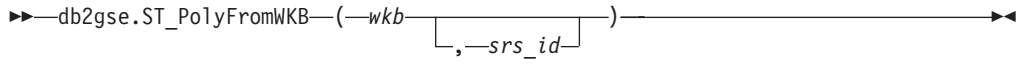
ST_PolyFromWKB

ST_PolyFromWKB takes a well-known binary representation of a polygon and, optionally, a spatial reference system identifier as input parameters and returns the corresponding polygon.

If the given well-known binary representation is null, then null is returned.

The recommended function for achieving the same result is the ST_Polygon function. It is recommended because of its flexibility: ST_Polygon takes additional forms of input as well as the well-known binary representation.

Syntax



Parameters

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting polygon.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting polygon.

If the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_Polygon

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_PolyFromWKB can be used to create a polygon from its well-known binary representation. The geometry is a polygon in spatial reference system 1. In this example, the polygon gets stored with ID = 1115 in the GEOMETRY column of the SAMPLE_POLYS table, and then the WKB column is updated with its well-known binary representation (using the ST_AsBinary function). Finally, the ST_PolyFromWKB function is used to return the multipolygon from the WKB column. The X and Y coordinates for this geometry are: (50, 20) (50, 40) (70, 30).

The SAMPLE_POLYS table has a GEOMETRY column, where the polygon is stored, and a WKB column, where the polygon's well-known binary representation is stored.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon,
  wkb BLOB(32K))

INSERT INTO sample_polys
  VALUES (10, ST_Polygon ('polygon ((50 20, 50 40, 70 30, 50 20))', 1) )

UPDATE sample_polys AS temporary_correlated
  SET wkb = ST_AsBinary( geometry )
  WHERE id = temporary_correlated.id
```

In the following SELECT statement, the ST_PolyFromWKB function is used to retrieve the polygon from the WKB column.

```
SELECT id, CAST( ST_AsText( ST_PolyFromWKB (wkb) )
  AS VARCHAR(120) ) POLYGON
  FROM sample_polys
  WHERE id = 1115
```

Results:

```
ID         POLYGON
---------- ------------------------------------------------------------
      1115 POLYGON (( 50.00000000 20.00000000, 70.00000000
              30.00000000,50.00000000 40.00000000, 50.00000000
              20.00000000))
```

ST_Polygon

ST_Polygon constructs a polygon from one of the following inputs:

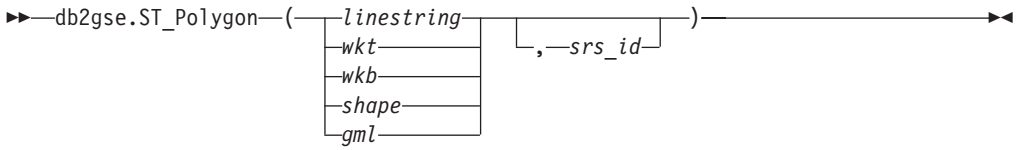
- A closed linestring that defines the exterior ring of the resulting polygon
- A well-known text representation
- A well-known binary representation
- A shape representation
- A representation in the geography markup language (GML)

An optional spatial reference system identifier can be specified to identify the spatial reference system that the resulting polygon is in.

If the polygon is constructed from a linestring and the given linestring is null, then null is returned. If the given linestring is empty, then an empty polygon is returned. If the polygon is constructed from its well-known text representation, its well-known binary representation, its shape representation, or its GML representation, and if the representation is null, then null is returned.

This function can also be called as a method for the following cases only: ST_Polygon(*linestring*) and ST_Polygon(*linestring*, *srs_id*).

Syntax



Parameters

linestring
A value of type ST_LineString that represents the linestring that defines the exterior ring for the outer boundary. If *linestring* is not closed and simple, an exception condition is raised (SQLSTATE 38SSL).

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting polygon.

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting polygon.

shape A value of type BLOB(2G) that represents the shape representation of the resulting polygon.

gml A value of type CLOB(2G) that represents the resulting polygon using the geography markup language.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting polygon.

If the polygon is constructed from a given *linestring* parameter and the *srs_id* parameter is omitted, then the spatial reference system from *linestring* is used implicitly. Otherwise, if the *srs_id* parameter is omitted, the spatial reference system with the numeric identifier 0 (zero) is used.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_Polygon

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_Polygon can be used to create and insert polygons. Three polygons are created and inserted. All of them are geometries in spatial reference system 1.

- The first polygon is created from a ring (a closed and simple linestring). The X and Y coordinates for this polygon are: (10, 20) (10, 40) (20, 30).
- The second polygon is created using its well-known text representation. The X and Y coordinates for this polygon are: (110, 120) (110, 140) (120, 130).
- The third polygon is a donut polygon. A donut polygon consists of an interior and an exterior polygon. This donut polygon is created using its well-known text representation. The X and Y coordinates for the exterior polygon are: (110,

120) (110, 140) (130, 140) (130, 120) (110, 120). The X and Y coordinates for the interior polygon are: (115, 125) (115, 135) (125, 135) (125, 135) (115, 125).

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1100,
          ST_Polygon (ST_LineString ('linestring
                     (10 20, 10 40, 20 30, 10 20)',1), 1))

INSERT INTO sample_polys
  VALUES (1101,
          ST_Polygon ('polygon
                    ((110 120, 110 140, 120 130, 110 120))', 1))

INSERT INTO sample_polys
  VALUES (1102,
          ST_Polygon ('polygon
                    ((110 120, 110 140, 130 140, 130 120, 110 120),
                    (115 125, 115 135, 125 135, 125 135, 115 125))', 1))
```

The following SELECT statement returns the polygons that were recorded in the table:

```
SELECT id, CAST( ST_AsText( geometry ) AS VARCHAR(120) ) POLYGONS
  FROM sample_polys
```

Results:

```
ID          POLYGONS
------- ------------------------------------------------------------------
   1110 POLYGON (( 10.00000000 20.00000000, 20.00000000 30.00000000
                   10.00000000 40.00000000, 10.00000000 20.00000000))

   1101 POLYGON (( 110.00000000 120.00000000, 120.00000000 130.00000000
                   110.00000000 140.00000000, 110.00000000 120.00000000))

   1102 POLYGON (( 110.00000000 120.00000000, 130.00000000 120.00000000
                   130.00000000 140.00000000, 110.00000000 140.00000000
                   110.00000000 120.00000000),
                 ( 115.00000000 125.00000000, 115.00000000 135.00000000
                   125.00000000 135.00000000, 125.00000000 135.00000000
                   115.00000000 125.00000000))
```

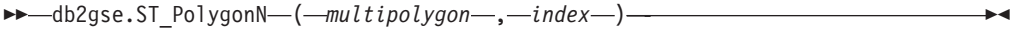
ST_PolygonN

ST_PolygonN takes a multipolygon and an index as input parameters and returns the polygon that is identified by the index. The resulting polygon is represented in the spatial reference system of the given multipolygon.

If the given multipolygon is null or is empty, or if the index is smaller than 1 or larger than the number of polygons, then null is returned.

This function can also be called as a method.

Syntax



Parameters

multipolygon
A value of type ST_MultiPolygon that represents the multipolygon from which the polygon that is identified by *index* is returned.

index A value of type INTEGER that identifies the *n*th polygon that is to be returned from *multipolygon*.

Return type

db2gse.ST_Polygon

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display

This example illustrates the use of ST_PolygonN.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_mpolys (id INTEGER, geometry ST_MultiPolygon)

INSERT INTO sample_mpolys
  VALUES (1, ST_Polygon ('multipolygon (((3 3, 4 6, 5 3, 3 3),
                                         (8 24, 9 25, 1 28, 8 24)
                                         (13 33, 7 36, 1 40, 10 43,
                                          13 33)))', 1))

SELECT id, CAST ( ST_AsText (ST_PolygonN (geometry, 2) )
    AS VARCHAR(120) ) SECOND_INDEX
FROM sample_mpolys
```

Results:

```
ID        SECOND_INDEX
--------- ------------------------------------------------------------
        1 POLYGON (( 8.00000000 24.00000000, 9.00000000 25.00000000,
                     1.00000000 28.00000000, 8.00000000 24.00000000))
```

ST_Relate

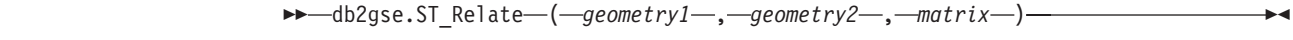
ST_Relate takes two geometries and a Dimensionally Extended 9 Intersection Model (DE-9IM) matrix as input parameters and returns 1 if the given geometries meet the conditions specified by the matrix. Otherwise, 0 (zero) is returned.

If any of the given geometries is null or is empty, then null is returned.

If the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system.

This function can also be called as a method.

Syntax



Parameters

geometry1
A value of type ST_Geometry or one of its subtypes that represents the geometry that is tested against *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the geometry that is tested against *geometry1*.

matrix A value of CHAR(9) that represents the DE-9IM matrix which is to be used for the test of *geometry1* and *geometry2*.

Return type

INTEGER

Example

The following code creates two separate polygons. Then, the ST_Relate function is used to determine several relationships between the two polygons. For example, whether the two polygons overlap.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_polys (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_polys
  VALUES (1,
          ST_Polygon('polygon ( (40 120, 90 120, 90 150, 40 150, 40 120) )', 0))
INSERT INTO sample_polys
  VALUES (2,
          ST_Polygon('polygon ( (30 110, 50 110, 50 130, 30 130, 30 110) )', 0))

SELECT ST_Relate(a.geometry, b.geometry, 'T*T***T**')  "Overlaps  ",
       ST_Relate(a.geometry, b.geometry, 'T*T***FF*')  "Contains  ",
       ST_Relate(a.geometry, b.geometry, 'T*F**F***')  "Within    "
       ST_Relate(a.geometry, b.geometry, 'T********')  "Intersects",
       ST_Relate(a.geometry, b.geometry, 'T*F**FFF2')  "Equals    "
  FROM sample_polys a, sample_polys b
  WHERE a.id = 1 AND b.id = 2
```

Results:

```
Overlaps    Contains    Within      Intersects  Equals
----------- ----------- ----------- ----------- -----------
          1           0           0           1           0
```

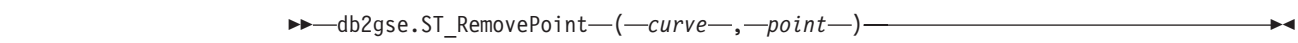
ST_RemovePoint

ST_RemovePoint takes a curve and a point as input parameters and returns the given curve with all points equal to the specified point removed from it. If the given curve has Z or M coordinates, then the point must also have Z or M coordinates. The resulting geometry is represented in the spatial reference system of the given geometry.

If the given curve is empty, then an empty curve is returned. If the given curve is null, or if the given point is null or empty, then null is returned.

This function can also be called as a method.

Syntax



Parameters

curve A value of type ST_Curve or one of its subtypes that represents the curve from which *point* is removed.

point A value of type ST_Point that identifies the points that are removed from *curve*.

Return type

db2gse.ST_Curve

Examples

Example 1

In the following example, two linestrings are added to the SAMPLE_LINES table. These linestrings are used in the examples below.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines (id INTEGER, line ST_LineString)

INSERT INTO sample_lines
  VALUES (1,ST_LineString('linestring
         (10 10, 5 5, 0 0, 10 0, 5 5, 0 10)', 0))

INSERT INTO sample_lines
  VALUES (2, ST_LineString('linestring z
         (0 0 4, 5 5 5, 10 10 6, 5 5 7, 0 0 8)', 0))
```

In the following examples, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

Example 2

The following example removes the point (5, 5) from the linestring that has ID = 1. This point occurs twice in the linestring. Therefore, both occurrences are removed.

```
SELECT CAST(ST_AsText (ST_RemovePoint (line, ST_Point(5, 5) ) )
  AS VARCHAR(120) ) RESULT
  FROM sample_lines
  WHERE id = 1
```

Results:

```
RESULT
------------------------------------------------------------
LINESTRING ( 10.00000000 10.00000000, 0.00000000 0.00000000,
             10.00000000 0.00000000, 0.00000000 10.00000000)
```

Example 3

The following example removes the point (5, 5, 5) from the linestring that has ID = 2. This point occurs only once, so only that occurrence is removed.

```
SELECT CAST (ST_AsText (ST_RemovePoint (line, ST_Point(5.0, 5.0, 5.0)))
  AS VARCHAR(160) ) RESULT
  FROM sample_lines
  WHERE id=2
```

Results:

```
RESULT
------------------------------------------------------------------------
LINESTRING Z ( 0.00000000 0.00000000 4.00000000, 10.00000000 10.00000000
               6.00000000,  5.00000000 5.00000000 7.00000000, 0.00000000
               0.00000000 8.00000000)
```

ST_SrsId, ST_SRID

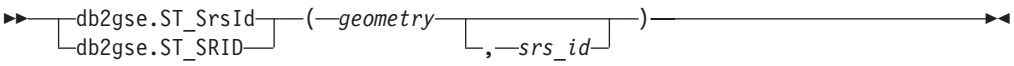
ST_SrsId (or ST_SRID) takes a geometry and, optionally, a spatial reference system identifier as input parameters. What it returns depends on what input parameters are specified:

- If the spatial reference system identifier is specified, it returns the geometry with its spatial reference system changed to the specified spatial reference system. No transformation of the geometry is performed.
- If no spatial reference system identifier is given as an input parameter, the current spatial reference system identifier of the given geometry is returned.

If the given geometry is null, then null is returned.

These functions can also be called as methods.

Syntax



Parameters

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry for which the spatial reference system identifier is to be set or returned.

srs_id A value of type INTEGER that identifies the spatial reference system to be used for the resulting geometry.

Attention: If this parameter is specified, the geometry is not transformed, but is returned with its spatial reference system changed to the specified spatial reference system. As a result of changing to the new spatial reference system, the data might be corrupted. For transformations, use ST_Transform instead.

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return types

- INTEGER, if an srs_id is not specified
- db2gse.ST_Geometry, if an srs_id is specified

Example

Two points are created in two different spatial reference systems. The ID of the spatial reference system that is associated with each point can be found by using the ST_SrsId function.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point)

INSERT INTO sample_points
  VALUES (1, ST_Point( 'point (80 180)', 0 ) )
INSERT INTO sample_points
  VALUES (2, ST_Point( 'point (-74.21450127 + 42.03415094)', 1 ) )

SELECT id, ST_SRSId (geometry) SRSID
  FROM sample_points
```

Results:

```
ID          SRSID
----------- -----------
          1           0
          2           1
```

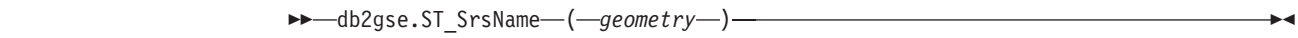
ST_SrsName

ST_SrsName takes a geometry as an input parameter and returns the name of the spatial reference system in which the given geometry is represented.

If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry for which the name of the spatial reference system is returned.

Return type

VARCHAR(128)

Example

Two points are created in different spatial reference systems. The ST_SrsName function is used to find out the name of the spatial reference system that is associated with each point.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry, ST_Point)

INSERT INTO sample_points
  VALUES (1, ST_Point ('point (80 180)', 0) )
```

```
INSERT INTO sample_points
  VALUES (2, ST_Point ('point (-74.21450127 + 42.03415094)', 1) )

SELECT id, ST_SrsName (geometry) SRSNAME
  FROM sample_points
```

Results:

```
ID          SRSNAME
----------- ------------------------------
          1 DEFAULT_SRS
          2 NAD83_SRS_1
```

ST_StartPoint

ST_StartPoint takes a curve as an input parameter and returns the point that is the first point of the curve. The resulting point is represented in the spatial reference system of the given curve. This result is equivalent to the function call ST_PointN(*curve*, 1)

If the given curve is null or is empty, then null is returned.

This function can also be called as a method.

Syntax

Parameters

curve A value of type ST_Curve or one of its subtypes that represents the geometry from which the first point is returned.

Return type

db2gse.ST_Point

Example

In the following example, two linestrings are added to the SAMPLE_LINES table. The first one is a linestring with X and Y coordinates. The second one is a linestring with X, Y, and Z coordinates. The ST_StartPoint function is used to return the first point in each linestring.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_lines (id INTEGER, line ST_LineString)

INSERT INTO sample_lines
  VALUES (1, ST_LineString ('linestring
         (10 10, 5 5, 0 0, 10 0, 5 5, 0 10)', 0))

INSERT INTO sample_lines
  VALUES (1, ST_LineString ('linestring z
         (0 0 4, 5 5 5, 10 10 6, 5 5 7, 0 0 8)', 0))

SELECT id, CAST( ST_AsText( ST_StartPoint( line ) ) AS VARCHAR(80))
  START_POINT
  FROM sample_lines
```

Results:

```
ID          START_POINT
----------- ----------------------------------------
          1 POINT ( 10.00000000 10.00000000)
          2 POINT Z ( 0.00000000 0.00000000 4.00000000)
```

ST_SymDifference

ST_SymDifference takes two geometries as input parameters and returns the geometry that is the symmetrical difference of the two geometries. The symmetrical difference is the nonintersecting part of the two given geometries. The resulting geometry is represented in the spatial reference system of the first geometry. The dimension of the returned geometry is the same as that of the input geometries. Both geometries must be of the same dimension.

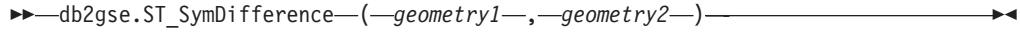
For non–geodetic data, if the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system. For geodetic data, both geometries must be in the same geodetic spatial reference system (SRS).

If the geometries are equal, an empty geometry of type ST_Point is returned. If either geometry is null, then null is returned.

The resulting geometry is represented in the most appropriate spatial type. If it can be represented as a point, linestring, or polygon, then one of those types is used. Otherwise, the multipoint, multilinestring, or multipolygon type is used.

This function can also be called as a method.

Syntax



Parameters

geometry1
A value of type ST_Geometry or one of its subtypes that represents the first geometry to compute the symmetrical difference with *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the second geometry to compute the symmetrical difference with *geometry1*.

Restrictions for geodetic data:

- Both geometries must be geodetic and they both must be in the same geodetic SRS.
- ST_SymDifference supports only ST_Point, ST_Polygon, ST_MultiPoint, and ST_MultiPolygon data types.

Return type

db2gse.ST_Geometry

Examples

Example 1

This example illustrates the use of the ST_SymDifference function. The geometries are stored in the SAMPLE_GEOMS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms
  VALUES (1,
          ST_Geometry ('polygon ( (10 10, 10 20, 20 20, 20 10, 10 10) )', 0))

INSERT INTO sample_geoms
  VALUES
    (2, ST_Geometry ('polygon ( (30 30, 30 50, 50 50, 50 30, 30 30) )', 0))

INSERT INTO sample_geoms
  VALUES
    (3,ST_Geometry ('polygon ( (40 40, 40 60, 60 60, 60 40, 40 40) )', 0))

INSERT INTO sample_geoms
  VALUES
    (4, ST_Geometry ('linestring (70 70, 80 80)' , 0) )

INSERT INTO sample_geoms
  VALUES
    (5, ST_Geometry('linestring(75 75, 90 90)' ,0));
```

In the following examples, the results have been reformatted for readability. Your results will vary according to your display.

Example 2

This example uses ST_SymDifference to return the symmetric difference of two disjoint polygons in the SAMPLE_GEOMS table.

```
SELECT a.id, b.id,
    CAST (ST_AsText (ST_SymDifference (a.geometry, b.geometry) )
    AS VARCHAR(350) ) SYM_DIFF
  FROM sample_geoms a, sample_geoms b
  WHERE a.id = 1 AND b.id = 2
```

Results:

```
ID    ID    SYM_DIFF
----- ----- ----------------------------------------------------------------
    1     2 MULTIPOLYGON ((( 10.00000000 10.00000000, 20.00000000 10.00000000,
              20.00000000 20.00000000, 10.00000000 20.00000000,
              10.00000000 10.00000000)),
                          (( 30.00000000 30.00000000, 50.00000000 30.00000000,
              50.00000000 50.00000000, 30.00000000 50.00000000,
              30.00000000 30.00000000)))
```

Example 3

This example uses ST_SymDifference to return the symmetric difference of two intersecting polygons in the SAMPLE_GEOMS table.

```
SELECT a.id, b.id,
    CAST (ST_AsText (ST_SymDifference (a.geometry, b.geometry) )
    AS VARCHAR(500) ) SYM_DIFF
  FROM sample_geoms a, sample_geoms b
  WHERE a.id = 2 AND b.id = 3
```

Results:

```
ID  ID  SYM_DIFF
--- --- ------------------------------------------------------------------
  2   3  MULTIPOLYGON ((( 40.00000000 50.00000000, 50.00000000 50.00000000,
           50.00000000 40.00000000, 60.00000000 40.00000000,
           60.00000000 60.00000000, 40.00000000 60.00000000,
           40.00000000 50.00000000)),
                       (( 30.00000000 30.00000000, 50.00000000 30.00000000,
           50.00000000 40.00000000, 40.00000000 40.00000000,
           40.00000000 50.00000000, 30.00000000 50.00000000,
           30.00000000 30.00000000)))
```

Example 4

This example uses ST_SymDifference to return the symmetric difference of two intersecting linestrings in the SAMPLE_GEOMS table.

```
SELECT a.id, b.id,
    CAST (ST_AsText (ST_SymDifference (a.geometry, b.geometry) )
    AS VARCHAR(350) ) SYM_DIFF
  FROM sample_geoms a, sample_geoms b
  WHERE a.id = 4 AND b.id = 5
```

Results:

```
ID   ID  SYM_DIFF
---- --- ------------------------------------------------------------------
   4   5 MULTILINESTRING (( 70.00000000 70.00000000, 75.00000000 75.00000000),
              ( 80.00000000 80.00000000, 90.00000000 90.00000000))
```

ST_ToGeomColl

ST_ToGeomColl takes a geometry as an input parameter and converts it to a geometry collection. The resulting geometry collection is represented in the spatial reference system of the given geometry.

If the specified geometry is empty, then it can be of any type. However, it is then converted to ST_Multipoint, ST_MultiLineString, or ST_MultiPolygon as appropriate.

If the specified geometry is not empty, then it must be of type ST_Point, ST_LineString, or ST_Polygon. These are then converted to ST_Multipoint, ST_MultiLineString, or ST_MultiPolygon respectively.

If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that is converted to a geometry collection.

Return type

db2gse.ST_GeomCollection

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display

This example illustrates the use of the ST_ToGeomColl function.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES (1, ST_Polygon ('polygon ((3 3, 4 6, 5 3, 3 3))', 1)),
         (2, ST_Point ('point (1 2)', 1))
```

In the following SELECT statement, the ST_ToGeomColl function is used to return geometries as their corresponding geometry collection subtypes.

```
SELECT id, CAST( ST_AsText( ST_ToGeomColl(geometry) )
    AS VARCHAR(120) ) GEOM_COLL
FROM sample_geometries
```

Results:

```
ID          GEOM_COLL
----------- ----------------------------------------------------
          1 MULTIPOLYGON ((( 3.00000000 3.00000000, 5.00000000
                             3.00000000, 4.00000000 6.00000000,
                             3.00000000 3.00000000)))
          2 MULTIPOINT ( 1.00000000 2.00000000)
```

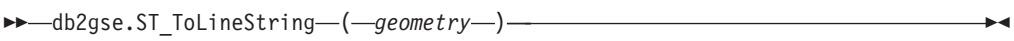
ST_ToLineString

ST_ToLineString takes a geometry as an input parameter and converts it to a linestring. The resulting linestring is represented in the spatial reference system of the given geometry.

The given geometry must be empty or a linestring. If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that is converted to a linestring.

A geometry can be converted to a linestring if it is empty or a linestring. If the conversion cannot be performed, then an exception condition is raised (SQLSTATE 38SUD).

Return type

db2gse.ST_LineString

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display

This example illustrates the use of the ST_ToLineString function.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES (1, ST_Geometry ('linestring z (0 10 1, 0  0 3, 10 0 5)', 0)),
         (2, ST_Geometry ('point empty', 1) ),
         (3, ST_Geometry ('multipolygon empty', 1) )
```

In the following SELECT statement, the ST_ToLineString function is used to return linestrings converted to ST_LineString from the static type of ST_Geometry.

```
SELECT CAST( ST_AsText( ST_ToLineString(geometry) )
     AS VARCHAR(130) ) LINES
FROM sample_geometries
```

Results:

```
LINES
------------------------------------------------------------------
LINESTRING Z ( 0.00000000 10.00000000 1.00000000, 0.00000000
               0.00000000 3.00000000, 10.00000000 0.00000000
               5.00000000)
LINESTRING EMPTY
LINESTRING EMPTY
```

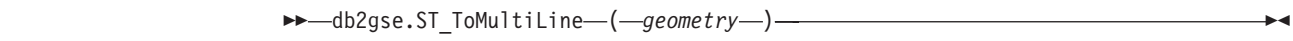
ST_ToMultiLine

ST_ToMultiLine takes a geometry as an input parameter and converts it to a multilinestring. The resulting multilinestring is represented in the spatial reference system of the given geometry.

The given geometry must be empty, a multilinestring, or a linestring. If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry

A value of type ST_Geometry or one of its subtypes that represents the geometry that is converted to a multilinestring.

A geometry can be converted to a multilinestring if it is empty, a linestring, or a multilinestring. If the conversion cannot be performed, then an exception condition is raised (SQLSTATE 38SUD).

Return type

db2gse.ST_MultiLineString

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display

This example illustrates the use of the ST_ToMultiLine function.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES (1, ST_Geometry ('multilinestring ((0 10 1, 0 0 3, 10 0 5),
                                           (23 43, 27 34, 35 12))', 0) ),
         (2, ST_Geometry ('linestring z (0 10 1, 0 0 3, 10 0 5)', 0) ),
         (3, ST_Geometry ('point empty', 1) ),
         (4, ST_Geometry ('multipolygon empty', 1) )
```

In the following SELECT statement, the ST_ToMultiLine function is used to return multilinestrings converted to ST_MultiLineString from the static type of ST_Geometry.

```
SELECT CAST( ST_AsText( ST_ToMultiLine(geometry) )
  AS VARCHAR(130) ) LINES
  FROM sample_geometries
```

Results:

```
LINES
-----------------------------------------------------
MULTILINESTRING Z ( 0.00000000 10.00000000 1.00000000,
                    0.00000000 0.00000000 3.00000000,
                   10.00000000 0.00000000 5.00000000)
MULTILINESTRING EMPTY
MULTILINESTRING EMPTY
```

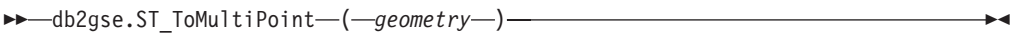
ST_ToMultiPoint

ST_ToMultiPoint takes a geometry as an input parameter and converts it to a multipoint. The resulting multipoint is represented in the spatial reference system of the given geometry.

The given geometry must be empty, a point, or a multipoint. If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that is converted to a multipoint.

A geometry can be converted to a multipoint if it is empty, a point, or a multipoint. If the conversion cannot be performed, then an exception condition is raised (SQLSTATE 38SUD).

Return type

db2gse.ST_MultiPoint

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display

This example illustrates the use of the ST_ToMultiPoint function.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES (1, ST_Geometry ('multipoint (0 0, 0 4)', 1) ),
         (2, ST_Geometry ('point (30 40)', 1) ),
         (3, ST_Geometry ('multipolygon empty', 1) )
```

In the following SELECT statement, the ST_ToMultiPoint function is used to return multipoints converted to ST_MultiPoint from the static type of ST_Geometry.

```
SELECT CAST( ST_AsText( ST_ToMultiPoint(geometry))
  AS VARCHAR(62) ) MULTIPOINTS
FROM sample_geometries
```

Results:

```
MULTIPOINTS
--------------------------------------------------------------
MULTIPOINT ( 0.00000000 0.00000000, 0.00000000 4.00000000)
MULTIPOINT ( 30.00000000 40.00000000)
MULTIPOINT EMPTY
```

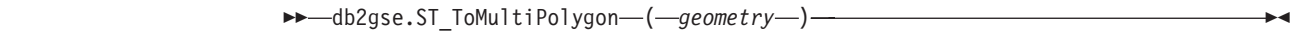
ST_ToMultiPolygon

ST_ToMultiPolygon takes a geometry as an input parameter and converts it to a multipolygon. The resulting multipolygon is represented in the spatial reference system of the given geometry.

The given geometry must be empty, a polygon, or a multipolygon. If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax



Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that is converted to a multipolygon.

A geometry can be converted to a multipolygon if it is empty, a polygon, or a multipolygon. If the conversion cannot be performed, then an exception condition is raised (SQLSTATE 38SUD).

Return type

db2gse.ST_MultiPolygon

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display

This example creates several geometries and then uses ST_ToMultiPolygon to return multipolygons.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES (1, ST_Geometry ('polygon ((0 0, 0 4, 5 4, 5 0, 0 0))', 1)),
         (2, ST_Geometry ('point empty', 1)),
         (3, ST_Geometry ('multipoint empty', 1))
```

In the following SELECT statement, the ST_ToMultiPolygon function is used to return multipolygons converted to ST_MultiPolygon from the static type of ST_Geometry.

```
SELECT CAST( ST_AsText( ST_ToMultiPolygon(geometry) )
  AS VARCHAR(130) ) POLYGONS
  FROM sample_geometries
```

Results:

```
POLYGONS
------------------------------------------------------------------------
MULTIPOLYGON (( 0.00000000 0.00000000, 5.00000000 0.00000000,
                5.00000000 4.00000000, 0.00000000 4.00000000,
                 0.00000000 0.00000000))

MULTIPOLYGON EMPTY

MULTIPOLYGON EMPTY
```

ST_ToPoint

ST_ToPoint takes a geometry as an input parameter and converts it to a point. The resulting point is represented in the spatial reference system of the given geometry.

The given geometry must be empty or a point. If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that is converted to a point.

A geometry can be converted to a point if it is empty or a point. If the conversion cannot be performed, then an exception condition is raised (SQLSTATE 38SUD).

Return type

db2gse.ST_Point

Example

This example creates three geometries in SAMPLE_GEOMETRIES and converts each to a point.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES (1, ST_Geometry ('point (30 40)', 1) ),
         (2, ST_Geometry ('linestring empty', 1) ),
         (3, ST_Geometry ('multipolygon empty', 1) )
```

In the following SELECT statement, the ST_ToPoint function is used to return points converted to ST_Point from the static type of ST_Geometry.

```
SELECT CAST( ST_AsText( ST_ToPoint(geometry) ) AS VARCHAR(35) ) POINTS
  FROM sample_geometries
```

Results:

```
POINTS
---------------------------------
POINT ( 30.00000000 40.00000000)
POINT EMPTY
POINT EMPTY
```

ST_ToPolygon

ST_ToPolygon takes a geometry as an input parameter and converts it to a polygon. The resulting polygon is represented in the spatial reference system of the given geometry.

The given geometry must be empty or a polygon. If the given geometry is null, then null is returned.

This function can also be called as a method.

Syntax

Parameter

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that is converted to a polygon.

A geometry can be converted to a polygon if it is empty or a polygon. If the conversion cannot be performed, then an exception condition is raised (SQLSTATE 38SUD).

Return type

db2gse.ST_Polygon

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display

This example creates three geometries in SAMPLE_GEOMETRIES and converts each to a polygon.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES (1, ST_Geometry ('polygon ((0 0, 0 4, 5 4, 5 0, 0 0))', 1) ),
         (2, ST_Geometry ('point empty', 1) ),
         (3, ST_Geometry ('multipolygon empty', 1) )
```

In the following SELECT statement, the ST_ToPolygon function is used to return polygons converted to ST_Polygon from the static type of ST_Geometry.

```
SELECT CAST( ST_AsText( ST_ToPolygon(geometry) ) AS VARCHAR(130) ) POLYGONS
  FROM sample_geometries
```

Results:

```
POLYGONS
--------------------------------------------------------------------------------
POLYGON (( 0.00000000 0.00000000, 5.00000000 0.00000000,
           5.00000000 4.00000000,0.00000000 4.00000000,
            0.00000000 0.00000000))

POLYGON EMPTY

POLYGON EMPTY
```

ST_Touches

ST_Touches takes two geometries as input parameters and returns 1 if the given geometries spatially touch. Otherwise, 0 (zero) is returned.

Two geometries touch if the interiors of both geometries do not intersect, but the boundary of one of the geometries intersects with either the boundary or the interior of the other geometry.

If the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system.

If both of the given geometries are points or multipoints, or if any of the given geometries is null or empty, then null is returned.

Syntax

Parameters

geometry1
A value of type ST_Geometry or one of its subtypes that represents the geometry that is to be tested to touch *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that represents the geometry that is to be tested to touch *geometry1*.

Return type

INTEGER

Example

Several geometries are added to the SAMPLE_GEOMS table. The ST_Touches function is then used to determine which geometries touch each other.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geoms
  VALUES (1, ST_Geometry('polygon ( (20 30, 30 30, 30 40, 20 40, 20 30) )' , 0) )

INSERT INTO sample_geoms
   VALUES (2, ST_Geometry('polygon ( (30 30, 30 50, 50 50, 50 30, 30 30) )' ,0) )

INSERT INTO sample_geoms
  VALUES (3, ST_Geometry('polygon ( (40 40, 40 60, 60 60, 60 40, 40 40) )' , 0) )

INSERT INTO sample_geoms
  VALUES (4, ST_Geometry('linestring( 60 60, 70 70 )' , 0) )

INSERT INTO sample_geoms
  VALUES (5, ST_Geometry('linestring( 30 30, 60 60 )' , 0) )

SELECT a.id, b.id, ST_Touches (a.geometry, b.geometry) TOUCHES
  FROM sample_geoms a, sample_geoms b
  WHERE b.id >= a.id
```

Results:

```
     ID          ID          TOUCHES
     ----------- ----------- -----------
               1           1           0
               1           2           1
               1           3           0
               1           4           0
               1           5           1
               2           2           0
               2           3           0
               2           4           0
               2           5           1
               3           3           0
               3           4           1
```

```
3          5          1
4          4          0
4          5          1
5          5          0
```

ST_Transform

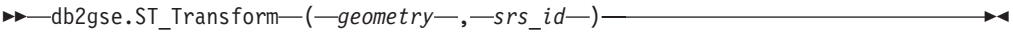
ST_Transform takes a geometry and a spatial reference system identifier as input parameters and transforms the geometry to be represented in the given spatial reference system. Projections and conversions between different coordinate systems are performed and the coordinates of the geometries are adjusted accordingly.

The geometry can be converted to the specified spatial reference system only if the geometry's current spatial reference system is based in the same geographic coordinate system as the specified spatial spatial reference system. If either the geometry's current spatial reference system or the specified spatial reference system is based on a projected coordinate system, a reverse projection is performed to determine the geographic coordinate system that underlies the projected one.

If the given geometry is null, then null will be returned.

This function can also be called as a method.

Syntax



Parameters

geometry
A value of type ST_Geometry or one of its subtypes that represents the geometry that is transformed to the spatial reference system identified by *srs_id*.

srs_id A value of type INTEGER that identifies the spatial reference system for the resulting geometry.

If the transformation to the specified spatial reference system cannot be performed because the current spatial reference system of *geometry* is not compatible with the spatial reference system identified by *srs_id*, then an exception condition is raised (SQLSTATE 38SUC).

If *srs_id* does not identify a spatial reference system listed in the catalog view DB2GSE.ST_SPATIAL_REFERENCE_SYSTEMS, then an exception condition is raised (SQLSTATE 38SU1).

Return type

db2gse.ST_Geometry

Examples

Example 1

The following example illustrates the use of ST_Transform to convert a geometry from one spatial reference system to another.

First, the state plane spatial reference system with an ID of 3 is created using a call to db2se.

```
db2se create_srs SAMP_DB
   -srsId 3 -srsName z3101a -xOffset 0 -yOffset 0 -xScale 1 -yScale 1
   - coordsysName NAD_1983_StatePlane_New_York_East_FIPS_3101_Feet
```

Then, points are added to:

- The SAMPLE_POINTS_SP table in state plane coordinates using that spatial reference system.
- The SAMPLE_POINTS_LL table using coordinates specified in latitude and longitude.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points_sp (id INTEGER, geometry ST_Point)
CREATE TABLE sample_points_ll (id INTEGER, geometry ST_Point)

INSERT INTO sample_points_sp
  VALUES (12457, ST_Point('point ( 567176.0 1166411.0)', 3) )

INSERT INTO sample_points_sp
  VALUES (12477, ST_Point('point ( 637948.0 1177640.0)', 3) )

INSERT INTO sample_points_ll
  VALUES (12457, ST_Point('point ( -74.22371600 42.03498700)', 1) )

INSERT INTO sample_points_ll
  VALUES (12477, ST_Point('point ( -73.96293200 42.06487900)', 1) )
```

Then the ST_Transform function is used to convert the geometries.

Example 2

This example converts points that are in latitude and longitude coordinates to state plane coordinates.

```
SELECT id, CAST( ST_AsText( ST_Transform( geometry, 3) )
    AS VARCHAR(100) ) STATE_PLANE
  FROM sample_points_ll
```

Results:

```
ID          STATE_PLANE
----------- ----------------------------------------
      12457 POINT ( 567176.00000000 1166411.00000000)
      12477 POINT ( 637948.00000000 1177640.00000000)
```

Example 3

This example converts points that are in state plane coordinates to latitude and longitude coordinates.

```
SELECT id, CAST( ST_AsText( ST_Transform( geometry, 1) )
    AS VARCHAR(100) ) LAT_LONG
  FROM sample_points_sp
```

Results:

```
ID          LAT_LONG
----------- ----------------------------------------------------------------
      12457 POINT ( -74.22371500 42.03498800)
      12477 POINT ( -73.96293100 42.06488000)
```

ST_Union

ST_Union takes two geometries as input parameters and returns the geometry that is the union of the given geometries. The resulting geometry is represented in the spatial reference system of the first geometry.

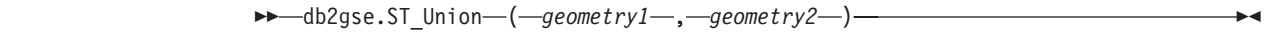
Both geometries must be of the same dimension. If any of the two given geometries is null, null is returned.

For non–geodetic data, if the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system. For geodetic data, both geometries must be in the same geodetic spatial reference system (SRS).

The resulting geometry is represented in the most appropriate spatial type. If it can be represented as a point, linestring, or polygon, then one of those types is used. Otherwise, the multipoint, multilinestring, or multipolygon type is used.

This function can also be called as a method.

Syntax



Parameters

geometry1
A value of type ST_Geometry or one of its subtypes that is combined with *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that is combined with *geometry1*.

Restrictions for geodetic data: Both geometries must be geodetic and they both must be in the same geodetic SRS.

Return type

db2gse.ST_Geometry

Examples

Example 1

The following SQL statements create and populate the SAMPLE_GEOMS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geoms (id INTEGER, geometry, ST_Geometry)

INSERT INTO sample_geoms
  VALUES (1, ST_Geometry( 'polygon
         ((10 10, 10 20, 20 20, 20 10, 10 10) )', 0))

INSERT INTO sample_geoms
  VALUES (2, ST_Geometry( 'polygon
         ((30 30, 30 50, 50 50, 50 30, 30 30) )', 0))
```

```
INSERT INTO sample_geoms
  VALUES (3, ST_Geometry( 'polygon
         ((40 40, 40 60, 60 60, 60 40, 40 40) )', 0))

INSERT INTO sample_geoms
  VALUES (4, ST_Geometry('linestring (70 70, 80 80)', 0))

INSERT INTO sample_geoms
  VALUES (5, ST_Geometry('linestring (80 80, 100 70)', 0))
```

In the following examples, the results have been reformatted for readability. Your results will vary according to your display.

Example 2

This example finds the union of two disjoint polygons.

```
SELECT a.id, b.id, CAST ( ST_AsText( ST_Union( a.geometry, b.geometry) )
    AS VARCHAR (350) ) UNION
  FROM sample_geoms a, sample_geoms b
  WHERE a.id = 1 AND b.id = 2
```

Results:

```
ID    ID    UNION
----- ----- ----------------------------------------------------------
    1     2 MULTIPOLYGON ((( 10.00000000 10.00000000, 20.00000000
                  10.00000000, 20.00000000 20.00000000, 10.00000000
                  20.00000000, 10.00000000 10.00000000))
                          (( 30.00000000 30.00000000, 50.00000000
                  30.00000000,50.00000000 50.00000000, 30.00000000
                  50.00000000,30.00000000 30.00000000)))
```

Example 3

This example finds the union of two intersecting polygons.

```
SELECT a.id, b.id, CAST ( ST_AsText( ST_Union(a.geometry, b.geometry))
    AS VARCHAR (250)) UNION
  FROM sample_geoms a, sample_geoms b
  WHERE a.id = 2 AND b.id = 3
```

Results:

```
ID    ID    UNION
----- ----- ----------------------------------------------------
    2     3 POLYGON (( 30.00000000 30.00000000, 50.00000000
                 30.00000000,50.00000000 40.00000000, 60.00000000
                 40.00000000,60.00000000 60.00000000, 40.00000000
                 60.00000000 40.00000000 50.00000000, 30.00000000
                 50.00000000, 30.00000000 30.00000000))
```

Example 4

Find the union of two linestrings.

```
SELECT a.id, b.id, CAST ( ST_AsText( ST_Union( a.geometry, b.geometry) )
    AS VARCHAR (250) ) UNION
  FROM sample_geoms a, sample_geoms b
  WHERE a.id = 4 AND b.id = 5
```

Results:

```
ID    ID    UNION
----- ----- ------------------------------------------------------------
    4     5 MULTILINESTRING (( 70.00000000 70.00000000, 80.00000000 80.00000000),
                 ( 80.00000000 80.00000000, 100.00000000 70.00000000))
```

ST_Within

ST_Within takes two geometries as input parameters and returns 1 if the first geometry is completely within the second geometry. Otherwise, 0 (zero) is returned.

If any of the given geometries is null or is empty, null is returned.

For non–geodetic data, if the second geometry is not represented in the same spatial reference system as the first geometry, it will be converted to the other spatial reference system. For geodetic data, both geometries must be in the same geodetic spatial reference system (SRS).

ST_Within performs the same logical operation that ST_Contains performs with the parameters reversed.

Syntax

Parameters

geometry1
A value of type ST_Geometry or one of its subtypes that is to be tested to be fully within *geometry2*.

geometry2
A value of type ST_Geometry or one of its subtypes that is to be tested to be fully within *geometry1*.

Restrictions for geodetic data: Both geometries must be geodetic and they both must be in the same geodetic SRS.

Return type

INTEGER

Examples

Example 1

This example illustrates use of the ST_Within function. Geometries are created and inserted into three tables, SAMPLE_POINTS, SAMPLE_LINES, and SAMPLE_POLYGONS.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point)
CREATE TABLE sample_lines (id INTEGER, line ST_LineString)
CREATE TABLE sample_polygons (id INTEGER, geometry ST_Polygon)

INSERT INTO sample_points (id, geometry)
  VALUES (1, ST_Point (10, 20, 1) ),
         (2, ST_Point ('point (41 41)', 1) )

INSERT INTO sample_lines (id, line)
  VALUES (10, ST_LineString ('linestring (1 10, 3 12, 10 10)', 1) ),
         (20, ST_LineString ('linestring (50 10, 50 12, 45 10)', 1) )
```

```
INSERT INTO sample_polygons (id, geometry)
  VALUES (100, ST_Polygon ('polygon (( 0 0, 0 40, 40 40, 40 0, 0 0))', 1) )
```

Example 2

This example finds points from the SAMPLE_POINTS table that are in the polygons in the SAMPLE_POLYGONS table.

```
SELECT a.id POINT_ID_WITHIN_POLYGONS
  FROM sample_points a, sample_polygons b
  WHERE ST_Within( b.geometry, a.geometry) = 0
```

Results:

```
POINT_ID_WITHIN_POLYGONS
----------------------
                     2
```

Example 3

This example finds linestrings from the SAMPLE_LINES table that are in the polygons in the SAMPLE_POLYGONS table.

```
SELECT a.id LINE_ID_WITHIN_POLYGONS
  FROM sample_lines a, sample_polygons b
  WHERE ST_Within( b.geometry, a.geometry) = 0
```

Results:

```
LINE_ID_WITHIN_POLYGONS
----------------------
                     1
```

ST_WKBToSQL

ST_WKBToSQL takes a well-known binary representation of a geometry and returns the corresponding geometry. The spatial reference system with the identifier 0 (zero) is used for the resulting geometry.

If the given well-known binary representation is null, then null is returned.

ST_WKBToSQL(*wkb*) gives the same result as ST_Geometry(*wkb*,0). Using the ST_Geometry function is recommended over using ST_WKBToSQL because of its flexibility: ST_Geometry takes additional forms of input as well as the well-known binary representation.

Syntax

Parameter

wkb A value of type BLOB(2G) that contains the well-known binary representation of the resulting geometry.

Return type

db2gse.ST_Geometry

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates use of the ST_WKBToSQL function. First, geometries are stored in the SAMPLE_GEOMETRIES table in its GEOMETRY column. Then, their well-known binary representations are stored in the WKB column using the ST_AsBinary function in the UPDATE statement. Finally, the ST_WKBToSQL function is used to return the coordinates of the geometries in the WKB column.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries
  (id INTEGER, geometry ST_Geometry, wkb BLOB(32K) )

INSERT INTO sample_geometries (id, geometry)
  VALUES (10, ST_Point ( 'point (44 14)', 0 ) ),
         (11, ST_Point ( 'point (24 13)', 0 ) ),
         (12, ST_Polygon ('polygon ((50 20, 50 40, 70 30, 50 20))', 0 ) )
UPDATE sample_geometries AS temp_correlated
  SET wkb = ST_AsBinary(geometry)
  WHERE id = temp_correlated.id
```

Use this SELECT statement to see the geometries in the WKB column.

```
SELECT id, CAST( ST_AsText( ST_WKBToSQL(wkb) ) AS VARCHAR(120) ) GEOMETRIES
  FROM sample_geometries
```

Results:

```
ID          GEOMETRIES
----------- ------------------------------------------------------------
         10 POINT ( 44.00000000 14.00000000)
         11 POINT ( 24.00000000 13.00000000)
         12 POLYGON (( 50.00000000 20.00000000, 70.00000000 30.00000000,
                       50.00000000 40.00000000, 50.00000000 20.00000000))
```

ST_WKTToSQL

ST_WKTToSQL takes a well-known text representation of a geometry and returns the corresponding geometry. The spatial reference system with the identifier 0 (zero) is used for the resulting geometry.

If the given well-known text representation is null, then null is returned.

ST_WKTToSQL(*wkt*) gives the same result as ST_Geometry(*wkt*,0). Using the ST_Geometry function is recommended over using ST_WKTToSQL because of its flexibility: ST_Geometry takes additional forms of input as well as the well-known text representation.

Syntax

Parameter

wkt A value of type CLOB(2G) that contains the well-known text representation of the resulting geometry.

Return type

db2gse.ST_Geometry

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how ST_WKTToSQL can create and insert geometries using their well-known text representations.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_geometries (id INTEGER, geometry ST_Geometry)

INSERT INTO sample_geometries
  VALUES (10, ST_WKTToSQL( 'point (44 14)' ) ),
         (11, ST_WKTTSQL ( 'point (24 13)' ) ),
         (12, ST_WKTToSQL ('polygon ((50 20, 50 40, 70 30, 50 20))' ) )
```

This SELECT statement returns the geometries that have been inserted.

```
SELECT id, CAST( ST_AsText(geometry) AS VARCHAR(120) ) GEOMETRIES
  FROM sample_geometries
```

Results:

```
ID          GEOMETRIES
----------- ------------------------------------------------------------
         10 POINT ( 44.00000000 14.00000000)
         11 POINT ( 24.00000000 13.00000000)
         12 POLYGON (( 50.00000000 20.00000000, 70.00000000 30.00000000,
                       50.00000000 40.00000000, 50.00000000 20.00000000))
```

ST_X

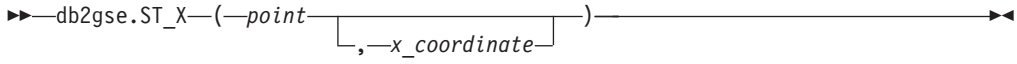
ST_X takes either:

- A point as an input parameter and returns its X coordinate
- A point and an X coordinate and returns the point itself with its X coordinate set to the given value

If the given point is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameters

point A value of type ST_Point for which the X coordinate is returned or modified.

x_coordinate
A value of type DOUBLE that represents the new X coordinate for *point*.

Return types

- DOUBLE, if *x_coordinate* is not specified
- db2gse.ST_Point, if *x_coordinate* is specified

Examples

Example 1

This example illustrates use of the ST_X function. Geometries are created and inserted into the SAMPLE_POINTS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point)

INSERT INTO sample_points (id, geometry)
  VALUES (1, ST_Point (2, 3, 32, 5, 1) ),
         (2, ST_Point (4, 5, 20, 4, 1) ),
         (3, ST_Point (3, 8, 23, 7, 1) )
```

Example 2

This example finds the X coordinates of the points in the table.

```
SELECT id, ST_X (geometry) X_COORD
  FROM sample_points
```

Results:

```
ID         X_COORD
---------- ----------------------
         1 +2.00000000000000E+000
         2 +4.00000000000000E+000
         3 +3.00000000000000E+000
```

Example 3

This example returns a point with its X coordinate set to 40.

```
SELECT id, CAST( ST_AsText( ST_X (geometry, 40)) AS VARCHAR(60) )
  X_40
  FROM sample_points
  WHERE id=3
```

Results:

```
ID         X_40
------ ------------------------------------------------------------
     3 POINT ZM ( 40.00000000 8.00000000 23.00000000 7.00000000)
```

ST_Y

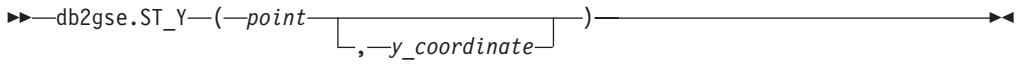
ST_Y takes either:

- A point as an input parameter and returns its Y coordinate
- A point and a Y coordinate and returns the point itself with its Y coordinate set to the given value

If the given point is null or is empty, then null is returned.

This function can also be called as a method.

Syntax



Parameters

point A value of type ST_Point for which the Y coordinate is returned or modified.

y_coordinate
A value of type DOUBLE that represents the new Y coordinate for *point*.

Return types

- DOUBLE, if *y_coordinate* is not specified
- db2gse.ST_Point, if *y_coordinate* is specified

Examples

Example 1

This example illustrates use of the ST_Y function. Geometries are created and inserted into the SAMPLE_POINTS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point)

INSERT INTO sample_points (id, geometry)
  VALUES (1, ST_Point (2, 3, 32, 5, 1) ),
         (2, ST_Point (4, 5, 20, 4, 1) ),
         (3, ST_Point (3, 8, 23, 7, 1) )
```

Example 2

This example finds the Y coordinates of the points in the table.

```
SELECT id, ST_Y (geometry) Y_COORD
  FROM sample_points
```

Results:

```
ID         Y_COORD
---------- ----------------------
         1 +3.00000000000000E+000
         2 +5.00000000000000E+000
         3 +8.00000000000000E+000
```

Example 3

This example returns a point with its Y coordinate set to 40.

```
SELECT id, CAST( ST_AsText( ST_Y (geometry, 40)) AS VARCHAR(60) )
  Y_40
  FROM sample_points
  WHERE id=3
```

Results:

```
ID         Y_40
-------- ------------------------------------------------------
     3 POINT ZM ( 3.00000000 40.00000000 23.00000000 7.00000000)
```

ST_Z

ST_Z takes either:

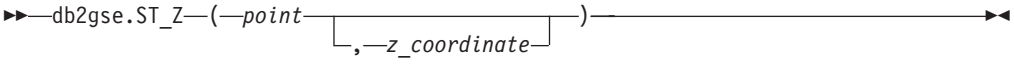
- A point as an input parameter and returns its Z coordinate
- A point and a Z coordinate and returns the point itself with its Z coordinate set to the given value, even if the specified point has no existing Z coordinate.

If the specified Z coordinate is null, then the Z coordinate is removed from the point.

If the specified point is null or empty, then null is returned.

This function can also be called as a method.

Syntax



Parameters

point A value of type ST_Point for which the Z coordinate is returned or modified.

z_coordinate
A value of type DOUBLE that represents the new Z coordinate for *point*.

If *z_coordinate* is null, then the Z coordinate is removed from *point*.

Return types

- DOUBLE, if *z_coordinate* is not specified
- db2gse.ST_Point, if *z_coordinate* is specified

Examples

Example 1

This example illustrates use of the ST_Z function. Geometries are created and inserted into the SAMPLE_POINTS table.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point)

INSERT INTO sample_points (id, geometry)
  VALUES (1, ST_Point (2, 3, 32, 5, 1) ),
         (2, ST_Point (4, 5, 20, 4, 1) ),
         (3, ST_Point (3, 8, 23, 7, 1) )
```

Example 2

This example finds the Z coordinates of the points in the table.

```
SELECT id, ST_Z (geometry) Z_COORD
  FROM sample_points
```

Results:

```
ID          Z_COORD
----------- ----------------------
          1 +3.20000000000000E+001
          2 +2.00000000000000E+001
          3 +2.30000000000000E+001
```

Example 3

This example returns a point with its Z coordinate set to 40.

```
SELECT id, CAST( ST_AsText( ST_Z (geometry, 40)) AS VARCHAR(60) )
  Z_40
  FROM sample_points
  WHERE id=3
```

Results:

```
ID          Z_40
------ ------------------------------------------------------
     3 POINT ZM ( 3.00000000 8.00000000 40.00000000 7.00000000)
```

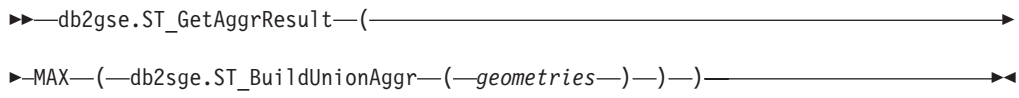
Union aggregate

A union aggregate is the combination of the ST_BuildUnionAggr and ST_GetAggrResult functions. This combination aggregates a column of geometries in a table to single geometry by constructing the union.

If all of the geometries to be combined in the union are null , then null is returned. If each of the geometries to be combined in the union are either null or are empty, then an empty geometry of type ST_Point is returned.

The ST_BuildUnionAggr function can also be called as a method.

Syntax



Parameters

geometries
A column in a table that has a type of ST_Geometry or one of its subtypes and represents all the geometries that are to be combined into a union.

Return type

db2gse.ST_Geometry

Restrictions

You cannot construct the union aggregate of a spatial column in a table in any of the following situations:

- In massively parallel processing (MPP) environments
- If a GROUP BY clause is used in the select
- If you use a function other than the DB2 aggregate function MAX

Example

In the following example, the lines of results have been reformatted for readability. The spacing in your results will vary according to your online display.

This example illustrates how a union aggregate can be used to combine a set of points into multipoints. Several points are added to the SAMPLE_POINTS table. The ST_GetAggrResult and ST_BuildUnionAggr functions are used to construct the union of the points.

```
SET CURRENT FUNCTION PATH = CURRENT FUNCTION PATH, db2gse
CREATE TABLE sample_points (id INTEGER, geometry ST_Point)

INSERT INTO sample_points
  VALUES (1, ST_Point (2, 3, 1) )
INSERT INTO sample_points
  VALUES (2, ST_Point (4, 5, 1) )
INSERT INTO sample_points
  VALUES (3, ST_Point (13, 15, 1) )
INSERT INTO sample_points
  VALUES (4, ST_Point (12, 5, 1) )
INSERT INTO sample_points
  VALUES (5, ST_Point (23, 2, 1) )
INSERT INTO sample_points
  VALUES (6, ST_Point (11, 4, 1) )

SELECT CAST (ST_AsText(
          ST_GetAggrResult( MAX( ST_BuildUnionAggregate (geometry) ) ))
       AS VARCHAR(160)) POINT_AGGREGATE
  FROM sample_points
```

Results:

```
POINT_AGGREGATE
------------------------------------------------------------
MULTIPOINT ( 2.00000000 3.00000000, 4.00000000 5.00000000,
            11.00000000 4.00000000, 12.00000000 5.00000000,
            13.00000000 15.00000000, 23.00000000 2.00000000)
```

Chapter 24. Transform groups

Transform groups

Spatial Extender provides four transform groups that are used to transfer geometries between the DB2 server and a client application. These transform groups accommodate the following data exchange formats:

- Well-known text (WKT) representation
- Well-known binary (WKB) representation
- ESRI shape representation
- Geography Markup Language (GML)

When data is retrieved from a table that contains a spatial column, the data from the spatial column is transformed to either a CLOB(2G) or a BLOB(2G) data type, depending on whether you indicated whether the transformed data was to be represented in binary or text format. You can also use the transform groups to transfer spatial data to the database.

To select which transform group is to be used when the data is transferred, use the SET CURRENT DEFAULT TRANSFORM GROUP statement to modify the DB2 special register CURRENT DEFAULT TRANSFORM GROUP. DB2 uses the value of this special register to determine which transform functions must be called to perform the necessary conversions.

Transform groups can simplify application programming. Instead of explicitly using conversion functions in the SQL statements, you can specify a transform group, which lets DB2 handle that task.

ST_WellKnownText transform group

You can use the ST_WellKnownText transform group to transmit data to and from DB2® using the well-known text (WKT) representation.

When binding out a value from the database server to the client, the same function provided by ST_AsText() is used to convert a geometry to the WKT representation. When the well-known text representation of a geometry is transferred to the database server, the ST_Geometry(CLOB) function is implicitly used to perform the conversions to an ST_Geometry value. Using the transform group for binding in values to DB2 causes the geometries to be represented in the spatial reference system with the numeric identifier 0 (zero).

Examples

In the following examples, the lines of results have been reformatted for readability. The spacing in your results might vary according to your online display.

Example 1

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The following SQL script shows how to use the ST_WellKnownText transform group to retrieve a geometry in its well-known text representation without using the explicit ST_AsText function.

```
CREATE TABLE transforms_sample (
   id   INTEGER,
   geom  db2gse.ST_Geometry)

INSERT
   INTO   transforms_sample
   VALUES (1, db2gse.ST_LineString('linestring
          (100 100, 200 100)', 0))

SET CURRENT DEFAULT TRANSFORM GROUP = ST_WellKnownText

SELECT id, geom
  FROM   transforms_sample
  WHERE  id = 1
```

Results:

```
ID   GEOM
---  ------------------------------------------------------------------
  1  LINESTRING ( 100.00000000 100.00000000, 200.00000000 100.00000000)
```

Example 2

The following C code shows how to use the ST_WellKnownText transform group to insert geometries using the explicit ST_Geometry function for the host-variable `wkt_buffer`, which is of type CLOB and contains the well-known text representation of the point (10 10) that is to be inserted.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id = 0;
   SQL TYPE IS db2gse.ST_Geometry AS CLOB(1000) wkt_buffer;
EXEC SQL END DECLARE SECTION;

// set the transform group for all subsequent SQL statements
EXEC SQL
   SET CURRENT DEFAULT TRANSFORM GROUP = ST_WellKnownText;

id = 100;
strcpy(wkt_buffer.data, "point ( 10 10 )");
wkt_buffer.length = strlen(wkt_buffer.data);

// insert point using WKT into column of type ST_Geometry
EXEC SQL
   INSERT
    INTO   transforms_sample(id, geom)
    VALUES (:id, :wkt_buffer);
```

ST_WellKnownBinary transform group

Use the ST_WellKnownBinary transform group to transmit data to and from DB2® using the well-known binary (WKB) representation.

When binding out a value from the database server to the client, the same function provided by ST_AsBinary() is used to convert a geometry to the WKB representation. When the well-known binary representation of a geometry is transferred to the database server, the ST_Geometry(BLOB) function is used implicitly to perform the conversions to an ST_Geometry value. Using the transform group for binding in values to DB2 causes the geometries to be represented in the spatial reference system with the numeric identifier 0 (zero).

Example

In the following examples, the lines of results have been reformatted for readability. The spacing in your results might vary according to your online display.

Example 1

The following SQL script shows how to use the ST_WellKnownBinary transform group to retrieve a geometry in its well-known binary representation without using the explicit ST_AsBinary function.

```
CREATE TABLE transforms_sample (
   id   INTEGER,
   geom  db2gse.ST_Geometry)

INSERT
   INTO transforms_sample
   VALUES ( 1, db2gse.ST_Polygon('polygon ((10 10, 20 10, 20 20,
              10 20, 10 10))', 0))

SET CURRENT DEFAULT TRANSFORM GROUP = ST_WellKnownBinary

SELECT id, geom
   FROM transforms_sample
   WHERE id = 1
```

Results:

```
ID    GEOM
----   ------------------------------------------------
   1   x'0103000000010000000500000000000000000000244000
       0000000000244000000000000000244000000000000003440
       0000000000003440000000000000344000000000000034
       4000000000000024400000000000002440000000000000
       2440'
```

Example 2

The following C code shows how to use the ST_WellKnownBinary transform group for inserting geometries using the explicit ST_Geometry function for the host-variable `wkb_buffer`, which is of type BLOB and contains the well-known binary representation of a geometry that is to be inserted.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id = 0;
   SQL TYPE IS db2gse.ST_Geometry AS BLOB(1000) wkb_buffer;
EXEC SQL END DECLARE SECTION;

// set the transform group for all subsequent SQL statements
EXEC SQL
   SET CURRENT DEFAULT TRANSFORM GROUP = ST_WellKnownBinary;

// initialize host variables
...
// insert geometry using WKB into column of type ST_Geometry

EXEC SQL
   INSERT
    INTO transforms_sample(id, geom)
    VALUES ( :id, :wkb_buffer );
```

ST_Shape transform group

Use the ST_Shape transform group to transmit data to and from DB2® using the ESRI shape representation.

When binding out a value from the database server to the client, the same function provided by ST_AsShape() is used to convert a geometry to its shape representation. When transferring the shape representation of a geometry to the database server, the ST_Geometry(BLOB) function is used implicitly to perform the conversions to an ST_Geometry value. Using the transform group for binding in values to DB2 causes the geometries to be represented in the spatial reference system with the numeric identifier 0 (zero).

Examples

In the following examples, the lines of results have been reformatted for readability. The spacing in your results might vary according to your online display.

Example 1

The following SQL script shows how the ST_Shape transform group can be used to retrieve a geometry in its shape representation without using the explicit ST_AsShape function.

```
CREATE TABLE transforms_sample(
   id INTEGER,
   geom db2gse.ST_Geometry)

INSERT
   INTO transforms_sample
   VALUES ( 1, db2gse.ST_Point(20.0, 30.0, 0) )

SET CURRENT DEFAULT TRANSFORM GROUP = ST_Shape

SELECT id, geom
   FROM transforms_sample
   WHERE id = 1
```

Results:

```
ID    GEOM
----   ------------------------------------------------
   1    x'0100000000000000000034400000000000003E40'
```

Example 2

The following C code shows how to use the ST_Shape transform group to insert geometries using the explicit ST_Geometry function for the host-variable `shape_buffer`, which is of type BLOB and contains the shape representation of a geometry that is to be inserted.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id = 0;
   SQL TYPE IS db2gse.ST_Geometry AS BLOB(1000) shape_buffer;
EXEC SQL END DECLARE SECTION;

// set the transform group for all subsequent SQL statements
EXEC SQL
   SET CURRENT DEFAULT TRANSFORM GROUP = ST_Shape;

// initialize host variables
```

```
...

SET CURRENT DEFAULT TRANSFORM GROUP = ST_Shape;

// insert geometry using shape representation into column of type ST_Geometry
EXEC SQL
     INSERT
    INTO transforms_sample(id, geom)
    VALUES ( :id, :shape_buffer );
```

ST_GML transform group

Use the ST_GML transform group to transmit data to and from DB2® using the geography markup language (GML).

When binding out a value from the database server to the client, the same function provided by ST_AsGML() is used to convert a geometry to its GML representation. When the GML representation of a geometry is transferred to the database server, the ST_Geometry(CLOB) function is used implicitly to perform the conversions to an ST_Geometry value. Using the transform group for binding in values to DB2 causes the geometries to be represented in the spatial reference system with the numeric identifier 0 (zero).

Examples

In the following examples, the lines of results have been reformatted for readability. The spacing in your results might vary according to your online display.

Example 1

The following SQL script shows how the ST_GML transform group can be used to retrieve a geometry in its GML representation without using the explicit ST_AsGML function.

```
CREATE TABLE transforms_sample (
   id  INTEGER,
   geom  db2gse.ST_Geometry)

INSERT
  INTO  transforms_sample
  VALUES ( 1, db2gse.ST_Geometry('multipoint z (10 10
           3, 20 20 4, 15 20 30)', 0) )
  SET CURRENT DEFAULT TRANSFORM GROUP = ST_GML

SELECT id, geom
FROM  transforms_sample
WHERE  id = 1
```

Results:

```
ID    GEOM
-----  ------------------------------------------------------------
    1 <gml:MultiPoint srsName=UNSPECIFIED><gml:PointMember>
      <gml:Point><gml:coord><gml:X>10</gml:X>
      <gml:Y>10</gml:Y><gml:Z>3</gml:Z>
      </gml:coord></gml:Point></gml:PointMember>
      <gml:PointMember><gml:Point><gml:coord>
      <gml:X>20</gml:X><gml:Y>20</gml:Y>
      <gml:Z>4</gml:Z></gml:coord></gml:Point>
      </gml:PointMember><gml:PointMember><gml:Point>
```

```
      <gml:coord><gml:X>15</gml:X><gml:Y>20
      </gml:Y><gml:Z>30</gml:Z></gml:coord>
      </gml:Point></gml:PointMember></gml:MultiPoint>
```

Example 2

The following C code shows how to use the ST_GML transform group for inserting geometries without using the explicit ST_Geometry function for the host-variable gml_buffer, which is of type CLOB and contains the GML representation of the point (20,20) that is to be inserted.

```
EXEC SQL BEGIN DECLARE SECTION;
   sqlint32 id = 0;
   SQL TYPE IS db2gse.ST_Geometry AS CLOB(1000) gml_buffer;
EXEC SQL END DECLARE SECTION;

// set the transform group for all subsequent SQL statements
EXEC SQL
   SET CURRENT DEFAULT TRANSFORM GROUP = ST_GML;
 id = 100;
strcpy(gml_buffer.data, "<gml:point><gml:coord>"
   "<gml:X>20</gml:X> <gml:Y>20</gml:Y></gml:coord></gml:point>");

//initialize host variables
wkt_buffer.length = strlen(gml_buffer.data);

// insert point using WKT into column of type ST_Geometry
EXEC SQL
   INSERT
   INTO transforms_sample(id, geom)
   VALUES ( :id, :gml_buffer );
```

Chapter 25. Supported data formats

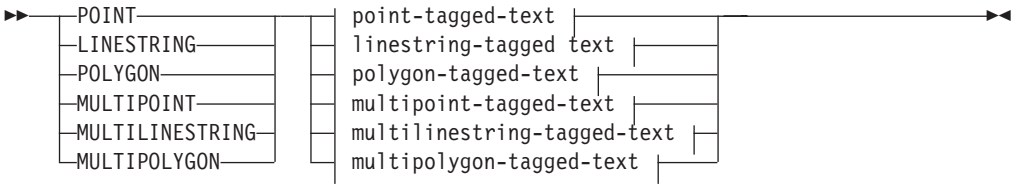
This chapter describes the industry standard spatial data formats that can be used with DB2 Spatial Extender. The following four spatial data formats are described:

- Well-known text (WKT) representation
- Well-known binary (WKB) representation
- Shape representation
- Geography Markup Language (GML) representation

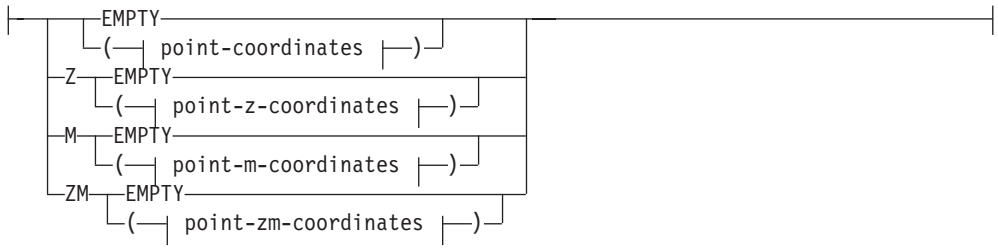
Well-known text (WKT) representation

The OpenGIS Consortium ″Simple Features for SQL″ specification defines the well-known text representation to exchange geometry data in ASCII format. This representation is also referenced by the ISO ″SQL/MM Part: 3 Spatial″ standard. See ″Spatial functions that convert geometries to and from data exchange formats″ for information on functions which accept and produce WKT data.

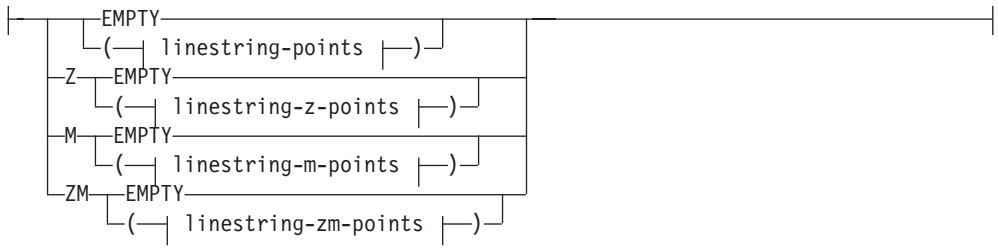
The well-known text representation of a geometry is defined as follows:



point-tagged-text:



linestring-tagged-text:



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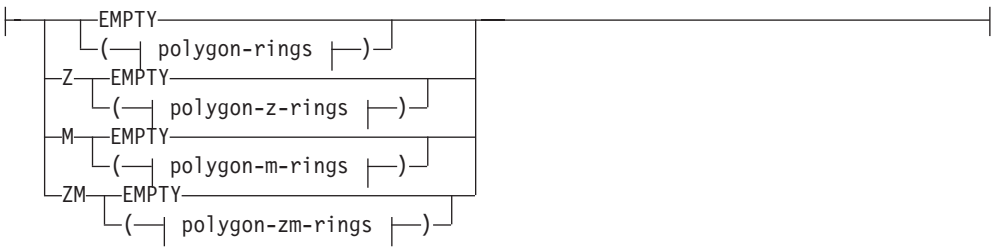
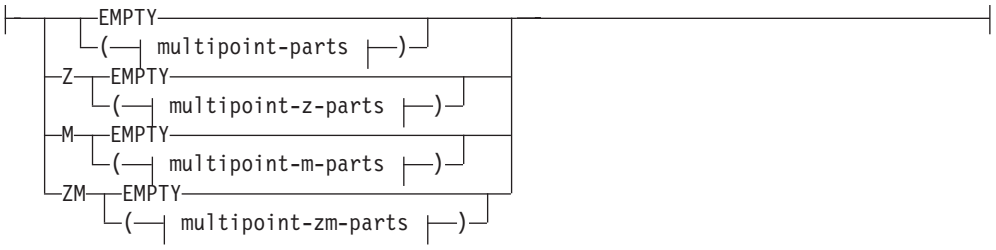
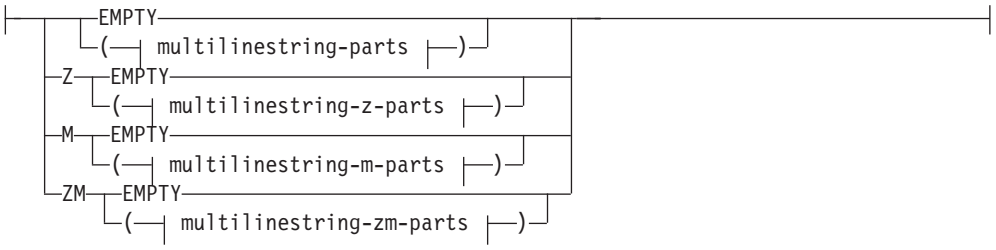
polygon-tagged-text:



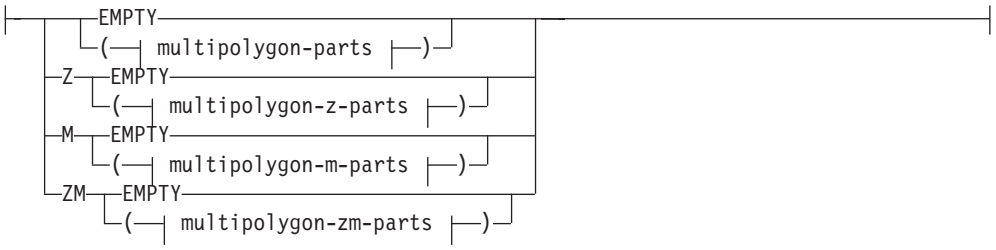
multipoint-tagged-text:



multilinestring-tagged-text:



multipolygon-tagged-text:

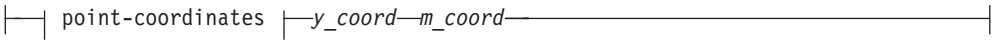


point-coordinates:

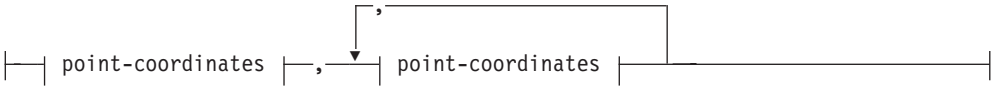
point-z-coordinates:

point-m-coordinates:

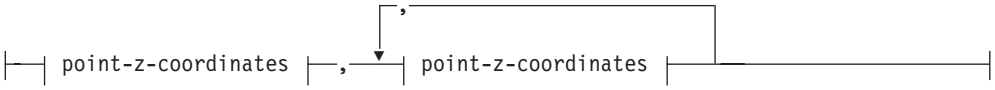
point-zm-coordinates:



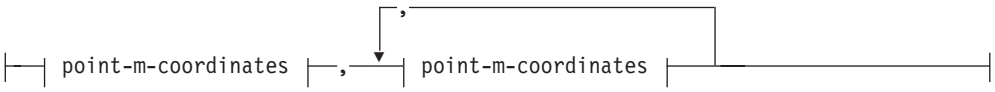
linestring-points:



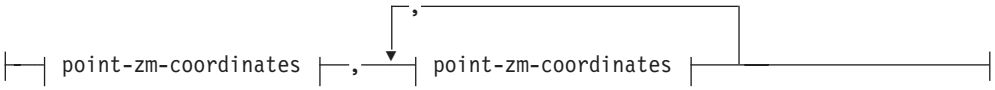
linestring-z-points:



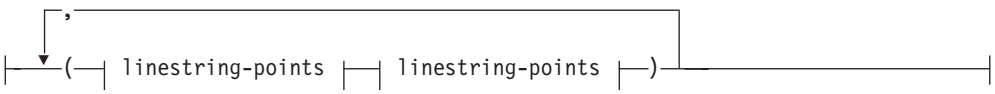
linestring-m-points:



linestring-zm-points:



polygon-rings:



polygon-z-rings:

polygon-m-rings:

polygon-zm-rings:

multipoint-parts:

multipoint-z-parts:

multipoint-m-parts:

multipoint-zm-parts:

multilinestring-parts:

multilinestring-z-parts:

multilinestring-m-parts:

multilinestring-zm-parts:

multipolygon-parts:

multipolygon-z-parts:

multipolygon-m-parts:

multipolygon-zm-parts:

Parameters

x_coord

A numerical value (fixed, integer, or floating point), which represents the X coordinate of a point.

y_coord

A numerical value (fixed, integer, or floating point), which represents the Y coordinate of a point.

z_coord

A numerical value (fixed, integer, or floating point), which represents the Z coordinate of a point.

m_coord

A numerical value (fixed, integer, or floating point), which represents the M coordinate (measure) of a point.

If the geometry is empty, then the keyword EMPTY is to be specified instead of the coordinate list. The EMPTY keyword must not be embedded within the coordinate list

The following table provides some examples of possible text representations.

Table 59. Geometry types and their text representations

Geometry type	WKT representation	Comment
point	POINT EMPTY	empty point
point	POINT (10.05 10.28)	point
point	POINT Z(10.05 10.28 2.51)	point with Z coordinate
point	POINT M(10.05 10.28 4.72)	point with M coordinate
point	POINT ZM(10.05 10.28 2.51 4.72)	point with Z coordinate and M coordinate
linestring	LINESTRING EMPTY	empty linestring
polygon	POLYGON ((10 10, 10 20, 20 20, 20 15, 10 10))	polygon
multipoint	MULTIPOINT Z(10 10 2, 20 20 3)	multipoint with Z coordinates
multilinestring	MULTILINESTRING M((310 30 1, 40 30 20, 50 20 10)(10 10 0, 20 20 1))	multilinestring with M coordinates
multipolygon	MULTIPOLYGON ZM(((1 1 1 1, 1 2 3 4, 2 2 5 6, 2 1 7 8, 1 1 1 1)))	multipolygon with Z coordinates and M coordinates

Well-known binary (WKB) representation

This section describes the well-known binary representation for geometries.

The OpenGIS Consortium ″Simple Features for SQL″ specification defines the well-known binary representation. This representation is also defined by the International Organization for Standardization (ISO) ″SQL/MM Part: 3 Spatial″ standard. See the related reference section at the end of this topic for information on functions that accept and produce the WKB.

The basic building block for well-known binary representations is the byte stream for a point, which consists of two double values. The byte streams for other geometries are built using the byte streams for geometries that are already defined.

The following example illustrates the basic building block for well-known binary representations.

```
// Basic Type definitions
// byte : 1 byte
// uint32 : 32 bit unsigned integer  (4 bytes)
// double : double precision number (8 bytes)
```

```
// Building Blocks : Point, LinearRing

Point {
  double x;
  double y;
};
LinearRing   {
  uint32  numPoints;
  Point   points[numPoints];
};
enum wkbGeometryType {
  wkbPoint = 1,
  wkbLineString = 2,
  wkbPolygon = 3,
  wkbMultiPoint = 4,
  wkbMultiLineString = 5,
  wkbMultiPolygon = 6
};
enum wkbByteOrder {
  wkbXDR = 0,     // Big Endian
  wkbNDR = 1     // Little Endian
};
WKBPoint {
  byte     byteOrder;
  uint32   wkbType;     // 1=wkbPoint
  Point    point;
};
WKBLineString {
  byte     byteOrder;
  uint32   wkbType;     // 2=wkbLineString
  uint32   numPoints;
  Point    points[numPoints];
};

WKBPolygon    {
  byte                byteOrder;
  uint32            wkbType;     // 3=wkbPolygon
  uint32            numRings;
  LinearRing        rings[numRings];
};
WKBMultiPoint    {
  byte                byteOrder;
  uint32            wkbType;     // 4=wkbMultipoint
  uint32            num_wkbPoints;
  WKBPoint            WKBPoints[num_wkbPoints];
};
WKBMultiLineString    {
  byte              byteOrder;
  uint32            wkbType;     // 5=wkbMultiLineString
  uint32            num_wkbLineStrings;
  WKBLineString     WKBLineStrings[num_wkbLineStrings];
};

wkbMultiPolygon {
  byte              byteOrder;
  uint32            wkbType;     // 6=wkbMultiPolygon
  uint32            num_wkbPolygons;
  WKBPolygon        wkbPolygons[num_wkbPolygons];
};

WKBGeometry  {
  union {
    WKBPoint                point;
    WKBLineString           linestring;
    WKBPolygon              polygon;
    WKBMultiPoint           mpoint;
```

```
    WKBMultiLineString       mlinestring;
    WKBMultiPolygon          mpolygon;
  }
};
```

The following figure shows an example of a geometry in well-known binary representation using NDR coding.

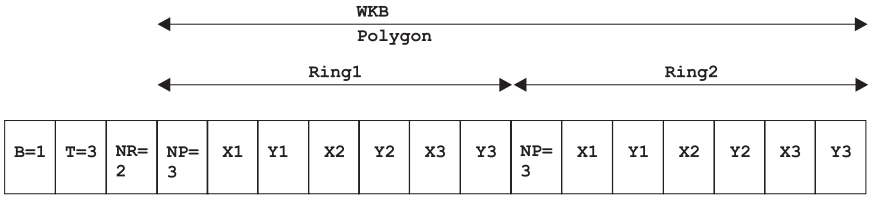


Figure 58. Geometry representation in NDR format. (B=1) of type polygon (T=3) with 2 linears (NR=2), where each ring has 3 points (NP=3).

Shape representation

Shape representation is a widely used industry standard defined by ESRI. For a full description of shape representation, see the ESRI website at http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf.

Geography Markup Language (GML) representation

DB2 Spatial Extender has several functions that generate geometries from representations in geography markup language(GML) representation.

The Geography Markup Language (GML) is an XML encoding for geographic information defined by the OpenGIS Consortium ″Geography Markup Language V2″ specification. This OpenGIS Consortium specification can be found at http://www.opengis.org/techno/implementation.htm.

Chapter 26. Supported coordinate systems

This topic provides an explanation of coordinate systems syntax and lists the coordinate system values that are supported by DB2 Spatial Extender.

Coordinate systems syntax

The well-known text representation of spatial reference systems provides a standard textual representation for coordinate system information. The definitions of the well-known text representation are defined by the OGC ″Simple Features for SQL″ specification and the ISO SQL/MM Part 3: Spatial standard.

A coordinate system is a geographic (latitude-longitude), a projected (X,Y), or a geocentric (X,Y,Z) coordinate system. The coordinate system is composed of several objects. Each object has a keyword in uppercase (for example, DATUM or UNIT) followed by the comma-delimited defining parameters of the object in brackets. Some objects are composed of other objects, so the result is a nested structure.

Note: Implementations are free to substitute standard brackets ( ) for square brackets [ ] and should be able to read both forms of brackets.

The EBNF (Extended Backus Naur Form) definition for the string representation of a coordinate system using square brackets is as follows (see note above regarding the use of brackets):

```
<coordinate system> = <projected cs> |
<geographic cs> | <geocentric cs>
<projected cs> = PROJCS["<name>",
<geographic cs>, <projection>, {<parameter>,}*
<linear unit>]
<projection> = PROJECTION["<name>"]
<parameter> = PARAMETER["<name>",
<value>]

<value> = <number>
```

The type of coordinate system is identified by the keyword used:

PROJCS
A data set's coordinate system is identified by the PROJCS keyword if the data is in projected coordinates

GEOGCS
A data set's coordinate system is identified by the GEOGCS keyword if the data is in geographic coordinates

GEOCCS
A data set's coordinate system is identified by the GEOCCS keyword if the data is in geocentric coordinates

The PROJCS keyword is followed by all of the ″pieces″ that define the projected coordinate system. The first piece of any object is always the name. Several objects follow the projected coordinate system name: the geographic coordinate system, the map projection, one or more parameters, and the linear unit of measure. All projected coordinate systems are based upon a geographic coordinate system, so this section describes the pieces specific to a projected coordinate system first. For example, UTM zone 10N on the NAD83 datum is defined:

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```
PROJCS["NAD_1983_UTM_Zone_10N",
<geographic cs>,
PROJECTION["Transverse_Mercator"],
PARAMETER["False_Easting",500000.0],
PARAMETER["False_Northing",0.0],
PARAMETER["Central_Meridian",-123.0],
PARAMETER["Scale_Factor",0.9996],
PARAMETER["Latitude_of_Origin",0.0],
UNIT["Meter",1.0]]
```

The name and several objects define the geographic coordinate system object in turn: the datum, the prime meridian, and the angular unit of measure.

```
<geographic cs> = GEOGCS["<name>", <datum>, <prime meridian>, <angular unit>]
<datum> = DATUM["<name>", <spheroid>]
<spheroid> = SPHEROID["<name>", <semi-major axis>, <inverse flattening>]
<semi-major axis> = <number>
<inverse flattening> = <number>
<prime meridian> = PRIMEM["<name>", <longitude>]
<longitude> = <number>
```

The semi-major axis is measured in meters and must be greater than zero.

The geographic coordinate system string for UTM zone 10 on NAD83:

```
GEOGCS["GCS_North_American_1983",
DATUM["D_North_American_1983",
SPHEROID["GRS_1980",6378137,298.257222101]],
PRIMEM["Greenwich",0],
UNIT["Degree",0.0174532925199433]]
```

The UNIT object can represent angular or linear unit of measures:

```
<angular unit> = <unit>
<linear unit> = <unit>
<unit> = UNIT["<name>", <conversion factor>]
<conversion factor> = <number>
```

The conversion factor specifies number of meters (for a linear unit) or number of radians (for an angular unit) per unit and must be greater than zero.

So the full string representation of UTM Zone 10N is as follows:

```
PROJCS["NAD_1983_UTM_Zone_10N",
GEOGCS["GCS_North_American_1983",
DATUM[ "D_North_American_1983",SPHEROID["GRS_1980",6378137,298.257222101]],
PRIMEM["Greenwich",0],UNIT["Degree",0.0174532925199433]],
PROJECTION["Transverse_Mercator"],PARAMETER["False_Easting",500000.0],
PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-123.0],
PARAMETER["Scale_Factor",0.9996],PARAMETER["Latitude_of_Origin",0.0],
UNIT["Meter",1.0]]
```

A geocentric coordinate system is quite similar to a geographic coordinate system:

```
<geocentric cs> = GEOCCS["<name>", <datum>, <prime meridian>, <linear unit>]
```

Supported linear units

Table 60. Supported linear units

Unit	Conversion factor
Meter	1.0
Foot (International)	0.3048

Table 60. Supported linear units (continued)

Unit	Conversion factor
U.S. Foot	12/39.37
Modified American Foot	12.0004584/39.37
Clarke's Foot	12/39.370432
Indian Foot	12/39.370141
Link	7.92/39.370432
Link (Benoit)	7.92/39.370113
Link (Sears)	7.92/39.370147
Chain (Benoit)	792/39.370113
Chain (Sears)	792/39.370147
Yard (Indian)	36/39.370141
Yard (Sears)	36/39.370147
Fathom	1.8288
Nautical Mile	1852.0

Supported angular units

Table 61. Supported angular units

Unit	Valid range for latitude	Valid range for longitude	Conversion factor
Radian	–pi/2 and pi/2 radians (inclusive)	–pi and pi radians (inclusive)	1.0
Decimal Degree	–90 and 90 degrees (inclusive)	–180 and 180 degrees (inclusive)	pi/180
Decimal Minute	–5400 and 5400 minutes (inclusive)	–10800 and 10800 minutes (inclusive)	(pi/180)/60
Decimal Second	–324000 and 324000 seconds (inclusive)	–648000 and 648000 seconds (inclusive)	(pi/180)*3600
Gon	–100 and 100 gradians (inclusive)	–200 and 200 gradians (inclusive)	pi/200
Grad	–100 and 100 gradians (inclusive)	–200 and 200 gradians (inclusive)	pi/200

Supported spheroids

Table 62. Supported spheroids

Name	Semi-major axis	Inverse flattening
Airy 1830	6377563.396	299.3249646
Airy Modified 1849	6377340.189	299.3249646
Average Terrestrial System 1977	6378135.0	298.257
Australian National Spheroid	6378160.0	298.25
Bessel 1841	6377397.155	299.1528128
Bessel Modified	6377492.018	299.1528128
Bessel Namibia	6377483.865	299.1528128
Clarke 1858	6378293.639	294.260676369
Clarke 1866	6378206.4	294.9786982
Clarke 1866 (Michigan)	6378450.047	294.978684677
Clarke 1880	6378249.138	293.466307656
Clarke 1880 (Arc)	6378249.145	293.466307656
Clarke 1880 (Benoit)	6378300.79	293.466234571
Clarke 1880 (IGN)	6378249.2	293.46602
Clarke 1880 (RGS)	6378249.145	293.465
Clarke 1880 (SGA 1922)	6378249.2	293.46598
Everest (1830 Definition)	6377299.36	300.8017
Everest 1830 Modified	6377304.063	300.8017
Everest Adjustment 1937	6377276.345	300.8017
Everest 1830 (1962 Definition)	6377301.243	300.8017255
Everest 1830 (1967 Definition)	6377298.556	300.8017
Everest 1830 (1975 Definition)	6377299.151	300.8017255
Everest 1969 Modified	6377295.664	300.8017
Fischer 1960	6378166.0	298.3
Fischer 1968	6378150 .0	298.3
Modified Fischer	6378155 .0	298.3
GEM 10C	6378137.0	298.257222101
GRS 1967	6378160.0	298.247167427

Table 62. Supported spheroids (continued)

Name	Semi-major axis	Inverse flattening
GRS 1967 Truncated	6378160.0	298.25
GRS 1980	6378137.0	298.257222101
Helmert 1906	6378200.0	298.3
Hough 1960	6378270.0	297.0
Indonesian National Spheroid	6378160.0	298.247
International 1924	6378388.0	297.0
International 1967	6378160.0	298.25
Krassowsky 1940	6378245.0	298.3
NWL 9D	6378145.0	298.25
NWL 10D	6378135.0	298.26
OSU 86F	6378136.2	298.25722
OSU 91A	6378136.3	298.25722
Plessis 1817	6376523.0	308.64
Sphere	6371000.0	0.0
Sphere (ArcInfo)	6370997.0	0.0
Struve 1860	6378298.3	294.73
Walbeck	6376896.0	302.78
War Office	6378300.0	296.0
WGS 1966	6378145.0	298.25
WGS 1972	6378135.0	298.26
WGS 1984	6378137.0	298.257223563

Supported geodetic datums

Table 63. Supported geodetic datums

Name	Geodetic datum
Adindan	Lisbon
Afgooye	Loma Quintana
Agadez	Lome
Australian Geodetic Datum 1966	Luzon 1911
Australian Geodetic Datum 1984	Mahe 1971

Table 63. Supported geodetic datums (continued)

Name	Geodetic datum
Ain el Abd 1970	Makassar
Amersfoort	Malongo 1987
Aratu	Manoca
Arc 1950	Massawa
Arc 1960	Merchich
Ancienne Triangulation Francaise	Militar-Geographische Institute
Barbados	Mhast
Batavia	Minna
Beduaram	Monte Mario
Beijing 1954	M'poraloko
Reseau National Belge 1950	NAD Michigan
Reseau National Belge 1972	North American Datum 1927
Bermuda 1957	North American Datum 1983
Bern 1898	Nahrwan 1967
Bern 1938	Naparima 1972
Ancienne Triangulation Francaise	Militar-Geographische Institute
Barbados	Mhast
Batavia	Minna
Beduaram	Monte Mario
Beijing 1954	M'poraloko
Reseau National Belge 1950	NAD Michigan
Reseau National Belge 1972	North American Datum 1927
Bermuda 1957	North American Datum 1983
Bern 1898	Nahrwan 1967
Bern 1938	Naparima 1972
Ancienne Triangulation Francaise	Militar-Geographische Institute
Barbados	Mhast
Batavia	Minna
Beduaram	Monte Mario
Beijing 1954	M'poraloko

Table 63. Supported geodetic datums (continued)

Name	Geodetic datum
Reseau National Belge 1950	NAD Michigan
Reseau National Belge 1972	North American Datum 1927
Bermuda 1957	North American Datum 1983
Bern 1898	Nahrwan 1967
Bern 1938	Naparima 1972
Bogota	Nord de Guerre
Bukit Rimpah	NGO 1948
Camacupa	Nord Sahara 1959
Campo Inchauspe	NSWC 9Z-2
Cape	Nouvelle Triangulation Francaise
Carthage	New Zealand Geodetic Datum 1949
Chua	OS (SN) 1980
Conakry 1905	OSGB 1936
Corrego Alegre	OSGB 1970 (SN)
Cote d'Ivoire	Padang 1884
Datum 73	Palestine 1923
Deir ez Zor	Pointe Noire
Deutsche Hauptdreiecksnetz	Provisional South American Datum 1956
Douala	Pulkovo 1942
European Datum 1950	Qatar
European Datum 1987	Qatar 1948
Egypt 1907	Qornoq
European Reference System 1989	RT38
Fahud	South American Datum 1969
Gandajika 1970	Sapper Hill 1943
Garoua	Schwarzeck
Geocentric Datum of Australia 1994	Segora
Guyane Francaise	Serindung
Herat North	Stockholm 1938
Hito XVIII 1963	Sudan

Table 63. Supported geodetic datums (continued)

Name	Geodetic datum
Hu Tzu	Shan Tananarive 1925
Hungarian Datum 1972	Timbalai 1948
Indian 1954	TM65
Indian 1975	TM75
Indonesian Datum 1974	Tokyo
Jamaica 1875	Trinidad 1903
Jamaica 1969	Trucial Coast 1948
Kalianpur	Voirol 1875
Kandawala	Voirol Unifie 1960
Kertau	WGS 1972
Kuwait Oil Company	WGS 1972 Transit Broadcast Ephemeris
La Canoa	WGS 1984
Lake	Yacare
Leigon	Yoff
Liberia 1964	Zanderij

Supported prime meridians

Table 64. Supported prime meridians

Location	Coordinates
Greenwich	0° 0′ 0″
Bern	7° 26′ 22.5″ E
Bogota	74° 4′ 51.3″ W
Brussels	4° 22′ 4.71″ E
Ferro	17° 40′ 0″ W
Jakarta	106° 48′ 27.79″ E
Lisbon	9° 7′ 54.862″ W
Madrid	3° 41′ 16.58″ W
Paris	2° 20′ 14.025″ E
Rome	12° 27′ 8.4″ E
Stockholm	18° 3′ 29″ E

Supported map projections

Table 65. Cylindrical projections

Cylindrical projections	Pseudocylindrical projections
Behrmann	Craster parabolic
Cassini	Eckert I
Cylindrical equal area	Eckert II
Equirectangular	Eckert III
Gall's stereographic	Eckert IV
Gauss-Kruger	Eckert V
Mercator	Eckert VI
Miller cylindrical	McBryde-Thomas flat polar quartic
Oblique	Mercator (Hotine) Mollweide
Plate-Carée	Robinson
Times	Sinusoidal (Sansom-Flamsteed)
Transverse Mercator	Winkel I

Table 66. Conic projections

Name	Conic projection
Albers conic equal-area	Chamberlin trimetric
Bipolar oblique conformal conic	Two-point equidistant
Bonne	Hammer-Aitoff equal-area
Equidistant conic	Van der Grinten I
Lambert conformal conic	Miscellaneous
Polyconic	Alaska series E
Simple conic	Alaska Grid (Modified-Stereographic by Snyder)

Table 67. Map projection parameters

Parameter	Description
central_meridian	The line of longitude chosen as the origin of x-coordinates.
scale_factor	Scale_factor is used generally to reduce the amount of distortion in a map projection.

Table 67. Map projection parameters (continued)

Parameter	Description
standard_parallel_1	A line of latitude that has no distortion generally. Also used for ″latitude of true scale.″
standard_parallel_2	A line of longitude that has no distortion generally.
longitude_of_center	The longitude that defines the center point of the map projection.
latitude_of_center	The latitude that defines the center point of the map projection.
longitude_of_origin	The longitude chosen as the origin of x-coordinates.
latitude_of_origin	The latitude chosen as the origin of y-coordinates.
false_easting	A value added to x-coordinates so that all x-coordinate values are positive.
false_northing	A value added to y-coordinates so that all y-coordinates are positive.
azimuth	The angle east of north that defines the center line of an oblique projection.
longitude_of_point_1	The longitude of the first point needed for a map projection.
latitude_of_point_1	The latitude of the first point needed for a map projection.
longitude_of_point_2	The longitude of the second point needed for a map projection.
latitude_of_point_2	The latitude of the second point needed for a map projection.
longitude_of_point_3	The longitude of the third point needed for a map projection.
latitude_of_point_3	The latitude of the third point needed for a map projection.
landsat_number	The number of a Landsat satellite.
path_number	The orbital path number for a particular satellite.
perspective_point_height	The height above the earth of the perspective point of the map projection.
fipszone	State Plane Coordinate System zone number.
zone	UTM zone number.

Chapter 27. Spatial tasks from the DB2 Control Center

Tasks that are available from the Spatial Extender user interface can help simplify tasks.

You can run many tasks from a command prompt as a command, from an application as a stored procedure, or from the DB2 Control Center. This section describes tasks that you can do from the DB2 Control Center.

Altering a coordinate system

Altering a coordinate system can significantly change the real location of the geometry and could render it useless. Be sure that you understand the ramifications of the changes before you alter a coordinate system.

You can change any of the fields except **Name**.

- **Organization** and **Organization ID:** These are optional values. These parameters must either both be null or both be non-null. The combination of the parameters uniquely identifies the coordinate system.
- **Definition:** The definition can be up to 2048 characters. The vendor who supplies the coordinate system usually includes this value.

Creating a coordinate system

Usually, you use an existing coordinate system.

If you must create your own coordinate system, verify that all of the coordinate information that you are providing is accurate and is compatible with the geobrowser that you are using.

- **Name:** This helps you identify the coordinate system. The Organization and Organization ID identify the coordinate system.
- **Organization** and **Organization ID:** These are optional values. These parameters must either both be null or both be non-null. The combination of the parameters uniquely identifies the coordinate system.
- **Definition:** The definition can be up to 2048 characters. The vendor who supplies the coordinate system usually includes this value.

Creating a spatial column

If you are adding spatial data to an existing table, create a spatial column and register the column with a spatial reference system.

To create a spatial column by using the Create Spatial Column window, you must open the Spatial Columns window from a table.

- **Column:** Type a name for the column.
- **Type schema** and **Type name:** Select values from the list.
- **Spatial reference system:** Optional: Select a spatial reference system from the list. To register the column with a geodetic spatial reference system, specify a geodetic reference system with an ID in the range 2000000000 to 2000001000.

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Creating a spatial index

You can create a spatial grid index or a geodetic Voronoi index on a spatial column. When you create an index, you can enhance performance by making the data easier for DB2 UDB to locate and retrieve.

Recommendation: Use the same coordinate system for all data in a spatial column on which you want to create an index to ensure that the index returns the correct results. You can register a spatial column to constrain all data to use the same spatial reference system and, correspondingly, the same coordinate system.

- **Spatial column:** Select the column on which the index will be created.
- **Finest grid:** To create a Voronoi index, type -1. Otherwise, type a number greater than 0.
- **Middle grid:** To create a Voronoi index, type -1. You can enter 0 to not use a middle grid, or type a number larger than the finest grid.
- **Coarsest grid:** To create a Voronoi index, type the identifier of the cell structure to use (1 through 14). You must use a middle grid to use a coarsest grid. This value must be larger than middle grid. You can enter 0 to not use a coarsest grid.

Running geocoding

Use the Run Geocoding notebook in the DB2 Control Center to geocode spatial data in batch mode.

Basic page

Specify the geocoder, and then select a result column. The **Result type** field is automatically completed based on the geocoder that you specify. You can further customize the batch job by specifying a commit scope and a WHERE clause.

Geocoder Parameters page

You can specify either your own column name or value for a parameter.

Setting up geocoding

When you set up geocoding, you associate a column with a geocoder that will be used to geocode the data, and you set up the corresponding geocoding parameters and other relevant information for later use by the geocoder.

Basic page

Select which geocoder to set up. The **Result type** field is automatically completed based on the geocoder that you specify. You can use the **Commit scope** field to select the number of rows to geocode before performing a commit.

Tip: You can select a geocoder from the list and select **Autogeocode** to automatically geocode the spatial column when it is updated.

Geocoder Parameters page

You can specify either your own column name or value for a parameter.

Altering a spatial reference system

Caution: If you alter any attribute other than the description, the values of all of the spatial data associated with that spatial reference system are changed and might no longer be valid.

- In the **ID** field, type the ID for the spatial reference system that you are altering. For a geodetic spatial reference system, you can change only the ID values in the range 2000000318 to 2000001000.
- **Offset:** For offset transformations, type the scale and offset values for the X, Y, Z, or M coordinates. A scale value is the multiplier value for your measures. The default value is 1. You can change the value to maintain accuracy when a coordinate is converted from a decimal value to an integer. An offset value is the number that will be subtracted from each value to get a positive integer for the coordinate and measure values. The scale and offset values are required to create a spatial reference system.
- **Extent:** For extent transformations, type the minimum and maximum values for the X, Y, Z, or M coordinates. A scale value is the multiplier value for your measures. The default value is 1. You can change the value to maintain accuracy when a coordinate is converted from a decimal value to an integer. The scale and extent values are required only when you select the **Extent** radio button.

Importing spatial data

You can import shape files or SDE files.

Basic page

Use this page to specify the source and target information. You can also specify exception and message files, which can be helpful for troubleshooting if the importing fails.

Advanced page

Use this page to specify table space details and details about how the import should proceed.

DB2 technical library in PDF format

The following tables describe the DB2® library available from the IBM® Publications Center at www.ibm.com/shop/publications/order.

Although the tables identify books available in print, the books might not be available in your country or region.

The information in these books is fundamental to all DB2 users; you will find this information useful whether you are a programmer, a database administrator, or someone who works with DB2 Connect™ or other DB2 products.

Table 68. DB2 technical information

Name	Form Number	Available in print
Administration Guide: Implementation	SC10-4221	Yes
Administration Guide: Planning	SC10-4223	Yes
Administrative API Reference	SC10-4231	Yes
Administrative SQL Routines and Views	SC10-4293	No
Call Level Interface Guide and Reference, Volume 1	SC10-4224	Yes
Call Level Interface Guide and Reference, Volume 2	SC10-4225	Yes
Command Reference	SC10-4226	No
Data Movement Utilities Guide and Reference	SC10-4227	Yes
Data Recovery and High Availability Guide and Reference	SC10-4228	Yes
Developing ADO.NET and OLE DB Applications	SC10-4230	Yes
Developing Embedded SQL Applications	SC10-4232	Yes
Developing Java™ Applications	SC10-4233	Yes
Developing Perl and PHP Applications	SC10-4234	No
Getting Started with Database Application Development	SC10-4252	Yes
Getting started with DB2 installation and administration on Linux® and Windows®	GC10-4247	Yes
Message Reference Volume 1	SC10-4238	No
Message Reference Volume 2	SC10-4239	No

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Table 68. DB2 technical information (continued)

Name	Form Number	Available in print
Migration Guide	GC10-4237	Yes
Net Search Extender Administration and User's Guide **Note:** HTML for this document is not installed from the HTML documentation CD.	SH12-6842	Yes
Performance Guide	SC10-4222	Yes
Query Patroller Administration and User's Guide	GC10-4241	Yes
Quick Beginnings for DB2 Clients	GC10-4242	No
Quick Beginnings for DB2 Servers	GC10-4246	Yes
Spatial Extender and Geodetic Data Management Feature User's Guide and Reference	SC18-9749	Yes
SQL Guide	SC10-4248	Yes
SQL Reference, Volume 1	SC10-4249	Yes
SQL Reference, Volume 2	SC10-4250	Yes
System Monitor Guide and Reference	SC10-4251	Yes
Troubleshooting Guide	GC10-4240	No
Visual Explain Tutorial	SC10-4319	No
What's New	SC10-4253	Yes
XML Extender Administration and Programming	SC18-9750	Yes
XML Guide	SC10-4254	Yes
XQuery Reference	SC18-9796	Yes

Table 69. Technical information specific to DB2 Connect

Name	Form Number	Available in print
DB2 Connect User's Guide	SC10-4229	Yes
Quick Beginnings for DB2 Connect Personal Edition	GC10-4244	Yes
Quick Beginnings for DB2 Connect Servers	GC10-4243	Yes

Table 70. WebSphere Information Integration technical information

Name	Form Number	Available in print
WebSphere® Information Integration: Administration Guide for Federated Systems	SC19-1001	Yes
WebSphere Information Integration: ASNCLP Program Reference for Replication and Event Publishing	SC19-1000	Yes
WebSphere Information Integration: Configuration Guide for Federated Data Sources	No form number	No
WebSphere Information Integration: SQL Replication Guide and Reference	SC19-1002	Yes

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A wide variety of troubleshooting and problem determination information is available to assist you in using DB2 products.

The following resources are available:

DB2 documentation

Troubleshooting information can be found in the DB2 Troubleshooting Guide or the Support and Troubleshooting section of the DB2 Information Center. There you will find information on how to isolate and identify problems using DB2 diagnostic tools and utilities, solutions to some of the most common problems, and other advice on how to solve problems you might encounter with your DB2 products.

DB2 Technical Support Web site

Refer to the DB2 Technical Support Web site if you are experiencing problems and want help finding possible causes and solutions. The Technical Support site has links to the latest DB2 publications, TechNotes, Authorized Program Analysis Reports (APARs or bug fixes), fix packs, and other resources. You can search through this knowledge base to find possible solutions to your problems.

Access the DB2 Technical Support Web site at http://www.ibm.com/software/data/db2/udb/support.html.

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