

Spatial SQL Reference

Altibase 7.3

Altibase® Application Development



Altibase Development Spatial SQL Reference
Release

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Table Of Contents

- [Preface](#)
 - [About This Manual](#)
- [1. Overview of Spatial Data](#)
 - [The Concept of Spatial Data](#)
 - [The Characteristics of Spatial Data in Altibase](#)
 - [Spatial Data Terminology](#)
- [2. Spatial SQL](#)
 - [GEOMETRY Data Type](#)
 - [The Format of the GEOMETRY Data Type](#)
 - [DDL For Geometry](#)
 - [Spatial Functions in Altibase](#)
 - [Basic Spatial Functions](#)
 - [Spatial Analysis Functions](#)
 - [Spatial Object Creation Functions](#)
 - [Dimensionally Extended Nine Intersection Model\(DE - 9IM\)](#)
 - [Spatial Relational Operators in Altibase SQL](#)
 - [Reserved Words](#)
- [3. Spatial Application Development](#)
 - [Using the Spatial API](#)
 - [Examples of Application Programming](#)
 - [Data Types and Functions for Use with the Spatial API](#)
 - [Handle & Error Management Functions](#)
 - [Spatial Object Creation Functions](#)
 - [Spatial Object Querying Functions](#)
 - [Endian Functions](#)
- [Appendix A. Limitations on the Use of Spatial Data in Altibase](#)
 - [Limitations on GEOMETRY Type Columns](#)
- [Appendix B. Spatial Schema](#)
 - [Sample Table Information](#)
 - [Sample Data](#)
- [Appendix C. Geometry Reference Tables](#)
 - [Geometry Reference Tables](#)
 - [Related Stored Procedures](#)

Preface

About This Manual

This manual describes how to use spatial SQL statements and the spatial API with spatial data.

Audience

This manual has been prepared for the following Altibase users:

- Database administrators
- Performance administrators
- Database users
- Application developers
- Technical Supporters

It is recommended for those reading this manual possess the following background knowledge:

- Basic knowledge in the use of computers, operating systems, and operating system utilities
- Experience in using relational database and an understanding of database concepts
- Computer programming experience
- Experience in database server management, operating system management, or network administration

Organization

This manual is organized as follows:

- Chapter 1: Overview of Spatial Data
This chapter explains fundamental spatial data concepts, defines some related terminology, and describes the features of spatial data that are particular to Altibase.
- Chapter 2: Spatial SQL
This chapter describes the spatial data types, spatial SQL statements, and spatial functions and operators that are supported in Altibase.
- Chapter 3: Spatial Application Development
This chapter describes the Spatial API, which can be used by application developers to access spatial data.
- Appendix A. Limitations on the Use of Spatial Data in Altibase
This Appendix explains the current limitations on GEOMETRY type columns.
- Appendix B. Spatial Schema
This Appendix provides a reference for the table schema and data used in the examples throughout this manual.
- Appendix C. Geometry Reference Tables
This Appendix discusses how to install and use the SPATIAL_REF_SYS and GEOMETRY_COLUMNS meta tables.

Documentation Conventions

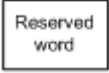



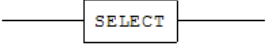
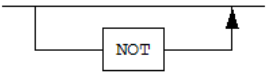
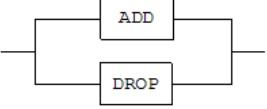
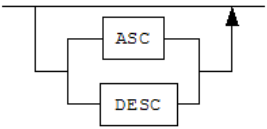
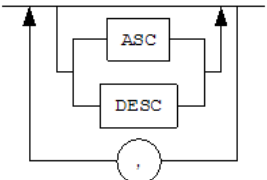
This section describes the conventions used in this manual. Understanding these conventions will make it easier to find information in this manual and in the other manuals in the series.

There are two sets of conventions:

- Syntax diagram conventions
- Sample code conventions

Syntax Diagram Conventions

This manual describes command syntax using diagrams composed of the following elements:

Elements	Meaning
	Indicates the start of a command. If a syntactic element starts with an arrow, it is not a complete command.
	Indicates that the command continues to the next line. If a syntactic element ends with this symbol, it is not a complete command.
	Indicates that the command continues from the previous line. If a syntactic element starts with this symbol, it is not a complete command.
	Indicates the end of a statement.
	Indicates a mandatory element.
	Indicates an optional element.
	Indicates a mandatory element comprised of options. One, and only one, option must be specified.
	Indicates an optional element comprised of options.
	Indicates an optional element in which multiple elements may be specified. A command must precede all but the first element.

Sample Code Conventions

The code examples explain SQL statements, stored procedures, iSQL statements, and other command line syntax.

The following table describes the printing conventions used in the code examples.

Rules	Meaning	Example
[]	Indicates an optional item	VARCHAR [(size)] [[FIXED] VARIABLE]
{ }	Indicates a mandatory field for which one or more items must be selected.	{ ENABLE DISABLE COMPILE }
	A delimiter between optional or mandatory arguments.	{ ENABLE DISABLE COMPILE } [ENABLE DISABLE COMPILE]
...	Indicates that the previous argument is repeated, or that sample code has been omitted.	<pre>SQL> SELECT ename FROM employee; ENAME ----- SWNO HJNO HSCHOI . . . 20 rows selected.</pre>
Other Symbols	Symbols other than those shown above are part of the actual code.	EXEC :p1 := 1; acc NUMBER(11,2)
Italics	Statement elements in italics indicate variables and special values specified by the user.	SELECT * FROM <i>table_name</i> ; CONNECT <i>userID/password</i> ;
Lower case words	Indicate program elements set by the user, such as table names, column names, file names, etc.	SELECT ename FROM employee;
Upper case words	Keywords and all elements provided by the system appear in upper case.	DESC SYSTEM.SYS_INDICES;

Related Documents

For more detailed information, please refer to the following documents.

- Installation Guide
- Getting Started Guide
- Administrator's Manual
- Replication Manual
- SQL Reference
- Stored Procedures Manual
- Precompiler User's Manual
- CLI User's Manual
- Application Program Interface User's Manual
- iSQL User's Manual

- Error Message Reference

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Thank you. We always welcome your feedbacks and suggestions.

1. Overview of Spatial Data

This chapter explains fundamental concepts of spatial data, defines some related terminology, and describes the features of spatial data that are particular to Altibase.

The Concept of Spatial Data

Spatial Data

The term “spatial data” refers to the representation of multidimensional data, such as points, lines and surfaces, as a list of numbers using a particular coordinate system. A typical example of spatial data is electronic map data, which is used to represent the topography of the real world in a coordinate system.

There are two fundamentally different kinds of spatial data: raster data and vector data.

In a vector model, points define coordinates, and points and lines define the borders between different aspects of the real world. The location of each of these aspects on a map is specified and maintained using a consistent coordinate system. Points, lines and polygons are used to represent coordinates or geographical features that are irregularly distributed in the real world. Lines are used to represent one-dimensional features such as roads, and polygons are used to represent two-dimensional features such as forests and the like.

In a raster model, space is uniformly divided into units known as pixels or cells. The location of a geographical aspect or set of coordinates is defined as a matrix of the pixels and cells in which the aspect or set of coordinates exists. The level of detail that it is possible to represent using a raster model depends on the cell size. The area in each cell cannot be divided any further; that is, all of the attributes that apply to the cell apply uniformly to the entire area within the cell. All cells are identical in size. A raster model typically consists of millions of cells.

The basic units in a vector model are points, lines and polygons. Compared to a raster model, a vector model typically consists of far fewer basic units, and moreover they are not uniform in size. A vector file typically contains thousands of elements, the specific location of each element being defined by one or more consecutive coordinate values. Vector data is easier to manipulate on a computer than raster data because the number of data items is lower, and additionally because the model is easier to adjust for different scales and yields more precise results when the scale is changed.

The advantages and disadvantages of vector and raster data are shown in the following table:

Type	Advantages	Disadvantages
Vector data	<ul style="list-style-type: none"> • Easier to represent real-world phenomena using data structures • More space-efficient data storage • Easier construction of topological relationships • More precise graphical representation • Enables normalization of locations and attributes 	<ul style="list-style-type: none"> • Complicated data structures • Difficulty overlapping map layers • Different topological form of respective units • Requires expensive equipment • Complicated spatial operations

Type	Advantages	Disadvantages
Raster data	<ul style="list-style-type: none"> • Makes spatial analysis easier • Simple and clear data structure • Consistent topological form of all units • Easy to overlap map layers • Low-cost technology and rapid development • Easier integration with remote sensing data 	<ul style="list-style-type: none"> • Difficulty constructing topological relationships • Creating a projection is time-consuming • Large amounts of graphical data • Large amounts of data loss upon data compression • Quality of output can be low

Table 1-1 Advantages and Disadvantages of Vector and Raster Data

The Characteristics of Spatial Data

Spatial data are generally characterized by an indefinite form and presence in large quantities.

Spatial data is said to be indefinite because the content and structure of each spatial object are represented in different ways depending on the type of the spatial object. Furthermore, even two objects of the same type can differ in the number of points, sub-objects, etc. they are comprised of, causing them to have different forms and lengths.

Spatial data is generally voluminous. The size of spatial data can exceed the size of a storage page in a DBMS. For example, it can take megabytes (MB) of storage just to store the data for the coastline of a single nation.

Because of these characteristics, there are many considerations that do not apply to non-spatial data that must be taken into account to store and manipulate spatial data efficiently.

Spatial Data Models

There are two conventional spatial data models: the field-based model, in which a space is represented using a series of attributes, and the entity-based model, in which a space is represented as an object (or entity) made up of a set of points. In the field-based model, in which each point in space has one or more attributes, spaces are defined in a manner similar to the use of a continuous function in the Cartesian coordinate system.

However, the field-based model does not take the concept of objects, which is important to the entity-based model, into account. The objects that are usually the most important in the entity-based model include points, which indicate the locations of objects; lines, which indicate two connected points; polylines, which indicate a series of connected lines; and polygons.

The spatial data model that was put forth by the Open Geospatial Consortium (OGC) is a conceptual model. That is, the model was defined in terms of spatial schema, and is an abstract data model rather than one that was intended for use in a particular implementation. This spatial schema forms the basis for the ISO 19107 Spatial Schema standard and is used in many other OGC specifications such as the OpenGIS Simple Features Specification and the GML Implementation Specification.

Spatial schema consists of the geometry package, which is a geometric object model in which is proposed a quantitative technique for describing the spatial characteristics of features that are abstractions of real world features, and the topology package, which provides a model for describing the relationships between geometric objects.

Based on the data models in the abstract specification, the OGC proposed more concrete OpenGIS geometry models in specifications intended for use in practical implementation, such as the OpenGIS Simple Features Specification.

The so-called “Geometry Class” is a root class and an abstract class, and consists of subclasses such as Point, Curve, Surface and GeometryCollection. All geometric objects are defined in relation to the spatial reference system for a defined coordinate space. The actual classes that can be instantiated for use are the Point, LineString, Polygon, GeometryCollection, MultiPoint, MultiLineString and MultiPolygon classes. The rest of the classes are defined as abstract classes.

Spatial Database Systems

A spatial database contains both non-spatial data, typically represented using characters and numbers, and spatial data, which are represented as coordinate values for spatial objects. The geographic objects (usually spatial objects) that are managed in a spatial database have both general and geometric attributes, and include topological information, that is, information about the spatial relationships between objects.

In order to store and manage such spatial data efficiently, a spatial database system must be able to represent and control non-spatial and spatial data at the logical level, and save and manage the data efficiently at the physical level. Therefore, in a spatial database system, it must be possible to represent data logically, and to provide functions for performing spatial operations on spatial data.

On the physical level, it must be possible to store data efficiently, and to provide spatial indexing so that spatial data can be accessed efficiently. In addition, it must be possible to efficiently store and manage the topological and general attributes of the spatial data that describe spatial objects.

Spatial data modeling is a technique that defines how spatial data is represented, and must support spatial data types such as points, lines and surfaces which can be used to describe real-world features. These spatial data types must be as simple and precise as possible, even when they are used to represent compound spatial objects. Additionally, the use of spatial operators must be supported with all spatial data types.

Spatial operators are those that are used to perform various kinds of spatial analysis, including the analysis of the topological relationships between spatial objects, so that spatial queries can be processed efficiently. For this reason, spatial database systems must support a variety of useful spatial operators.

Spatial

In general, complex and expensive operations on geometric figures are required in order to process spatial queries. Traditionally, point object operations involve sequential scanning and evaluation to determine which points are included in which objects. This incurs high processing costs because of frequent, repeated disk access and the repetitive assessment of geometric conditions.

Therefore, efficient spatial access methods have been developed in order to reduce the number of objects that actually need to be processed in order to analyze large amounts of stored spatial data. A so-called “spatial access method” is a method in which a spatial index is used to reduce the number of objects that need to be processed when processing a spatial query. This method has a time complexity requirement, whereby it must be possible to conduct a search in sub-linear time, and a spatial complexity requirement, whereby the size of a spatial index must be smaller than the size of the indexed data. It also requires dynamic update, by which an object can be added to

or removed from a spatial index without entailing a great reduction in performance. A typical spatial data access method that satisfies these requirements is one that uses an R-Tree.

The R-Tree, a height-balanced hierarchical multi-dimensional index structure that was originally designed for use with secondary storage, is a generalization of the B-tree for use with multi-dimensional data spaces. Like a B-tree, an R-Tree has a height-balanced tree structure, meaning that references to objects exist only at terminal nodes. The R-tree, which uses an MBR (Minimum Bounding Rectangle) to represent a spatial object, was designed to reduce the number of nodes that must be visited in order to locate a spatial object. In addition, because R-trees support the dynamic creation of tree structures, update and search operations can be performed on one R-tree at the same time, and there is no need to periodically rearrange the tree structure.

Spatial Reference Systems

In a spatial reference system, mutual associations are drawn between locations in real-world space and spatial objects that are defined on the basis of coordinates in mathematically expressed vector space. Spatial references can be realized using either spatial coordinates or identifiers.

A spatial reference system can be used to define a coordinate system for use with spatial data and the range of geographic area to which each data item refers.

Coordinate System

A coordinate system is used to specify the relative location of objects in a given area (for example, all or part of the earth's surface).

A reference system that is used to represent a location on the earth using longitude and latitude values is, together with an ellipsoid that represents the topology of the earth, called a geodetic reference system. In Korea, the Korean Geodetic System, which is based on the Bessel Ellipsoid and on longitude, latitudes and azimuth values determined through astronomical observations, is used. GPS surveying has become more common, the demand for universal location reference systems that can be used around the world has grown, giving rise to international geodetic systems that can be used the same way all over the world. International survey systems can be classified as ITRF (International Terrestrial Reference Frame), WGS (World Geodetic System) and PZ (Parametry Zemli) systems, depending on the reference and ellipsoid on which they are based.

Reference Ellipsoids

A reference ellipsoid is a mathematical representation of the earth. It is a model of the earth that is obtained by rotating the earth around the major and minor axes of an earth-shaped ellipsoid. It is used as a reference model on which to base coordinate values. Various ellipsoids are used around the world, depending on the conditions in each country. One universal ellipsoid that is used around the world is WGS84.

Geoids

A geoid is a model of the earth's topology that is based on an imagined average sea level if the ocean were somehow able to penetrate the continents, in which all points are perpendicular to the direction of gravity. In other words, a geoid is an ellipsoid that represents the earth and throughout the surface of which the gravitational pull of the earth is the same, and represents a reference surface 0m above sea level which is the average sea level. Although the topology of a geoid is irregular due to differences in the gravitational pull of the earth in different locations, it can be approximated as an ellipsoid having a regular surface.

The Datum

A datum, meaning a parameter or a set of parameters that is either used unchanged or as the basis for the calculation of other parameters, is a value (i.e. a point, line, or surface) that is determined based on an observation and used as an arbitrary basis for calibrating other observations. A datum consists of longitudinal, latitudinal and azimuth values, and can also be referred to as a “horizontal datum” or “horizontal geodetic datum”. In addition, a datum defines an origin, scale and direction according to the axes of the terrestrial coordinate system, and can be a geodetic datum, a vertical datum or an engineering datum. When a datum is changed, the coordinates of its spatial data are also changed.

Projection

Projection is the process in which three-dimensional information about all or part of the earth is converted to a two-dimensional map by projecting it onto a two-dimensional planar surface, such as a cylinder, a cone, a disk, etc. Everyday paper maps, as well as the numerical maps that are used for 2D GIS, are created using this projection process. Because shape, distance, direction, scale and area are inevitably distorted during the projection process, it is important to choose a projection method such that the distortion of the area to be projected is minimized.

In Korea, the Transverse Mercator (TM) projection method is used to create topographical maps. In TM projection, a geographic area is projected by bringing it into contact with a cylinder at its center meridian line (e.g. 127 ° East Longitude), which accurately projects the area close to the center meridian line. This projection method is thus frequently used when projecting areas that are extensive in the North-South direction. As one moves further from the center meridian, the distortion of distance, area, scale and direction becomes greater.

The Characteristics of Spatial Data in Altibase

The method by which spatial data is processed in Altibase has the following characteristics:

- Since Altibase features high-performance memory database technology and includes a spatial data model, it is superior not only for existing GIS applications, but also for the next-generation high-speed spatial data processing systems that will be required in the ubiquitous data environment. Moreover, because the spatial model is integrated with a conventional SQL-based RDBMS model, existing DBMS development environments and expertise can be utilized, leading to increased productivity.
- In Altibase, spatial data (i.e. information about the location of a particular area) can be stored, managed and analyzed alongside traditional character and numeric data. This allows users to create, analyze and utilize spatial data such as information about the locations of office buildings or the size of flooded areas.
- The capability of Altibase has been expanded through the inclusion of a series of advanced spatial data types for representing geometric objects such as points, lines and polygons, as well as numerous functions and features for working with these data types. Because it is so easy to integrate business data and spatial data, users can readily increase the range of business logic in their database applications.

Spatial Data Terminology

- **Closed**
If the start and end points of a LINESTRING object are the same, the spatial object is said to be “closed”. In order for a spatial object to be considered to be a closed object, all of the elements that the spatial object consists of must be closed. For a more detailed explanation of this concept, please refer to the description of the ISCLOSED function.
- **Compound Object**
Compound objects are those spatial objects that are made up of two or more spatial objects.
- **Dimension**
A dimension is the minimum number of real numbers needed to represent the location of any point within a figure, object or space. A point has zero (0) dimensions, a straight line has one dimension, a plane has two dimensions, and a body that has volume has 3 dimensions. Note that n-dimensional space is possible, as there is no limit on the number of dimensions.
- **Element**
An element is any of the common figures that comprise a spatial object. A single spatial object can be constructed from elements such as points, lines or surfaces.
- **Empty**
A spatial object in which no elements exist is said to be “empty”. Unlike NULL, which implies that the contents of an object are unknown, the empty state indicates definitively that the object contains nothing. For a more detailed explanation of this concept, please refer to the description of the ISEMPY function.
- **Line**
A line can be thought of as a trace of the continuous movement of a point. Next to the point, the line is the simplest figure. It has a location and a length, but no width or thickness. Lines can be straight or curved.
- **Multiple Object**
Multiple objects are spatial objects that are made up of more than one spatial object having the same form and comprise the MultiPoint, which consists only of points, the MultiLineString, which consists only of LineStrings, and the MultiPolygon, which consists only of Polygons.
- **Point**
This is the simplest spatial object. It has a location, but no size.
- **Scale**
Scale is the ratio between the distance shown in a map or picture and the actual distance in the real world. A scale value is typically expressed as a ratio, which enables the same units to be used for measurements on the map and in the real world. If, for example, the scale of a map is 1:25,000, one real-world unit of distance on the map represents 25,000 times that much distance in the real world. In other words, 1 cm on the map represents 25,000 cm in the real world. Note that the scale of a map describes horizontal distances only, and is not applicable to measurements of area or height.
- **Simple**
If the elements of a spatial object do not have unusual points, such as intersections or points of tangency, the spatial object is considered to be “simple”. For a more detailed explanation of this concept, please refer to the description of the ISSIMPLE function.

- Spatial Object

A spatial object consists of both spatial data, which are used to represent the real world, and operations, such as procedures, methods and functions, related to this data.

- Surface

A surface can be thought of as a trace of the continuous movement of a line, or as a planar form that cannot be described using a single point or line. Surfaces are classified as either planes or curved surfaces depending on whether their profile protrudes from a plane (i.e. a flat surface). Generally, the term “surface” is understood to refer to a planar surface, unless otherwise specified.

2. Spatial SQL

This chapter describes the spatial data types, spatial SQL statements, and spatial functions and operators that are supported in Altibase.

The implementation of spatial SQL in Altibase conforms with the ISO SQL/MM spatial standards and the Simple Features Specification for SQL proposed by the Open Geospatial Consortium (OGC).

Because the Simple Features Specification for SQL is an extension of standard SQL, users who are familiar with SQL can continue to use queries in the way to which they are accustomed when dealing with spatial data.

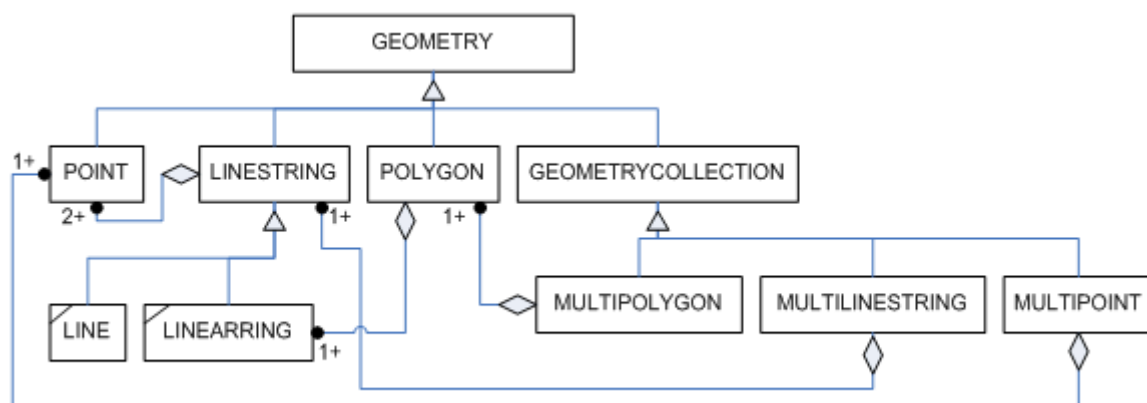
GEOMETRY Data Type

An understanding of spatial data types is required in order to manipulate spatial data in a database using spatial SQL. In this section, the spatial data types will be described in detail.

The spatial data type that is currently supported for use with SQL is the GEOMETRY type. The GEOMETRY type consists of the following 7 subtypes:

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

The following diagram illustrates the relationships between the GEOMETRY data type and the seven subtypes that it consists of.



[Figure 2-1] The relationships between the GEOMETRY data type and the seven subtypes

The GEOMETRY data type, as supported in Altibase, uses X and Y coordinates to represent a POINT, which represents a single point in space, and uses two or more POINTS to represent a LINESTRING. Depending on whether or not it is closed (i.e. on whether the two terminal points are the same), a LINESTRING is referred to either as a LINE1, which is unclosed, or as a LINEARRING2,

which is closed. The terms LINE and LINEARRING are used to indicate the shape of spatial objects, but do not denote mutually distinct data types.

A POLYGON consists of one or more LINEARRINGS. A MULTIPOINT consists of one or more POINTS, a MULTILINESTRING consists of one or more LINESTRINGS, and a MULTIPOLYGON consists of one or more POLYGONS. Finally, a GEOMETRYCOLLECTION can comprise any of the foregoing objects. In addition to the seven subtypes described above, Altibase also supports the EMPTY type. The EMPTY type can only be created by performing operations on spatial objects. The EMPTY type is returned by an operator whose return type is GEOMETRY when there is nothing to return as the result of an operation.

Classification of Subtypes

The criteria that are used to distinguish the 7 subtypes of the GEOMETRY data type from each other are described in the following [Table 2-1]:

Subtype Name	Constituent Elements	Dimensions	Simple	Closed	Interior	Boundary	Exterior
Point	One Point	0	O	X	Point	∅ ¹	Surface
LINESTRING	Two or more POINTs	1	* ²	*	Line	∅ ¹ when closed; both end points when not closed	Surface
POLYGON	One or more simple closed LINESTRINGS	2	O ³	O	Surface	A LINESTRING that includes all internal and external rings	Surface
MULTIPOINT	One or more POINTs	0	*	X	Point	∅	Surface
MULTILINESTRING	One or more LINESTRINGS	1	*	*	Line	∅ ¹ when closed; both end points when not closed	Surface
MULTIPOLYGON	One or more POLYGONS	2	O	O	Surface	A LINESTRING that includes all internal and external rings in all spatial objects that is consists of	Surface
GEOMETRYCOLLECTION	Two or more non- GEOMETRYCOLLECTION type spatial objects	Maximum of 2 dimensions	*	*	The interior of all spatial objects	The boundaries of all spatial objects	Surface

[¹] This symbol indicates an empty set that contains no results.

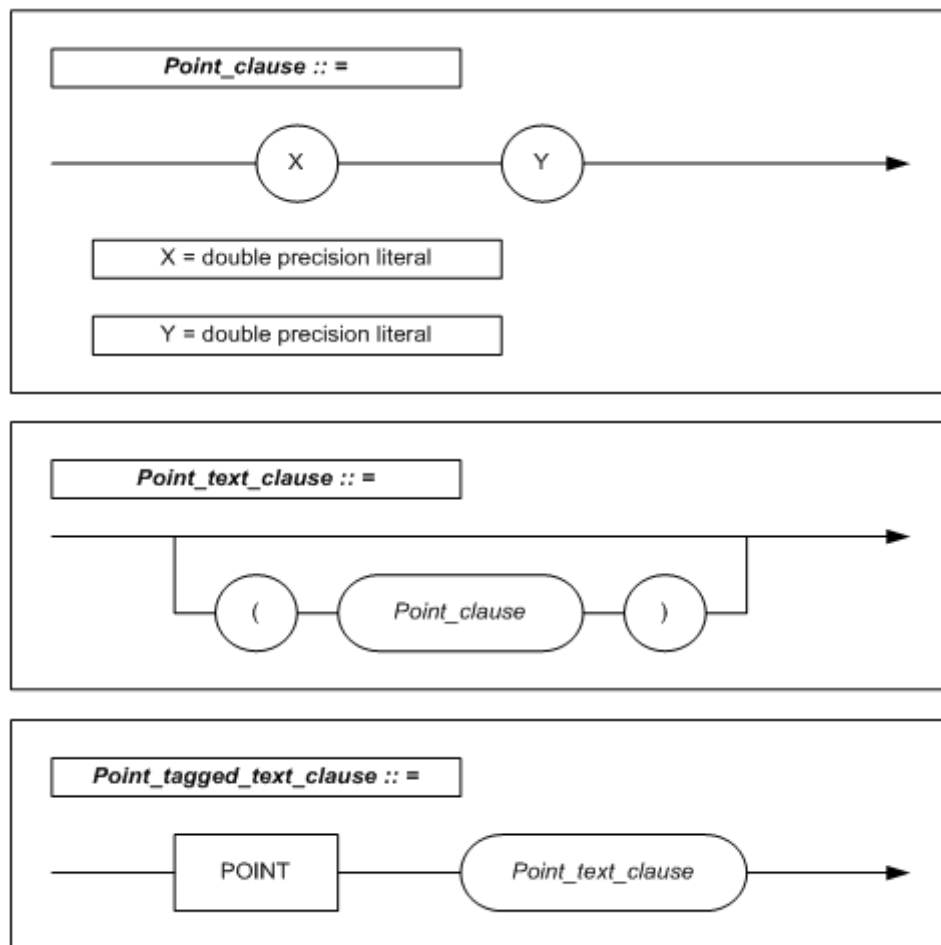
[²] This symbol means that this subtype may or may not satisfy this condition.

[³] A non-simple POLYGON violates the definition of a POLYGON, and thus cannot be inserted.

[Table 2-1] Subtypes of the Geometry Data Type

POINT

Syntax



POINT(x y)

x: The x-coordinate

y: The y-coordinate

Description

A POINT represents the location of a single point in a coordinate system. It is a zero-dimensional simple unclosed spatial object that has a single point as its only element. The interior of the spatial object is the POINT itself. It has no boundary. The exterior is the surrounding surface, not including the POINT itself.

Characteristic

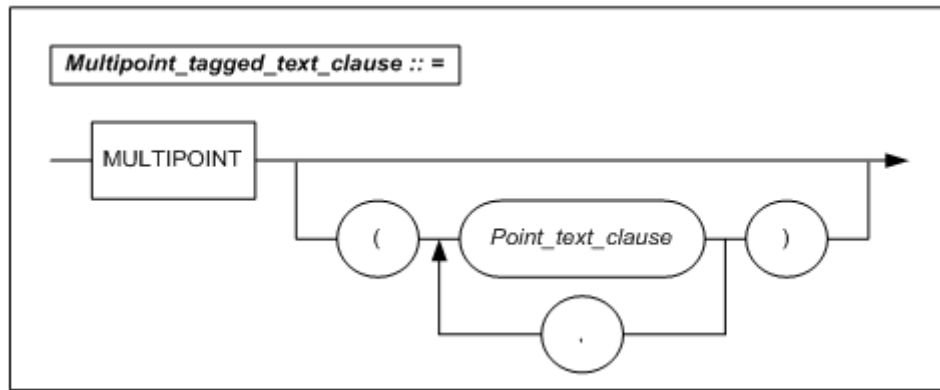
A POINT has x- and y-coordinate values.

Example

```
CREATE TABLE building ( id INTEGER, obj GEOMETRY ) ;
INSERT INTO building VALUES (1, GEOMETRY'POINT( 10 10 ) ' ) ;
INSERT INTO building VALUES (2, GEOMFROMTEXT('POINT(20 20)'));
INSERT INTO building VALUES (3, POINTFROMTEXT('POINT( 100 100 )')) ;
INSERT INTO building VALUES (4, GEOMETRY'POINT EMPTY');
INSERT INTO building VALUES (5, GEOMFROMTEXT('POINT EMPTY'));
INSERT INTO building VALUES (6, POINTFROMTEXT('POINT EMPTY'));
```

MULTIPOINT

Syntax



MULTIPOINT(x1 y1 [, xn yn])

x_n : The value of the x-coordinate for the nth point

y_n : The value of the y-coordinate for the nth point

Description

A MULTIPOINT is a zero-dimensional unclosed spatial object that has one or more POINTs as its elements. The interior of the spatial object is defined by the points that comprise the MULTIPOINT object. It has no boundary. The exterior is the surrounding surface, not including the POINTs themselves.

Characteristics

A MULTIPOINT is considered simple if no two of its points have the same coordinates.

Limitation

A MULTIPOINT only has points as its constituent elements. These points are not interconnected or ordered.

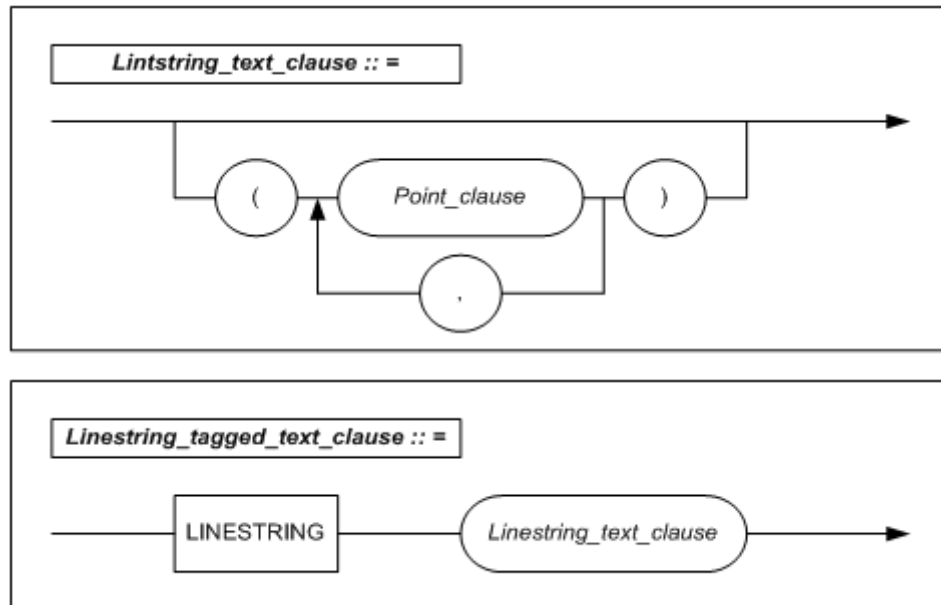
Example

```
CREATE TABLE building ( id INTEGER, obj GEOMETRY ) ;
INSERT INTO building VALUES (1, GEOMETRY'MULTIPOINT( 10 10, 20 20 )') ;
INSERT INTO building VALUES (2, GEOMFROMTEXT('MULTIPOINT( 10 20, 20 30 ) ')) ;
INSERT INTO building VALUES (3, MPOINTFROMTEXT('MULTIPOINT( 100 100, 150 150 )'))
;
INSERT INTO building VALUES (4, GEOMETRY'MULTIPOINT EMPTY');
INSERT INTO building VALUES (5, GEOMFROMTEXT('MULTIPOINT EMPTY'));
INSERT INTO building VALUES (6, MPOINTFROMTEXT('MULTIPOINT EMPTY'));
```

LINESTRING

The following is a text string representation of a linestring object.

Syntax



LINESTRING(x1 y1 , x2 y2 [, xn yn])

x_n : The value of the x-coordinate for the nth point

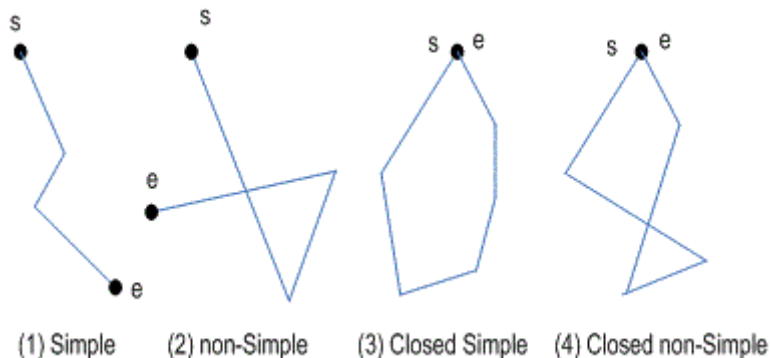
y_n : The value of the y-coordinate for the nth point

Description

A LINESTRING is a one-dimensional spatial object that has two or more POINTs as its elements. These POINTs are connected with each other via straight lines. The interior of the spatial object is the actual segment that is the LINESTRING. If the segment is closed, the LINESTRING has no boundary, whereas if the segment is not closed, the LINESTRING has the two terminal POINTs as its boundary. The exterior is the surrounding surface, not including the LINESTRING itself.

Characteristics

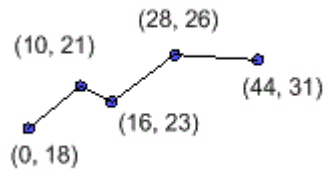
If a LINESTRING is closed and simple, it is called a LINEARRING. In the following figure, LINESTRING #3 is a LINEARRING because it is a closed and simple LINESTRING, while LINESTRING #4 is not a LINEARRING because even though it is closed, it is not a simple LINESTRING.



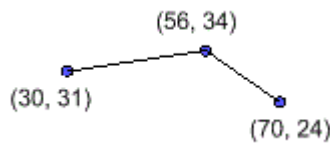
[Figure 2-2] Examples of LineString

Example

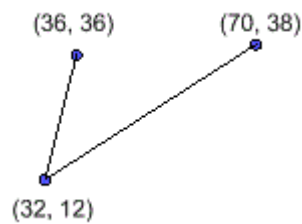
```
CREATE TABLE road ( id INTEGER, obj GEOMETRY ) ;
INSERT INTO road VALUES (1, GEOMETRY'LINESTRING( 0 18, 10 21, 16 23, 28 26, 44 31
)' ) ;
```



```
INSERT INTO road VALUES (2, GEOMFROMTEXT('LINESTRING( 30 31, 56 34, 70 24 )')) ;
```



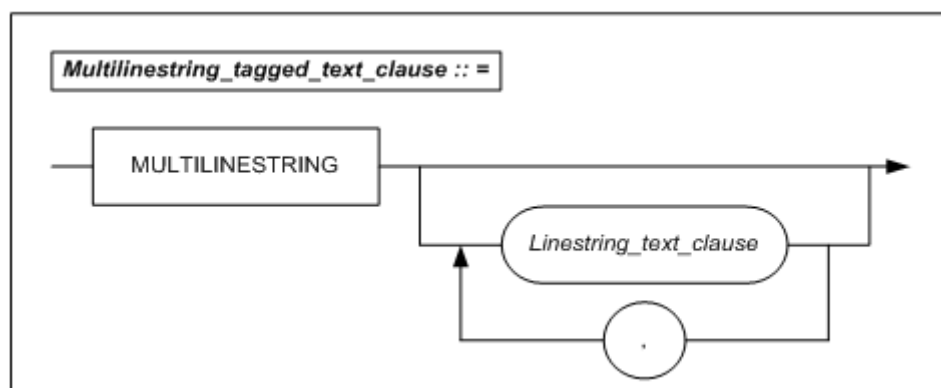
```
INSERT INTO road VALUES (3, LINEFROMTEXT('LINESTRING( 70 38, 32 12, 36 36 )')) ;
```



```
INSERT INTO road VALUES (4, GEOMETRY'LINESTRING EMPTY');
INSERT INTO road VALUES (5, GEOMFROMTEXT('LINESTRING EMPTY'));
INSERT INTO road VALUES (6, LINEFROMTEXT('LINESTRING EMPTY'));
```

MULTILINESTRING

Syntax



MULTILINESTRING((x1 y1, x2 y2 [, xn yn]) [, (x1 y1, x2 y2 [, xn yn])])

x_n : The value of the x-coordinate for the nth point

y_n : The value of the y-coordinate for the nth point

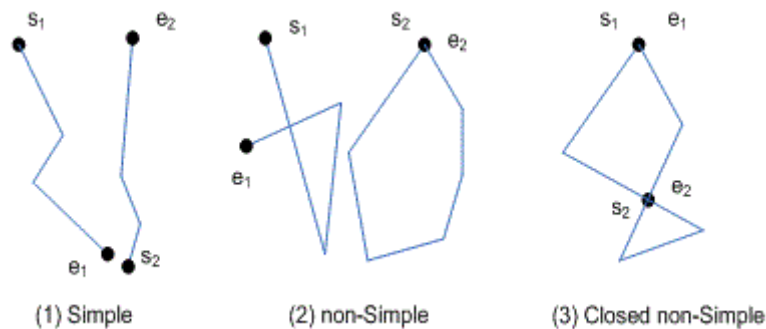
Description

A MULTILINESTRING is a one-dimensional spatial object comprising one or more LINESTRINGs (segments) as its elements. The interior of the spatial object is defined by the segments that comprise the MULTILINESTRING. The boundary of the MULTILINESTRING consists of the two terminal POINTs of any constituent segments that are not closed. If all segments are closed, the MULTILINESTRING has no boundary. The exterior is the surrounding surface, not including the segments.

Characteristics

If all of the LINESTRINGs that a MULTILINESTRING consists of are closed, the MULTILINESTRING itself is closed, and has no boundary

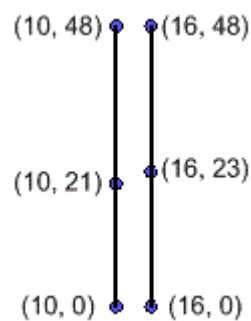
In the following figure, the boundaries of the MultiLineStrings are $\{s_1, e_2\}$ for (1), $\{s_1, e_1\}$ for (2) and \emptyset (i.e. an empty set) for (3).



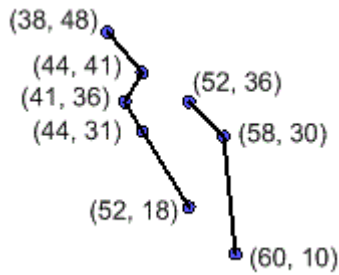
[Figure 2-3] Examples of MultiLineString

Example

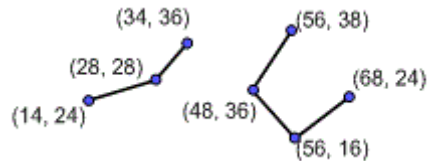
```
CREATE TABLE road ( id INTEGER, obj GEOMETRY ) ;
INSERT INTO road VALUES (1, GEOMETRY'MULTILINESTRING(( 10 48, 10 21, 10 0 ), (16
0, 16 23, 16 48) )') ;
```



```
INSERT INTO road VALUES (2, GEOMFROMTEXT('MULTILINESTRING(( 38 48, 44 41, 41 36,
44 31, 52 18 ), ( 60 10, 58 30, 52 36))')) ;
```



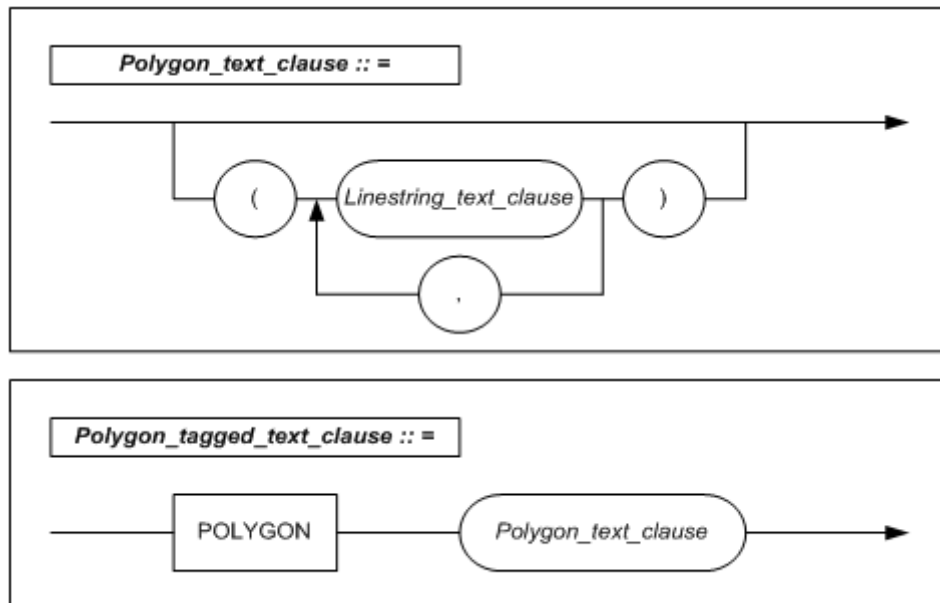
```
INSERT INTO road VALUES (3, MLINEFROMTEXT('MULTILINESTRING(( 14 24, 28 28, 34 36
), ( 56 38, 48 36, 56 16, 68 24 ))')) ;
```



```
INSERT INTO road VALUES (4, GEOMETRY'MULTILINESTRING EMPTY');
INSERT INTO road VALUES (5, GEOMFROMTEXT('MULTILINESTRING EMPTY'));
INSERT INTO road VALUES (6, MLINEFROMTEXT('MULTILINESTRING EMPTY'));
```

POLYGON

Syntax



POLYGON((x1 y1, x2 y2, x3 y3 [, xn yn])[, (x1 y1, x2 y2, x3 y3 [, xn yn])])

x_n : The value of the x-coordinate for the nth point

y_n : The value of the y-coordinate for the nth point

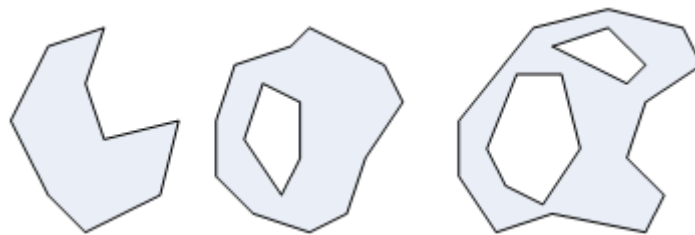
Description

A POLYGON is a spatial object that represents a surface in a space. It is a two-dimensional spatial object comprising one or more simple closed LINESTRINGS. A POLYGON must also be simple and closed. The interior of the spatial object is the surface defined by the POLYGON. The exterior is the surrounding surface, not including the POLYGON itself. The boundary consists of any exterior rings that comprise the POLYGON. For example, the boundary of a POLYGON that consists of an exterior ring and an interior ring is the LINESTRINGS that respectively define the exterior ring and the interior ring.

Characteristics

- A POLYGON is defined as a surface that has one exterior boundary and 0 (zero) or more interior boundaries.
- A POLYGON is a simple closed spatial object.
- The boundary of a POLYGON consists of LINEARRINGS that form interior and exterior boundaries.

The following figure shows representative examples of POLYGONS.



[Figure 2-4] Examples of Polygon

Requirements for a Polygon

No two closed LINESTRINGS that form the boundary of a POLYGON can intersect or be tangent to each other. They can only meet each other at a single point, and both LINESTRINGS must have POINTs defined where they meet.

$$\forall P \in \text{Polygon}, \forall c1, c2 \in P.\text{Boundary}(), c1 \neq c2, \forall p, q \in \text{Point}, \\ p, q \in c1, p \neq q, [p \in c2 \Rightarrow q \in c2]$$

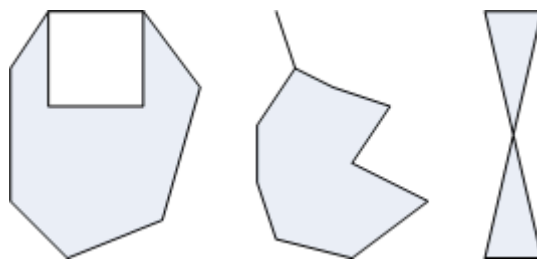
The interior ring must not be connected to the exterior of a Polygon.

A Polygon cannot have a segment protruding from it, nor can it have within it a point that is not part of a closed LINESTRING.

$$\forall P \in \text{Polygon}, P = \text{Closure}(\text{Interior}(P))$$

The entire interior of a POLYGON must form a single interconnected surface.

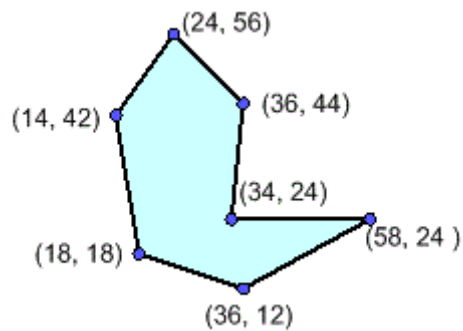
The following figure shows objects that do not satisfy the above requirements, and thus cannot be represented as POLYGONS.



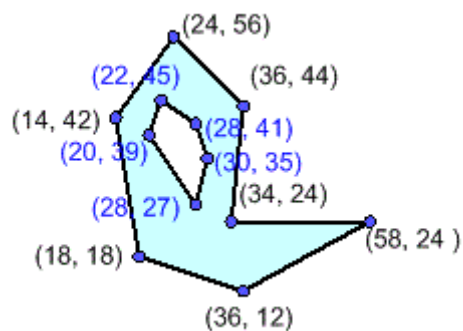
[Figure 2-5] Examples of spatial objects that cannot be represented as Polygon.

Examples

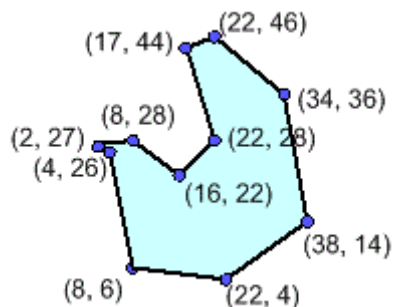
```
CREATE TABLE lake ( id INTEGER, obj GEOMETRY ) ;
INSERT INTO lake VALUES (1, GEOMETRY'POLYGON(( 14 42, 18 18, 36 12, 58 24, 34 24,
36 44, 24 56, 14 42 ))') ;
```



```
INSERT INTO lake VALUES (2, GEOMFROMTEXT('POLYGON(( 14 42, 18 18, 36 12, 58 24,
34 24, 36 44, 24 56, 14 42 ), ( 20 39, 28 27, 30 35, 28 41, 22 45, 20 39 ))')) ;
```



```
INSERT INTO lake VALUES (3, POLYFROMTEXT('POLYGON(( 8 6, 22 4, 38 14, 34 36, 22
46, 17 44, 22 28, 16 22, 8 28, 2 27, 4 26, 8 6 ))')) ;
```



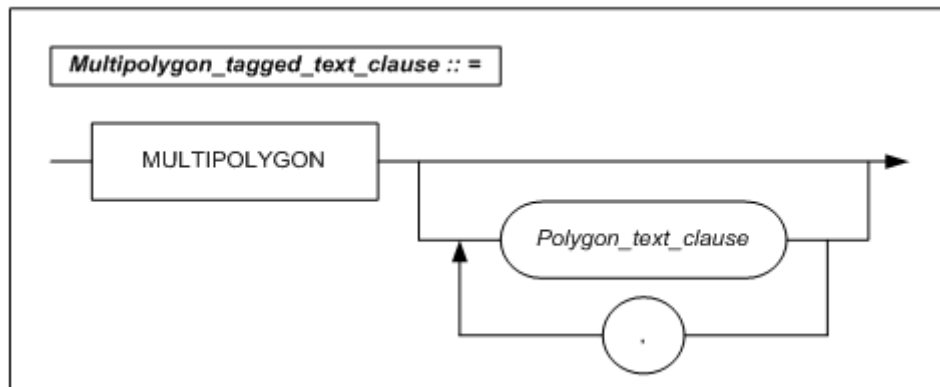

```

INSERT INTO lake VALUES (4, GEOMETRY'POLYGON EMPTY');
INSERT INTO lake VALUES (5, GEOMFROMTEXT('POLYGON EMPTY'));
INSERT INTO lake VALUES (6, POLYFROMTEXT('POLYGON EMPTY'));

```

MULTIPOLYGON

Syntax



```

MULTIPOLYGON(( (x1 y1, x2 y2, x3 y3 [, xn yn ]), (x1 y1, x2 y2, x3 y3 [, xn
yn ])) [(x1 y1, x2 y2, x3 y3 [, xn yn ]), (x1 y1, x2 y2, x3 y3 [, xn yn
)]))

```

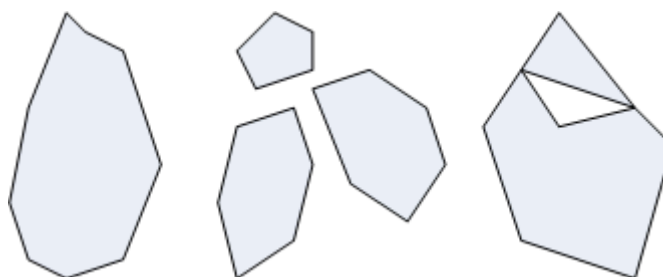
Description

A MultiPolygon is a collection class that consists of Polygons as its constituent elements. It is a two-dimensional simple unclosed spatial object comprising one or more POLYGONS as its elements. The interior of the spatial object is the surfaces defined by the constituent POLYGONS. The exterior is the surrounding surface, not including the POLYGONS. Its boundary is defined by the LINESTRINGS that define exterior and interior rings of the constituent POLYGONS.

Characteristics

- A MULTIPOLYGON is a simple closed spatial object.
- The boundary of a MULTIPOLYGON is a set of LINESTRINGS.

The following figure shows examples of MULTIPOLYGONS. The third MultiPolygon doesn't comprise an exterior Polygon and an interior Polygon, but two Polygons, one of which is above the other.



[Figure 2-6] Examples of MULTIPOLYGONS

Limitation

The intersection of the interiors of two Polygons that comprise a MultiPolygon is an empty set.

$$\forall M \in \text{MultiPolygon}, \forall P_i, P_j \in M.\text{Geometries}(), i \neq j, \text{Interior}(P_i) \cap \text{Interior}(P_j) = \emptyset$$

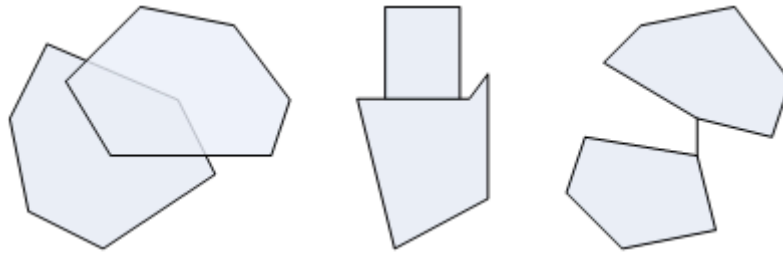
Two LINESTRINGs that form all or part of the boundary of a MULTIPOLYGON can only meet each other at individual POINTS, and both LINESTRINGs must have POINTs defined where they meet.

$$\forall M \in \text{MultiPolygon}, \forall P_i, P_j \in M.\text{Geometries}(), \forall c_i \in P_i.\text{Boundaries}(), c_j \in P_j.\text{Boundaries}(), c_i \cap c_j = \{p_1, \dots, p_k \mid p_i \in \text{Point}, 1 \leq i \leq k\}$$

A MULTIPOLYGON cannot have a segment protruding from it, nor can it have within any of its constituent POLYGONs a point that is not part of a closed LINESTRING.

$$\forall M \in \text{MultiPolygon}, M = \text{Closure}(\text{Interior}(M))$$

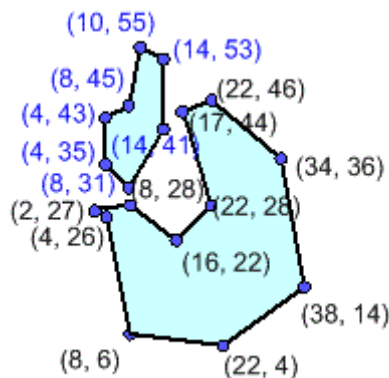
The following figure shows objects that do not satisfy the above criteria, and thus cannot be represented as MULTIPOLYGONS.



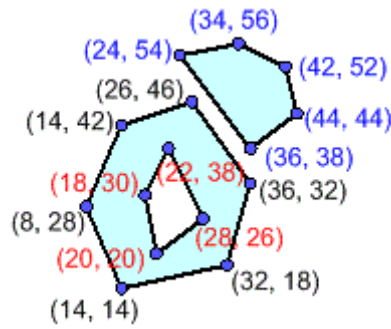
[Figure 2-7] Examples of spatial objects that cannot be represented as MULTIPOLYGONS

Examples

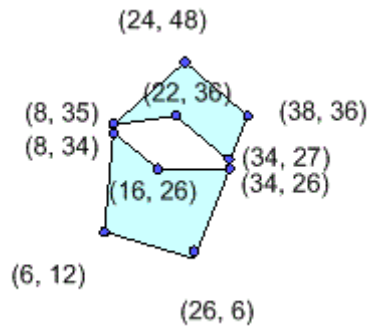
```
CREATE TABLE lake ( id INTEGER, obj GEOMETRY );
INSERT INTO lake VALUES (1, GEOMETRY'MULTIPOLYGON(((8 6, 22 4, 38 14, 34 36, 22
46, 17 44, 22 28, 16 22, 8 28, 2 27, 4 26, 8 6 )), (( 4 35, 8 31, 14 41, 14 53,
10 55, 8 45, 4 43, 4 35 )))') ;
```



```
INSERT INTO lake VALUES (2, GEOMFROMTEXT('MULTIPOLYGON((( 8 28, 14 14, 32 18, 36
32, 26 46, 14 42, 8 28 ), ( 18 30, 20 20, 28 26, 22 38, 18 30 )), (( 24 54, 36
38, 44 44, 42 52, 34 56, 24 54 )))') ;
```



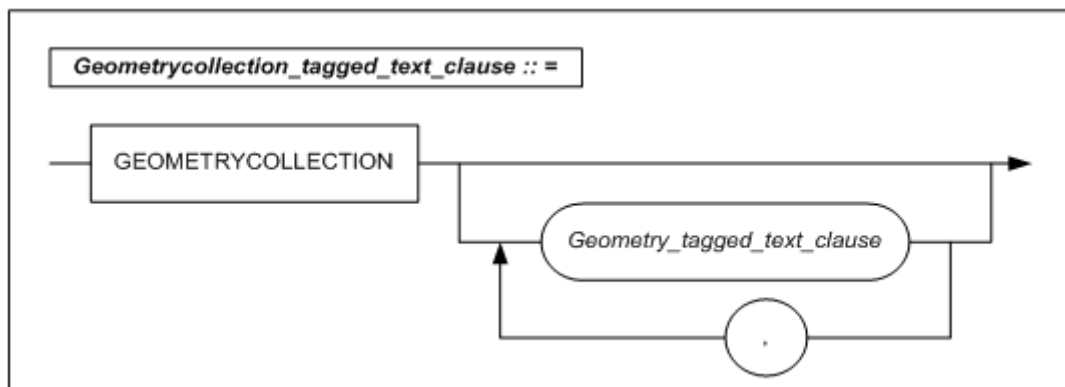
```
INSERT INTO lake VALUES (3, MPOLYFROMTEXT('MULTIPOLYGON((( 8 34, 6 12, 26 6, 34
26, 16 26, 8 34 )), (( 8 35, 22 36, 34 27, 38 36, 24 48, 8 35 )))')) ;
```



```
INSERT INTO lake VALUES (4, GEOMETRY'MULTIPOLYGON EMPTY');
INSERT INTO lake VALUES (5, GEOMFROMTEXT('MULTIPOLYGON EMPTY'));
INSERT INTO lake VALUES (6, MPOLYFROMTEXT('MULTIPOLYGON EMPTY'));
```

GEOMETRYCOLLECTION

Syntax



GEOMETRYCOLLECTION(Point | LineString | Polygon | MultiPoint |
MultiLineString | MultiPolygon, [Point | LineString | Polygon | MultiPoint
| MultiLineString | MultiPolygon])

- Point: This is a POINT type object
- LineString: This is a LINESTRING type object
- Polygon: This is a POLYGON type object
- MultiPoint: This is a MULTIPOINT type object
- MultiLineString: This is a MULTILINESTRING type object
- MultiPolygon: This is a MULTIPOLYGON type object

Description

A GEOMETRYCOLLECTION is a set of one or more spatial objects.

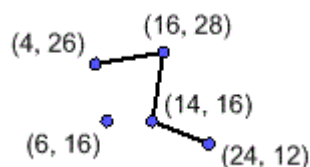
A GEOMETRYCOLLECTION is a spatial object that has a maximum of two dimensions and consists of two or more spatial objects as its elements. These elements cannot themselves be other GEOMETRYCOLLECTION type objects, meaning that the GEOMETRYCOLLECTION type cannot be nested. The interior of the spatial object is the collective interiors of all of the constituent spatial objects, and its boundary consists of the boundaries of all the spatial objects it contains. The exterior is the surrounding surface, not including the elements that the GEOMETRYCOLLECTION consists of.

Limitation

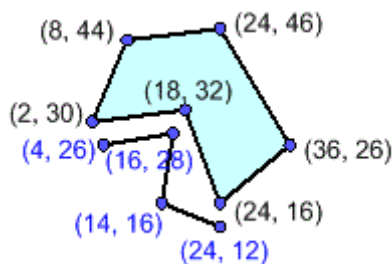
The criteria for a GEOMETRYCOLLECTION object depend on the criteria for each of the spatial objects that comprise the GEOMETRYCOLLECTION.

Examples

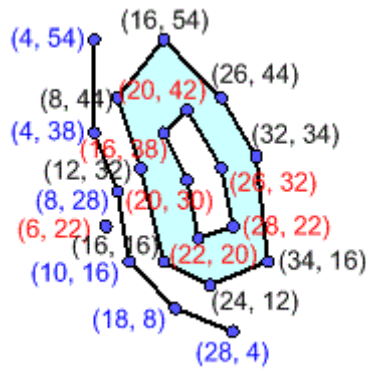
```
CREATE TABLE test1 ( id INTEGER, obj GEOMETRY ) ;
INSERT INTO test1 VALUES (1, GEOMETRY'GEOMETRYCOLLECTION( POINT( 6 16 ),
LINESTRING( 4 26, 16 28, 14 16, 24 12 ))') ;
```



```
INSERT INTO test1 VALUES (2, GEOMFROMTEXT('GEOMETRYCOLLECTION( LINESTRING( 4 26,
16 28, 14 16, 24 12 ), POLYGON(( 2 30, 18 32, 24 16, 36 26, 24 46, 8 44, 2 30
)))')) ;
```



```
INSERT INTO test1 VALUES (3, GEOMCOLLFROMTEXT ('GEOMETRYCOLLECTION (POINT( 6 22
), LINESTRING( 4 54, 4 38, 8 28, 10 16, 18 8, 28 4 ), POLYGON(( 8 44, 12 32, 16
16, 24 12, 34 16, 32 34, 26 44, 16 54, 8 44 ), ( 16 38, 20 30, 22 20, 28 22, 26
32, 20 42, 16 38 )))')) ;
```



```
INSERT INTO test1 VALUES (4, GEOMETRY'GEOMETRYCOLLECTION EMPTY');
INSERT INTO test1 VALUES (5, GEOMFROMTEXT('GEOMETRYCOLLECTION EMPTY'));
INSERT INTO test1 VALUES (6, GEOMCOLLFROMTEXT('GEOMETRYCOLLECTION EMPTY'));
```

The Format of the GEOMETRY Data Type

In Altibase, the GEOMETRY data type can be represented using any of the three ways described below:

- WKT (Well-Known Text): A text format in which a spatial object is represented using letters and numbers. This allows it to be processed directly within SQL applications or other similar applications. The WKT format was designed using simple grammar for easy readability.
- WKB (Well-Known Binary): A format in which a spatial object is represented in binary form. It was designed for the purpose of efficiently transferring and performing operations on GEOMETRY type data.
- EWKT(Extended Well-Known Text) format: A text format in which Spatial Reference Identifier (SRID) information representing spatial objects has been added to the WKT format.
- EWKB(Extended Well-Known Binary) format: A text format in which Spatial Reference Identifier (SRID) information representing spatial objects is added to the WKB format
- Internal Binary: A format in which data is stored within Altibase. It was designed for the purpose of efficiently managing and performing spatial operations on spatial data. Data saved in the internal binary format of Altibase can only be manipulated using the C API. The C API will be described in Spatial Application Development.

WKT (Well-Known Text)

WKT (Well-known Text) is a format for representing a spatial object using letters and numbers. WKT is defined using Backus-Naur Form (BNF) notation, as shown below:

```
<Geometry Tagged Text> : =
<Point Tagged Text>
| <LineString Tagged Text>
| <Polygon Tagged Test>
| <MultiPoint Tagged Test>
| <MultiLineString Tagged Test>
| <MultiPolygon Tagged Test>
| <GeometryCollection Tagged Test>
<Point Tagged Test> : = POINT <Point Text>
<LineString Tagged Text> : = LINESTRING <LineString Test>
<Polygon Tagged Text> := POLYGON <Polygon Text>
```

```

<MultiPoint Tagged Text> := MULTIPOINT (MultiPoint Text>
<MultiLineString Tagged Text> := MULTILINESTRING (MultiLineString Text>
<MultiPolygon Tagged Text> := MULTIPOLYGON <MultiPolygon Text>
<GeometryCollection Tagged Text> := GEOMETRYCOLLECTION <GeometryCollection Text>
<Point Text> := ( <Point> )
<Point> := <x> <y>
<x> := double precision literal
<y> := double precision literal
<LineString Text> := ( <Point > {, <Point > }*)
<Polygon Text> := ( <LineString Text > {, < LineString Text > }*)
<MultiPoint Text> := ( <Point Text > {, <Point Text > }*)
<MultiLineString Text> := ( <LineString Text > {, < LineString Text > }*)
<MultiPolygon Text> := ( < Polygon Text > {, < Polygon Text > }*)
<GeometryCollection Text> := ( <Geometry Tagged Text > {, <Geometry Tagged Text>
}*)

```

Format	WKT Expression	Description
Point	POINT (10 10)	A Point
LineString	LINESTRING (10 10, 20 20, 30 40)	A LineString having three points
Polygon	POLYGON ((10 10, 10 20, 20 20, 20 15, 10 10))	A Polygon consisting of one exterior ring and zero interior rings
MultiPoint	MULTIPOINT (10 10, 20 20)	A MultiPoint comprising two Points
MultiLineString	MULTILINESTRING ((10 10, 20 20), (15 15, 30 15))	A MultiLineString comprising two LineStrings
MultiPolygon	`MULTIPOLYGON (((10 10, 10 20, 20 20, 20 15, 10 10)), ((60 60, 70 70, 80 60, 60 60)))	A MultiPolygon comprising two Polygons
GeometryCollection	`GEOMETRYCOLLECTION (POINT (10 10), POINT (30 30), LINESTRING (15 15, 20 20))	A collection of spatial objects comprising two points and one LineString

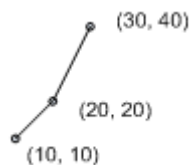
Examples

The examples of spatial data shown in WKT format above are shown graphically below:

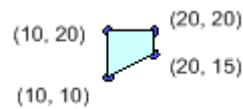
- Point

• (10, 10)

- LineString



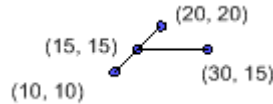
- Polygon



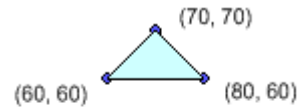
- MultiPoint



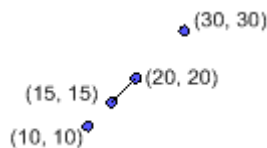
- MultiLineString



- MultiPolygon



- GeometryCollection



WKB (Well-Known Binary)

WKB (Well-known Binary) is a format in which a spatial object is represented in binary form.

This is the binary form put forth in the OGC Standards. It is used to ensure data compatibility between heterogeneous spatial DBMSs.

The WKB format represents a spatial object using UNSIGNED INTEGER and DOUBLE type numerical data. It is encoded using either NDR or XDR, which differ from each other with respect to byte order (Endian).

The byte order of XDR, which stands for “External Data Representation”, is Big Endian, whereas that of NDR, which stands for “Network Data Representation”, is Little Endian. The UNSIGNED INTEGER data type is a 32-bit data type whose value can be a positive integer in the range from 0 to 4294967295. DOUBLE is a 64-bit double precision data type that follows the IEEE 754 double precision format for representing double precision numbers.

The WKB representation of spatial objects is shown below. The basic type is the POINT, which is represented using two DOUBLE type numbers. The representations of all other kinds of spatial objects are based on the definition of the POINT, or on the definitions of other spatial objects that are themselves defined based on the definition of the POINT.

```
// 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 {
unit32 numPoints ;
Point points{numPoints} ;
}

enum wkbGeometryType {
wkbPoint = 1,
wkbLineString = 2,
wkbPolygon = 3,
wkbMultiPoint = 4,
wkbMultiLineString = 5,
wkbMultiPolygon = 6,
wkbGeometryCollection = 7
} ;

enum wkbByteorder {
wkbXDR = 0 ;    // Big Endian
wkbNDR = 1 ;    // Little Endian
} ;

WKBPoint {
byte byteOrder ;
unit32 wkbType ;      // 1
Point point ;
}

WKBLineString {
byte byteOrder ;
unit32 wkbType ;      // 2
unit32 numPoints ;
Point points{numPoints} ;
}

WKBPolygon {
byte byteOrder ;
unit32 wkbType ;      // 3
unit32 numRings ;
LinearRing rings{numRings} ;
}

WKBMultiPoint {
byte byteOrder ;
unit32 wkbType ;      // 4
unit32 num_wkbPoints ;
WKBPoint WKBpoints{num_wkbPoints} ;
}

WKBMultiLineString {
byte byteOrder ;
unit32 wkbType ;      // 5
```



```

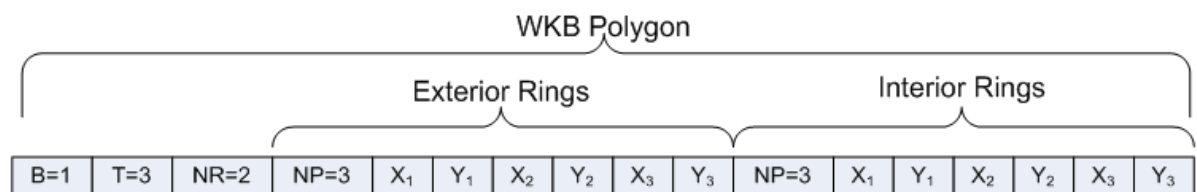
unit32 num_wkbLineStrings ;
WKBLineString WKBLineStrings{num_wkbLineStrings} ;
}

WKBMultiPolygon {
byte byteOrder ;
unit32 wkbType ;          / / 6
unit32 num_wkbPolygons ;
WKBPolygon wkbPolygons{num_wkbPolygons} ;
}

WKBGeometry {
union {
WKBPoint point ;
WKBLineString linestring ;
WKBPolygon polygon ;
WKBGeometryCollection collection ;
WKBMultiPoint mpoint ;
WKBMultiLineString mlinestring ;
WKBMultiPolygon mpolygon ;
}
} ;

WKBGeometryCollection {
byte byte_order ;
unit32 wkbType ;          / / 7
unit32 num_wkbGeometries ;
WKBGeometry wkbGeometries{num_wkbGeometries} ;
} ;

```



Byte Order NDR (B=1), Polygon Type (T=3) with 2 Linear Rings (NR=2) having 3 Points (NP=3)

[Figure 2-8] Example of WKB Structure

In this example, the Little Endian (NDR) byte order is used, and a POLYGON with one exterior ring and one interior ring is described. Each of the exterior and interior rings consists of three points.

EWKT (Extended Well-Known Text)

EWKT indicates SRID information in addition to WKT format. Except for the notation of SRID information, the notation is identical to the WKT format. The EWKT format is not an OpenGIS standard and an example of spatial data described using the EWKT format is as follows.

Format	EWKT Expression	SRID	Description
Point	SRID=4326;POINT(10 10)	4326	One Point; SRID is 4326

Format	EWKT Expression	SRID	Description
LineString	SRID=100;LINESTRING(10 10, 20 20, 30 40)	100	3-point linestring; SRID is 100
Polygon	SRID=-999;POLYGON((10 10, 10 20, 20 20, 20 15, 10 10))	-999	A polygon consisting of one outer ring and zero inner rings; SRID is -999
MultiPoint	SRID=0;MULTIPOINT(10 10, 20 20)	0	Multipoint with two points; SRID is 0

EWKB (Extended Well-Known Binary)

EWKB represents SRID information in addition to the WKB format. Except for the notation of SRID information, the notation is identical to the WKB format. The EWKB format is not an OpenGIS standard. The notation of the EWKB format is almost the same as that of the WKB format, but after the byte order (one byte; either NDR or XDR) and the GEOMETRY data type (four bytes; POINT, MULTIPOINT, etc.), the four-byte SRID is written differently. After the SRID notation, the object information is expressed in binary form similar to the WKB format.

DDL For Geometry

This section will describe with examples the syntax and features of SQL DDL statements used to create database objects. A detailed description will be provided only for aspects directly related to the GEOMETRY data type. For a more detailed description of each SQL statement described below, please refer to the *Altibase SQL Reference*.

CREATE TABLE

Syntax

```
CREATE TABLE table_name (
    column_name GEOMETRY [(precision)] [(SRID srid)];
```

Description

This is used to specify the maximum size of the column to be created. The allowable range is from 16 bytes to 100 megabytes. If not specified, the column will default to a size of 32,000 bytes. Any attempt to INSERT a spatial object that occupies more space than the precision specified here will fail.

This specifies the SRID of the column to be created. A 4-byte integer can be used, which will default to 0 if not specified.

For more detailed information about the CREATE TABLE statement, please refer to the *SQL Reference*.

Limitations

The following limitations apply to the use of the GEOMETRY column:

- A GEOMETRY column cannot be used as a primary key.
- The UNIQUE constraint cannot be specified for a GEOMETRY column.

Examples

Create a table having an `id` column, whose type is `INTEGER`, and an `obj` column, whose type is `GEOMETRY`.

```
iSQL> CREATE TABLE t1 ( id INTEGER, obj GEOMETRY ) ;
Create success.
```

Create a table having an *id* column, whose type is `INTEGER`, as well as a `GEOMETRY` column named *obj* having a maximum size of 128 bytes.

```
iSQL> CREATE TABLE t2 ( id INTEGER, obj GEOMETRY (128) ) ;
Create success.
```

Create a table with a `GEOMETRY` column `obj` with an interger column `ID` and `SRID 100`.

```
iSQL> CREATE TABLE t3 ( id INTEGER, obj GEOMETRY SRID 100) ;
Create success.
```

CREATE INDEX

Syntax

```
CREATE INDEX index_name ON table_name ( column_name ) [INDEXTYPE IS RTREE];
```

Description

When an index is created on a column using the `GEOMETRY` data type, there is no need to specify an `INDEXTYPE` because an R-Tree index is used automatically. If a user attempts to set the `INDEXTYPE` to `BTREE`, an error will occur.

For more detailed information about `CREATE INDEX`, please refer to the *SQL Reference*.

Limitations

- The `UNIQUE` option cannot be specified for the index.
- The use of a `GEOMETRY` type column in a so-called “compound index” is not supported. That is, if an index is created on the basis of two or more columns, none of those columns can be a `GEOMETRY` type column.
- R-Tree indexes can be based on `GEOMETRY` type columns only

Examples

Create an R-Tree index *idx_t1* based on the `GEOMETRY` type column *obj* in table *t1*

```
iSQL> CREATE INDEX idx_t1 ON t1 ( obj ) ;
Create success.
```

Create an R-Tree index *idx_t2* based on the `GEOMETRY` type column *obj* in table *t2*

```
iSQL> CREATE INDEX idx_t2 ON t2 ( obj ) INDEXTYPE IS RTREE ;
Create success.
```

The following example shows that an attempt to create an R-Tree index on the basis of a non-GEOMETRY type column will fail.

```
isql> CREATE INDEX idx_t3 ON t3 ( id ) INDEXTYPE IS RTREE ;
[ERR-31246 : cannot create index on the datatype.]
```

Spatial Functions in Altibase

This section describes the spatial functions that are supported for use in Altibase.

Types of Spatial Functions

The spatial functions that are available in Altibase can be broadly classified as follows based on their characteristics:

- **Basic Functions**
These functions are used to check the values of attributes, both general attributes and those specific to the GEOMETRY type.
- **Spatial Analysis Functions**
These functions are used to perform various analytical tasks on GEOMETRY type data.
- **Spatial Object Creation Functions**
These functions are used to create spatial objects in WKT or WKB format, rather than in the internal storage format of Altibase.

Basic Spatial Functions

DIMENSION

Syntax

```
DIMENSION( GEOMETRY )
```

Description

This function returns the minimum number of dimensions that are needed in order to represent a spatial object.

This function returns -1 if the spatial object is EMPTY, 0 for POINT and MULTIPOINT type objects, 1 for LINESTRING and MULTILINESTRING type objects, and 2 for POLYGON and MULTIPOLYGON type objects.

If this function is executed on a GEOMETRYCOLLECTION type object comprising several different types of spatial objects as its constituent elements, it returns the number of dimensions needed to represent the constituent element having the largest number of dimensions.

Return Type

```
INTEGER
```

Example

```

iSQL> SELECT F1, DIMENSION(F2) FROM TB1;
F1          DIMENSION(F2)
-----
100
101          0
102          0
103          1
104          1
105          2
106          2
107          2
108          1
109         -1
10 rows selected.

```

GEOMETRYTYPE

Syntax

```
GEOMETRYTYPE( GEOMETRY )
```

Description

This function returns the name of the subtype of a GEOMETRY object. The subtype name is one of the following, returned in string form:

- NULL
- EMPTY⁴
- POINT
- LINESTRING
- POLYGON
- MULTIPOINT
- MULTILINESTRING
- MULTIPOLYGON
- GEOMETRYCOLLECTION

^[4] The EMPTY subtype is created only as a result of performing operations on spatial objects, and cannot be explicitly created by the user.

Return Type

```
VARCHAR
```

Example

```

iSQL> SELECT F1, GEOMETRYTYPE(F2) FROM TB1;
F1          GEOMETRYTYPE(F2)
-----
100

```

```

101      POINT
102      MULTIPOINT
103      LINESTRING
104      MULTILINESTRING
105      POLYGON
106      POLYGON
107      MULTIPOLYGON
108      GEOMETRYCOLLECTION
109      EMPTY
10 rows selected.

```

ENVELOPE

Syntax

```
ENVELOPE( GEOMETRY )
```

Description

This function returns the Minimum Bounding Rectangle (MBR) for a spatial object in the form of a POLYGON. This POLYGON is defined by the corner points of the bounding rectangle, namely (MINX, MINY), (MAXX, MINY), (MAXX, MAXY), (MINX, MAXY) and (MINX, MINY).

Return Type

```
GEOMETRY
```

Example

```

iSQL> SELECT F1, ATEXT(ENVELOPE(F2)) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'POLYGON';
F1
-----
ATEXT(ENVELOPE(F2))
-----
105
POLYGON((0 0, 0 10, 10 10, 10 0, 0 0))
106
POLYGON((3 5, 3 9, 7 9, 7 5, 3 5))
2 rows selected.

```

ASTEXT

Syntax

```
ASTEXT( GEOMETRY[,precision] )
```

Description

This function returns a spatial object in WKT (Well-Known Text) format.

The precision argument can be used to set the maximum length of the WKT. The default value is 256 bytes. This argument can be set anywhere in the range from 32 to 32,000.

Return Type

VARCHAR

Example

```
iSQL> SELECT F1, ASTEXT(F2) FROM TB1;
F1
-----
ASTEXT(F2)
100
101
POINT(1 1)
102
MULTIPOINT(1 1, 2 2)
103
LINESTRING(1 1, 2 2)
104
MULTILINESTRING((1 1, 2 2), (3 3, 4 5))
105
POLYGON((0 0, 10 0, 10 10, 0 10, 0 0))
106
POLYGON((3 5, 7 5, 7 9, 3 9, 3 5), (4 6, 4 8, 6 8, 6 6, 4 6))
107
MULTIPOLYGON(((1 1, 2 1, 2 2, 1 2, 1 1)), ((3 3, 3 5, 5 5, 5 3, 3 3)))
108
GEOMETRYCOLLECTION( POINT(1 1) , LINESTRING(2 2, 3 3) )
109
EMPTY
10 rows selected.
```

ASBINARY

Syntax

ASBINARY(GEOMETRY)

Description

This function returns a spatial object in WKB (Well-Known Binary) format.

Return Type

BINARY

Example⁵

[⁵] Because the ASBINARY function returns a GEOMETRY object in binary form, its content cannot be viewed in a console window. Accordingly, the ASTEXT function has been provided for use in converting a GEOMETRY object to WKT format so that it can be output in a readily understandable form.

```
iSQL> SELECT F1, ASTEXT(GEOMFROMWKB(ASBINARY(F2))) FROM TB1;
F1
```

```

-----
ASEWKT(GEOMFROMWKB(ASBINARY(F2)))
100

101
POINT(1 1)
102
MULTIPOINT(1 1, 2 2)
103
LINESTRING(1 1, 2 2)
104
MULTILINESTRING((1 1, 2 2), (3 3, 4 5))
105
POLYGON((0 0, 10 0, 10 10, 0 10, 0 0))
106
POLYGON((3 5, 7 5, 7 9, 3 9, 3 5), (4 6, 4 8, 6 8, 6 6, 4 6))
107
MULTIPOLYGON(((1 1, 2 1, 2 2, 1 2, 1 1)), ((3 3, 3 5, 5 5, 5 3, 3 3)))
108
GEOMETRYCOLLECTION( POINT(1 1) , LINESTRING(2 2, 3 3) )
109

10 rows selected.

```

ASEWKT

Syntax

```
ASEWKT( GEOMETRY[,precision] )
```

Description

Spatial objects are returned in EWKT (Extended Well-Known Text) expression format.

Precision can be used to control the maximum length of WKT. The default value is 256 bytes, with a minimum of 32 and a maximum of 32000.

Return Type

```
VARCHAR
```

Example

```

iSQL> SELECT F1, ASEWKT(F2, 40) FROM TB1;
F1          ASEWKT(F2, 40)
-----
1          SRID=0;POINT(2 2)
2          SRID=100;POINT(2 2)
3          SRID=101;POINT(2 2)
4          SRID=102;POINT(2 2)
5          SRID=103;POINT(2 2)
5 rows selected.

```


ASEWKB

Syntax

```
ASEWKB( GEOMETRY )
```

Description

Spatial objects are returned in EWKB(Extended Well-Known Binary) expression format.

Return Type

```
BINARY
```

Example

```
iSQL> SELECT F1, ASEWKT(GEOMFROMEWKB(ASEWKB(F2)), 40) FROM TB1;
F1          ASEWKT(GEOMFROMEWKB(ASEWKB(F2)), 40)
-----
1          SRID=0;POINT(2 2)
2          SRID=100;POINT(2 2)
3          SRID=101;POINT(2 2)
4          SRID=102;POINT(2 2)
5          SRID=103;POINT(2 2)
5 rows selected.
```

ISEMPTY

Syntax

```
ISEMPTY( GEOMETRY )
```

Description

Returns 1 if a spatial object does not have any coordinates. Otherwise, it returns 0 (zero).

Return Type

```
INTEGER
```

Example

```
iSQL> SELECT F1, ISEMPTY(F2) FROM TB1;
F1          ISEMPTY(F2)
-----
100
101          0
102          0
103          0
104          0
105          0
106          0
107          0
108          0
```

```
109          1
10 rows selected.
```

ISSIMPLE

Syntax

```
ISSIMPLE( GEOMETRY )
```

Description

This function returns 1 if a GEOMETRY object does not have any exceptional points, such as points of intersection or contact. If the GEOMETRY object has any such points, it returns 0 (zero).

The POINT, POLYGON and MULTIPOLYGON subtypes are always simple. The LINESTRING subtype is simple as long as its constituent segments do not intersect each other. The MULTIPOINT subtype is simple as long as no two of its constituent points have the same coordinates. The MULTILINESTRING type is simple if all of its LINESTRINGs are simple and they intersect only at their boundary points.

Return Type

```
INTEGER
```

Example

```
iSQL> SELECT F1, ISSIMPLE(F2) FROM TB1;
F1          ISSIMPLE(F2)
-----
100
101          1
102          1
103          1
104          1
105          1
106          1
107          1
108          1
109          1
10 rows selected.
```

ISVALID

Syntax

```
ISVALID( GEOMETRY )
```

Description

This function allows you to test whether a GEOMETRY object meets its requirements for validity.

If a GEOMETRY object meets all of the criteria for validity for that subtype, this function returns 1. If the object in question does not meet all of its criteria for validity, this function returns 0.

Be careful to avoid inserting invalid GEOMETRY objects into the DBMS, as this will result in errors or unpredictable results.

Return Value

INTEGER

Example

```
iSQL> SELECT F1, ISVALID(F2) FROM TB1;
F1          ISVALID(F2)
-----
100         1
101         1
102         1
103         1
104         1
105         1
106         1
107         1
108         1
109         1
10 rows selected.
```

ISVALIDHEADER

Syntax

ISVALIDHEADER(GEOMETRY)

Description

This function allows you to test whether a GEOMETRY object meets its requirements for validity by checking only the header information of the object.

If a GEOMETRY object meets all of the criteria for validity for that subtype, this function returns 1. If the object in question does not meet all of its criteria for validity, this function returns 0. Be careful to avoid inserting invalid GEOMETRY objects into the DBMS, as this will result in errors or unpredictable results.

Return Type

INTEGER

Example

```
iSQL> SELECT F1, ISVALIDHEADER(F2) FROM TB1;
F1          ISVALIDHEADER(F2)
-----
100         1
101         1
102         1
103         1
104         1
```

```

105          1
106          1
107          1
108          1
109          1
10 rows selected.

```

BOUNDARY

Syntax

```
BOUNDARY( GEOMETRY )
```

Description

This function returns the boundary of a GEOMETRY object.

If the argument is a GEOMETRY object whose subtype is POINT, MULTIPOINT, closed LINESTRING, or closed MULTILINESTRING, or if it is an EMPTY object, this function returns EMPTY. If the argument is a POLYGON having one or more interior rings or a MULTIPOLYGON comprising such POLYGONS, this function returns multiple objects.

Return Type

```
GEOMETRY
```

Example

```

iSQL> SELECT F1, ATEXT(BOUNDARY(F2)) FROM TB1;
F1
-----
ATEXT(BOUNDARY(F2))
-----
100

101
EMPTY
102
EMPTY
103
MULTIPOINT(1 1, 2 2)
104
MULTIPOINT(1 1, 2 2, 3 3, 4 5)
105
LINESTRING(0 0, 10 0, 10 10, 0 10, 0 0)
106
MULTILINESTRING((3 5, 7 5, 7 9, 3 9, 3 5), (4 6, 4 8, 6 8, 6 6, 4 6))
107
MULTILINESTRING((1 1, 2 1, 2 2, 1 2, 1 1), (3 3, 3 5, 5 5, 5 3, 3 3))
108
EMPTY
109
EMPTY
10 rows selected.

```

X (COORDX)

Syntax

```
X( GEOMETRY )
or
COORDX( GEOMETRY )
```

Description

This function returns the x coordinate of a GEOMETRY object whose subtype is POINT.

This function returns an error if the subtype of the GEOMETRY object is not POINT.

Return Type

DOUBLE

Example

```
iSQL> SELECT F1, COORDX(F2) FROM TB1 WHERE GEOMETRYTYPE(F2) = 'POINT';
F1          COORDX(F2)
-----
101          1
1 row selected.

iSQL> SELECT F1, X(F2) FROM TB1;
F1          X(F2)
-----
100
101          1
[ERR-A1019 : Not applicable object type]
2 rows selected.
```

Y (COORDY)

Syntax

```
Y( GEOMETRY )
or
COORDY( GEOMETRY )
```

Description

This function returns the y coordinate of a GEOMETRY object whose subtype is POINT.

This function returns an error if the subtype of the GEOMETRY object is not POINT.

Return Type

DOUBLE

Example

```

iSQL> SELECT F1, COORDY(F2) FROM TB1 WHERE GEOMETRYTYPE(F2) = 'POINT';
F1          COORDY(F2)
-----
101          1
1 row selected.

iSQL> SELECT F1, Y(F2) FROM TB1;
F1          Y(F2)
-----
100
101          1
[ERR-A1019 : Not applicable object type]
2 rows selected.

```

MINX

Syntax

```
MINX( GEOMETRY )
```

Description

This function returns the minimum x coordinate value for the minimum bounding rectangle of the GEOMETRY object in question. If the subtype of the GEOMETRY object is POINT, this function simply returns the x coordinate of the POINT.

Note:

To determine the coordinate values for the minimum bounding rectangle for the results of a query, use the MINX, MINY, MAXX, and MAXY functions together with the MIN and MAX aggregate functions.

```
SELECT MIN(MINX(F2)), MIN(MINY(F2)), MAX(MAXX(F2)), MAX(MAXY(F2)) FROM TB1;
```

Return Value

DOUBLE

Example

```

iSQL> SELECT F1, MINX(F2) FROM TB1;
F1          MINX(F2)
-----
100
101          1
102          1
103          1
104          1
105          0
106          3
107          1
108          1

```

```
109
10 rows selected.
```

MINY

Syntax

```
MINY( GEOMETRY )
```

Description

This function returns the minimum y coordinate value for the minimum bounding rectangle of the GEOMETRY object in question. If the subtype of the GEOMETRY object is POINT, this function simply returns the y coordinate of the POINT.

Return Type

```
DOUBLE
```

Example

```
iSQL> SELECT F1, MINY(F2) FROM TB1;
F1          MINY(F2)
-----
100
101          1
102          1
103          1
104          1
105          0
106          5
107          1
108          1
109
10 rows selected.
```

MAXX

Syntax

```
MAXX( GEOMETRY )
```

Description

This function returns the maximum x coordinate value for the minimum bounding rectangle of the GEOMETRY object in question. If the subtype of the GEOMETRY object is POINT, this function simply returns the x coordinate of the POINT.

Return Type

```
DOUBLE
```

Example

```
iSQL> SELECT F1, MAXX(F2) FROM TB1;
F1          MAXX(F2)
-----
100
101          1
102          2
103          2
104          4
105         10
106          7
107          5
108          3
109
10 rows selected.
```

MAXY**Syntax**

```
MAXY( GEOMETRY )
```

Description

This function returns the maximum y coordinate value for the minimum bounding rectangle of the GEOMETRY object in question. (+If the subtype of the GEOMETRY object is POINT, this function simply returns the y coordinate of the POINT.

Return Type

```
DOUBLE
```

Example

```
iSQL> SELECT F1, MAXY(F2) FROM TB1;
F1          MAXY(F2)
-----
100
101          1
102          2
103          2
104          5
105         10
106          9
107          5
108          3
109
10 rows selected.
```


GEOMETRYLENGTH

Syntax

```
GEOMETRYLENGTH( GEOMETRY )
```

Description

This function returns the length of a LINESTRING or MULTILINESTRING type GEOMETRY object.

If the subtype of the GEOMETRY type is not LINESTRING or MULTILINESTRING, this function returns an error.

Return Type

```
DOUBLE
```

Example

```
iSQL> SELECT F1, GEOMETRYLENGTH(F2) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'LINESTRING' OR GEOMETRYTYPE(F2) = 'MULTILINESTRING';
SELECT F1, GEOMETRYLENGTH(F2) FROM TB1;F1          GEOMETRYLENGTH(F2)
-----
103          1.4142135623731
104          3.65028153987288
2 rows selected.
```

```
iSQL> SELECT F1, GEOMETRYLENGTH(F2) FROM TB1;
F1          GEOMETRYLENGTH(F2)
-----
100
[ERR-A1019 : Not applicable object type]
1 row selected.
```

STARTPOINT

Syntax

```
STARTPOINT( GEOMETRY )
```

Description

This function returns the start point of a LINESTRING.

If the subtype of the GEOMETRY type argument is not LINESTRING, this function returns an error.

Return Type

```
GEOMETRY
```

Example

```

iSQL> SELECT F1, ATEXT(STARTPOINT(F2)) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'LINESTRING';
F1
-----
ATEXT(STARTPOINT(F2))
-----
103
POINT(1 1)
1 row selected.

iSQL> SELECT F1, ATEXT(STARTPOINT(F2)) FROM TB1;
F1
-----
ATEXT(STARTPOINT(F2))
-----
100

[ERR-A1019 : Not applicable object type]
1 row selected.

```

ENDPOINT

Syntax

```
ENDPOINT( GEOMETRY )
```

Description

This function returns the end point of a LINESTRING.

If the subtype of the GEOMETRY type argument is not LINESTRING, this function returns an error.

Return Type

```
GEOMETRY
```

Example

```

iSQL> SELECT F1, ATEXT(ENDPOINT(F2)) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'LINESTRING';
F1
-----
ATEXT(ENDPOINT(F2))
-----
103
POINT(2 2)
SELECT F1, ATEXT(ENDPOINT(F2)) FROM TB1;
1 row selected.

iSQL> SELECT F1, ATEXT(ENDPOINT(F2)) FROM TB1;
F1
-----
ATEXT(ENDPOINT(F2))

```

```
-----
100
```

```
[ERR-A1019 : Not applicable object type]
1 row selected.
```

ISCLOSED

Syntax

```
ISCLOSED( GEOMETRY )
```

Description

This function returns 1 if LINESTRING is closed, that is, if the following expression is true:

```
StartPoint(geometry) = EndPoint(geometry)
```

If the start point and the end point are not the same, that is, if the above expression is false, this function returns 0 (zero).

If the subtype of the GEOMETRY type argument is not LINESTRING or MULTILINESTRING, this function returns an error.

Return Type

```
INTEGER
```

Example

```
iSQL> SELECT F1, ISCLOSED(F2) FROM TB1 WHERE GEOMETRYTYPE(F2) = 'LINESTRING' OR
GEOMETRYTYPE(F2) = 'MULTILINESTRING';
```

```
F1          ISCLOSED(F2)
```

```
-----
```

```
103          0
```

```
104          0
```

```
2 rows selected.
```

```
iSQL> SELECT F1, ISCLOSED(F2) FROM TB1;
```

```
F1          ISCLOSED(F2)
```

```
-----
```

```
100
```

```
[ERR-A1019 : Not applicable object type]
```

```
1 row selected.
```

ISRING

Syntax

```
ISRING( GEOMETRY )
```

Description

This function returns 1 if the LINESTRING or MULTILINESTRING type argument is simple and closed. The test of whether a LINESTRING is closed is as follows:

```
StartPoint(geometry) = EndPoint(geometry)
```

If the input LINESTRING or MULTILINESTRING is not simple, not closed, or neither simple nor closed, this function returns 0 (zero).

If the subtype of the GEOMETRY type argument is not a LINESTRING or a MULTILINESTRING, this function outputs an error.

Return Type

INTEGER

Example

```
iSQL> SELECT F1, ISRING(F2) FROM TB1 WHERE GEOMETRYTYPE(F2) = 'LINESTRING' OR
GEOMETRYTYPE(F2) = 'MULTILINESTRING';
```

```
F1          ISRING(F2)
-----
```

```
103          0
```

```
104          0
```

```
2 rows selected.
```

```
iSQL> SELECT F1, ISRING(F2) FROM TB1;
```

```
F1          ISRING(F2)
-----
```

```
100
```

```
[ERR-A1019 : Not applicable object type]
```

```
1 row selected.
```

ST_ISCOLLECTION

Syntax

```
ST_ISCOLLECTION( GEOMETRY )
```

Description

This function returns 1 if the spatial object, which is the parameter, is MULTIPOINT, MULTILINESTRING, MULTIPOLYGON or GEOMETRYCOLLECTION. If not, 0 is returned.

Return Type

INTEGER

Example

```

iSQL> SELECT ST_ISCOLLECTION(GEOMETRY'POINT(1 1)');
ST_ISCOLLECTION(GEOMETRY'POINT(1 1)')
-----
0
1 row selected.

iSQL> SELECT ST_ISCOLLECTION(GEOMETRY'MULTIPOINT(1 1)');
ST_ISCOLLECTION(GEOMETRY'MULTIPOINT(1 1)')
-----
1
1 row selected.

iSQL> SELECT ST_ISCOLLECTION(GEOMETRY'GEOMETRYCOLLECTION(POINT(1 1), LINESTRING(2
2, 3 3))');
ST_ISCOLLECTION(GEOMETRY'GEOMETRYCOLLECTIO
-----
1
1 row selected.

```

NUMPOINTS**Syntax**

```
NUMPOINTS( GEOMETRY )
```

Description

This function returns the number of POINTs that comprise a GEOMETRY object.

Return Type

```
INTEGER
```

Example

```

iSQL> select f1, numPoints(f2) from TB1;
F1          NUMPOINTS(F2)
-----
100
101          1
102          2
103          2
104          4
105          5
106         10
107         10
108          3
[ERR-A1019 : Inapplicable object type]
9 rows selected.

```

POINTN

Syntax

```
POINTN( GEOMETRY, N )
```

Description

This function returns the Nth POINT that consists of the input LINESTRING type GEOMETRY object.

This function outputs an error if N is 0 (zero) or negative, if N is greater than the number of POINTs in LINESTRING, or if the subtype of the GEOMETRY type argument is not LINESTRING.

Return Type

```
GEOMETRY
```

Example

```
iSQL> SELECT F1, ATEXT(POINTN(F2, 2)) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'LINESTRING';
```

```
F1
```

```
-----
```

```
ATEXT(POINTN(F2, 2))
```

```
-----
```

```
103
```

```
POINT(2 2)
```

```
1 row selected.
```

```
iSQL> SELECT F1, ATEXT(POINTN(F2, 1)) FROM TB1;
```

```
F1
```

```
-----
```

```
ATEXT(POINTN(F2, 1))
```

```
-----
```

```
100
```

```
[ERR-A1019 : Not applicable object type]
```

```
1 row selected.
```

AREA

Syntax

```
AREA( GEOMETRY )
```

Description

This function returns the area of an input POLYGON or MULTIPOLYGON type GEOMETRY object.

If the subtype of the input GEOMETRY type is not POLYGON or MULTIPOLYGON, this function outputs an error.

Return Type

DOUBLE

Example

```
iSQL> SELECT F1, AREA(F2) FROM TB1 WHERE GEOMETRYTYPE(F2) = 'POLYGON';
F1          AREA(F2)
-----
105          100
106           12
2 rows selected.

iSQL> SELECT F1, AREA(F2) FROM TB1;
F1          AREA(F2)
-----
100
[ERR-A1019 : Not applicable object type]
1 row selected.
```

CENTROID

Syntax

CENTROID(GEOMETRY)

Description

This function returns the mathematical center of gravity of an input POLYGON type GEOMETRY object.

Note that the resultant center of gravity may not actually be located within the surface of the input POLYGON or MULTIPOLYGON.

If the subtype of the input GEOMETRY type is not POLYGON or MULTIPOLYGON, this function outputs an error.

Return Type

GEOMETRY

Example

```
iSQL> SELECT F1, ASTEXT(CENTROID(F2)) FROM TB1 WHERE GEOMETRYTYPE(F2) = 'POLYGON'
OR GEOMETRYTYPE(F2) = 'MULTIPOLYGON';
F1
-----
ASTEXT(CENTROID(F2))
-----
105
POINT(5 5)
106
POINT(5 7)
107
POINT(2.75 2.75)
```

```
3 rows selected.
```

```
iSQL> SELECT F1, ATEXT(CENTROID(F2)) FROM TB1;
F1
-----
ATEXT(CENTROID(F2))
-----
100

[ERR-A1019 : Not applicable object type]
1 row selected.
```

POINTONSURFACE

Syntax

```
POINTONSURFACE( GEOMETRY )
```

Description

This function returns a POINT that is guaranteed to be in the interior or on the boundary of an input POLYGON type GEOMETRY object.

If the subtype of the input GEOMETRY type is not POLYGON or MULTIPOLYGON, this function outputs an error.

Return Type

```
GEOMETRY
```

Example

```
iSQL> SELECT F1, ATEXT(POINTONSURFACE(F2)) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'POLYGON' OR GEOMETRYTYPE(F2) = 'MULTIPOLYGON';
F1
-----
ATEXT(POINTONSURFACE(F2))
-----
105
POINT(5 5)
106
POINT(3.5 7)
107
POINT(1.5 1.5)
3 rows selected.
```

```
iSQL> SELECT F1, ATEXT(POINTONSURFACE(F2)) FROM TB1;
F1
-----
ATEXT(POINTONSURFACE(F2))
-----

-----
100
```



```
[ERR-A1019 : Not applicable object type]
1 row selected.
```

EXTERIORRING

Syntax

```
EXTERIORRING( GEOMETRY )
```

Description

This function returns the exterior ring of an input POLYGON type GEOMETRY object. If the input POLYGON has no interior ring, the return value is the same as the boundary of the POLYGON.

If the subtype of the input GEOMETRY type is not POLYGON, this function outputs an error.

Return Type

```
GEOMETRY
```

Example

```
iSQL> SELECT F1, ATEXT(EXTERIORRING(F2)) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'POLYGON';
```

```
F1
```

```
-----
```

```
ATEXT(EXTERIORRING(F2))
```

```
-----
```

```
105
```

```
LINESTRING(0 0, 10 0, 10 10, 0 10, 0 0)
```

```
106
```

```
LINESTRING(3 5, 7 5, 7 9, 3 9, 3 5)
```

```
2 rows selected.
```

```
iSQL> SELECT F1, ATEXT(EXTERIORRING(F2)) FROM TB1;
```

```
F1
```

```
-----
```

```
ATEXT(EXTERIORRING(F2))
```

```
-----
```

```
100
```

```
-----
```

```
[ERR-A1019 : Not applicable object type]
```

1 row selected.

NUMINTERIORRING

Syntax

```
NUMINTERIORRING( GEOMETRY )
```

Description

This function returns the number of interior rings that the input POLYGON type GEOMETRY object consists of.

This function returns 0 (zero) if the POLYGON has no interior rings. If the subtype of the input GEOMETRY type is not POLYGON, this function outputs an error

Return Type

INTEGER

Example

```
iSQL> SELECT F1, NUMINTERIORRING(F2) FROM TB1 WHERE GEOMETRYTYPE(F2) = 'POLYGON';
F1          NUMINTERIORRING(F2)
-----
105          0
106          1
2 rows selected.

iSQL> SELECT F1, NUMINTERIORRING(F2) FROM TB1;
F1          NUMINTERIORRING(F2)
-----
100
[ERR-A1019 : Not applicable object type]
1 row selected.
```

INTERIORRINGN

Syntax

```
INTERIORRINGN( GEOMETRY, N )
```

Description

This function returns the Nth interior ring of the input POLYGON type GEOMETRY object.

If N is 0 or negative, or if N is greater than the number of interior rings in the POLYGON, this function returns an error.

If the subtype of the input GEOMETRY type is not POLYGON, this function outputs an error.

Return Type

GEOMETRY

Example

```
iSQL> SELECT F1, ATEXT(INTERIORRINGN(F2, 1)) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'POLYGON' AND NUMINTERIORRING(F2) > 0;
```

F1

ATEXT(INTERIORRINGN(F2, 1))

106

LINESTRING(4 6, 4 8, 6 8, 6 6, 4 6)

1 row selected.

```
iSQL> SELECT F1, ATEXT(INTERIORRINGN(F2, 1)) FROM TB1;
```

F1

ATEXT(INTERIORRINGN(F2, 1))

100

[ERR-A1019 : Not applicable object type]

1 row selected.

NUMGEOMETRIES

Syntax

NUMGEOMETRIES(GEOMETRY)

Description

This function returns the number of GEOMETRY objects in the input GEOMETRYCOLLECTION type GEOMETRY object.

If the input argument is not a multiple object or a GEOMETRYCOLLECTION type object, this function outputs an error.

Return Type

INTEGER

Example

```

iSQL> SELECT F1, NUMGEOMETRIES(F2) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'GEOMETRYCOLLECTION';
F1          NUMGEOMETRIES(F2)
-----
108          2
1 row selected.

iSQL> SELECT F1, NUMGEOMETRIES(F2) FROM TB1;
F1          NUMGEOMETRIES(F2)
-----
100
[ERR-A1019 : Not applicable object type]
1 row selected.

```

GEOMETRYN

Syntax

```
GEOMETRYN( GEOMETRY, N )
```

Description

This function returns the Nth GEOMETRY object in the input GEOMETRYCOLLECTION type GEOMETRY object.

If N is less than 1 or greater than the number of GEOMETRY objects in the input GEOMETRYCOLLECTION, or if the input argument is not a multiple object or a GEOMETRYCOLLECTION type object, this function returns an error.

Return Type

```
GEOMETRY
```

Example

```

iSQL> SELECT F1, ASTEXT(GEOMETRYN(F2, 1)) FROM TB1 WHERE GEOMETRYTYPE(F2) =
'GEOMETRYCOLLECTION';
F1
-----
ASTEXT(GEOMETRYN(F2, 1))

108
POINT(1 1)

1 row selected.

iSQL> SELECT F1, ASTEXT(GEOMETRYN(F2, 1)) FROM TB1;
F1
-----

```

```
ASTEXT(GEOMETRYN(F2, 1))
```

```
100
```

```
[ERR-A1019 : Not applicable object type]
1 row selected.
```

Spatial Analysis Functions

DISTANCE

Syntax

```
DISTANCE( GEOMETRY1, GEOMETRY2 )
```

Description

This function returns the shortest distance between two points in two respective GEOMETRY objects.

Return Type

```
DOUBLE
```

Example

```
iSQL> SELECT TB1.F1, TB2.F1, DISTANCE(TB1.F2, TB2.F2)
FROM TB1, TB2 WHERE TB1.F1 + 100 = TB2.F1;
F1          F1          DISTANCE(TB1.F2, TB2.F2)
-----
100         200
101         201         12.7279220613579
102         202         11.3137084989848
103         203         11.3137084989848
104         204         7.81024967590665
105         205         2
106         206         1
107         207         7.07106781186548
108         208         9.89949493661167
109         209         0
10 rows selected.
```

BUFFER

Syntax

```
BUFFER( GEOMETRY, NUMBER )
```

Description

This function returns a GEOMETRY object that contains all the points that are spaced apart from the input GEOMETRY object by a distance smaller than or equal to the value specified in the NUMBER argument. In other words, it returns a buffer around the input GEOMETRY object.

The subtype of the GEOMETRY input argument cannot be a GEOMETRYCOLLECTION object. Additionally, the distance (indicated by the NUMBER argument) must be greater than 0 (zero).

Return Type

```
GEOMETRY
```

Example

```
iSQL> SELECT F1, ATEXT(BUFFER(F2, 10)) FROM TB1
WHERE GEOMETRYTYPE(TB1.F2) = 'GEOMETRYCOLLECTION';
[ERR-A1019 : Not applicable object type]

iSQL> SELECT F1, ATEXT(BUFFER(F2, 10)) FROM TB1
WHERE DIMENSION(F2) = 0;
  F1          ATEXT(BUFFER(F2, 10))

-----
101
POLYGON((11 1, 9.660254 6, 6 9.660254, 1 11, -4 9.660254,
-7.660254 6, -9 1, -7.660254 -4, -4 -7.660254, 1 -9,
6 -7.660254, 9.660254 -4, 11 1))

102
POLYGON((2 12, -3 10.66025, -4 9.660254, -6.660254 7,
-7.660254 6, -9 1, -7.660254 -4, -4 -7.660254, 1 -9,
6 -7.660254, 9.66 0254 -4, 10.66025 -3, 12 2, 10.66025 7,
7 10.66025, 2 12))

2 rows selected.
```

CONVEXHULL

Syntax

```
CONVEXHULL( GEOMETRY )
```

Description

This function returns a GEOMETRY object that represents the smallest closed convex polygon that surrounds a GEOMETRY object.

The subtype of the GEOMETRY input argument cannot be a GEOMETRYCOLLECTION object.

Return Type

GEOMETRY

Example

```
iSQL> SELECT F1, ATEXT(CONVEXHULL(F2)) FROM TB1
      WHERE GEOMETRYTYPE(TB1.F2) = 'GEOMETRYCOLLECTION';
[ERR-A1019 : Not applicable object type]

iSQL> SELECT F1, ATEXT(CONVEXHULL(F2)) FROM TB1
      WHERE GEOMETRYTYPE(TB1.F2) = 'POLYGON';
F1
-----
ATEXT(CONVEXHULL(F2))
-----
105
POLYGON((0 10, 0 0, 10 0, 10 10, 0 10))
106
POLYGON((3 9, 3 5, 7 5, 7 9, 3 9))
2 rows selected.
```

INTERSECTION

Syntax

INTERSECTION(GEOMETRY1, GEOMETRY2)

Description

This function returns the intersection(s) of the input GEOMETRY1 and GEOMETRY2 GEOMETRY objects in the form of an output GEOMETRY object.

Neither of the GEOMETRY input arguments can be a GEOMETRYCOLLECTION object.

Return Type

GEOMETRY

Example

```
iSQL> SELECT TB1.F1, TB2.F1,
      ATEXT(INTERSECTION(TB1.F2, TB2.F2)) FROM TB1, TB2
      WHERE GEOMETRYTYPE(TB1.F2) != 'GEOMETRYCOLLECTION';
F1          F1
-----
ATEXT(INTERSECTION(TB1.F2, TB2.F2))
-----
```

```

101          200

101          201
EMPTY
101          202
EMPTY
101          203
EMPTY
101          204
EMPTY
101          205
EMPTY
101          206
EMPTY
101          207
EMPTY
[ERR-A1019 : Not applicable object type]
8 rows selected.

iSQL> SELECT TB1.F1, TB2.F1,
           ASTEXT(INTERSECTION(TB1.F2, TB2.F2))
           FROM TB1, TB2
           WHERE GEOMETRYTYPE(TB1.F2) = 'POLYGON'
                AND GEOMETRYTYPE(TB2.F2) = 'POLYGON';
F1          F1
-----
ASTEXT(INTERSECTION(TB1.F2, TB2.F2))
-----
105          205
POLYGON((10 10, 2 10, 2 2, 10 2, 10 10))
105          206
POLYGON((9 5, 8 5, 8 3, 9 3, 9 5), (8.8 3.2, 8.2 3.2, 8.2 4.8, 8.8 4.8, 8.8 3.2))
106          205
POLYGON((7 9, 3 9, 3 5, 7 5, 7 9), (6 6, 4 6, 4 8, 6 8, 6 6))
106          206
EMPTY
4 rows selected.

```

UNION

Syntax

```
UNION( GEOMETRY1, GEOMETRY2 )
```

Description

This function returns a new GEOMETRY object that represents the union (i.e. the combined total) of two GEOMETRY objects.

Neither of the GEOMETRY input arguments can be a GEOMETRYCOLLECTION object. Additionally, the two GEOMETRY objects must have the same number of dimensions.

Return Type

GEOMETRY

Example

```
iSQL> SELECT ATEXT(UNION(TB1.F2, TB2.F2)) FROM TB1, TB2
        WHERE DIMENSION(TB1.F2) = 1 AND DIMENSION(TB2.F2) = 2;
[ERR-A1019 : Not applicable object type]

iSQL> SELECT ATEXT(UNION(TB1.F2, TB2.F2)) FROM TB1, TB2
        WHERE GEOMETRYTYPE(TB1.F2) = 'POLYGON'
        AND GEOMETRYTYPE(TB2.F2) = 'POLYGON';
ATEXT(UNION(TB1.F2, TB2.F2))
-----
POLYGON((12 12, 2 12, 2 10, 0 10, 0 0, 10 0, 10 2, 12 2, 12 12))
POLYGON((10 10, 0 10, 0 0, 10 0, 10 10))
POLYGON((12 12, 2 12, 2 2, 12 2, 12 12))
MULTIPOLYGON(((8 3, 9 3, 9 5, 8 5, 8 3), (8.2 3.2, 8.2 4.8, 8.8 4.8, 8.8 3.2, 8.2
3.2)), ((3 5, 7 5, 7 9, 3 9, 3 5), (4 6, 4 8, 6 8, 6 6, 4 6)))
4 rows selected.
```

DIFFERENCE

Syntax

DIFFERENCE(GEOMETRY1, GEOMETRY2)

Description

This function returns the difference between two GEOMETRY objects.

The difference between two GEOMETRY objects is the portion of GEOMETRY1 that does not overlap with GEOMETRY2.

Neither of the GEOMETRY input arguments can be a GEOMETRYCOLLECTION object. Additionally, the two GEOMETRY objects must have the same number of dimensions.

Return Type

GEOMETRY

Example

```
iSQL> SELECT ATEXT(DIFFERENCE(TB1.F2, TB2.F2)) FROM TB1, TB2
        WHERE DIMENSION(TB1.F2) = 1 AND DIMENSION(TB2.F2) = 2;
[ERR-A1019 : Not applicable object type]

iSQL> SELECT ATEXT(DIFFERENCE(TB1.F2, TB2.F2)) FROM TB1, TB2
        WHERE GEOMETRYTYPE(TB1.F2) = 'POLYGON'
        AND GEOMETRYTYPE(TB2.F2) = 'POLYGON';
ATEXT(DIFFERENCE(TB1.F2, TB2.F2))
-----
POLYGON((2 10, 0 10, 0 0, 10 0, 10 2, 2 2, 2 10))
```

```
MULTIPOLYGON(((8.8 4.8, 8.2 4.8, 8.2 3.2, 8.8 3.2, 8.8 4.8)), ((10 10, 0 10, 0 0,
10 0, 10 10), (9 3, 8 3, 8 5, 9 5, 9 3)))
EMPTY
POLYGON((7 9, 3 9, 3 5, 7 5, 7 9), (6 6, 4 6, 4 8, 6 8, 6 6))
4 rows selected.
```

SYMDIFFERENCE

Syntax

```
SYMDIFFERENCE( GEOMETRY1, GEOMETRY2 )
```

Description

This function returns a GEOMETRY object that represents the two input GEOMETRY objects, excluding the intersection between the two input objects. That is, it returns a GEOMETRY object that represents the part of GEOMETRY1 that is not included in GEOMETRY2, together with the part of GEOMETRY2 that is not included in GEOMETRY1.

Neither of the GEOMETRY input arguments can be a GEOMETRYCOLLECTION object. Additionally, the two GEOMETRY objects must have the same number of dimensions.

Return Type

```
GEOMETRY
```

Example

```
iSQL> SELECT ATEXT(SYMDIFFERENCE(TB1.F2, TB2.F2))
        FROM TB1, TB2
        WHERE DIMENSION(TB1.F2) = 1 AND DIMENSION(TB2.F2) = 2;
[ERR-A1019 : Not applicable object type]

iSQL> SELECT ATEXT(SYMDIFFERENCE(TB1.F2, TB2.F2))
        FROM TB1, TB2
        WHERE GEOMETRYTYPE(TB1.F2) = 'POLYGON'
              AND GEOMETRYTYPE(TB2.F2) = 'POLYGON';
ATEXT(SYMDIFFERENCE(TB1.F2, TB2.F2))
-----
MULTIPOLYGON(((12 12, 2 12, 2 10, 10 10, 10 2, 12 2, 12 12)), ((2 10, 0 10, 0 0,
10 0, 10 2, 2 2, 2 10)))
MULTIPOLYGON(((8.8 4.8, 8.2 4.8, 8.2 3.2, 8.8 3.2, 8.8 4.8)), ((10 10, 0 10, 0 0,
10 0, 10 10), (9 3, 8 3, 8 5, 9 5, 9 3)))
MULTIPOLYGON(((6 8, 4 8, 4 6, 6 6, 6 8)), ((12 12, 2 12, 2 2, 12 2, 12 12), (7 5,
3 5, 3 9, 7 9, 7 5)))
MULTIPOLYGON(((7 9, 3 9, 3 5, 7 5, 7 9), (6 6, 4 6, 4 8, 6 8, 6 6)), ((9 5, 8 5,
8 3, 9 3, 9 5), (8.8 3.2, 8.2 3.2, 8.2 4.8, 8.8 4.8, 8.8 3.2)))
4 rows selected.
```

SRID

Syntax

```
SRID( GEOMETRY )
```

Description

This function returns the SRID of the spatial object.

Return Type

```
INTEGER
```

Example

```
iSQL> SELECT F1, SRID(F2) FROM TB1;
F1          SRID(F2)
-----
1           0
2          100
3          101
4          102
5          103
5 rows selected.
```

SETSRID

Syntax

```
SETSRID( GEOMETRY, INTEGER )
```

Description

This function changes the SRID of a spatial object.

Return Type

```
GEOMETRY
```

Example

```
iSQL> SELECT F1, SRID(F2) FROM TB1;
F1          SRID(F2)
-----
1           0
2          100
3          101
4          102
5          103
5 rows selected.

iSQL> INSERT INTO TB1 SELECT F1, SETSRID(F2, 9999) FROM TB1;
```

```

5 rows inserted.
iSQL> SELECT F1, SRID(F2) FROM TB1;
F1          SRID(F2)
-----
1           0
2          100
3          101
4          102
5          103
1          9999
2          9999
3          9999
4          9999
5          9999
10 rows selected.

```

Spatial Object Creation Functions

GEOMFROMTEXT

Syntax

```
GEOMFROMTEXT( WKT)
```

Description

This function accepts a description of a spatial object in WKT (Well-known Text)⁶ format as input and creates and outputs a GEOMETRY object.

[⁶] For more detailed information about WKT (Well-Known Text), please refer to GEOMETRY expression format.

The input can be any type of spatial object that can be described using WKT. If the syntax of the input WKT is not valid, this function outputs an error.

The SRID of the created object is 0.

Return Value

```
GEOMETRY
```

Example

```

iSQL> INSERT INTO TB3 VALUES (101, GEOMFROMTEXT('GEOMETRYCOLLECTION(POINT(10 10),
POINT(30 30), LINESTRING(15 15, 20 20))'));
1 row inserted.

```

```

iSQL> SELECT ID, ASTEXT(OBJ) FROM TB3;
ID
-----
ASTEXT(OBJ)
-----

```

```
101
GEOMETRYCOLLECTION( POINT(10 10) , POINT(30 30) , LINESTRING(15 15, 20 20) )
```

```
1 row selected.
```

```
iSQL> INSERT INTO TB3 VALUES (102, GEOMFROMTEXT('POLYGON((10 10, 10 20, 20 20, 20
15, 10))'));
[ERR-A101A : Parsing error of well-known-text]
```

POINTFROMTEXT

Syntax

```
POINTFROMTEXT( WKT)
```

Description

This function accepts a spatial object in WKT (Well-known Text) format as input and creates and outputs a GEOMETRY object whose subtype is POINT.

If the syntax of the input WKT is not valid, or if the WKT describes a GEOMETRY subtype other than a POINT, this function outputs an error.

This function returns NULL if the value of the WKT argument is NULL.

The SIRD of the created object is 0.

Return Type

```
GEOMETRY
```

Example

```
iSQL> INSERT INTO TB3 VALUES (102, POINTFROMTEXT('POINT(10 10)'));
1 row inserted.
```

```
iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE GEOMETRYTYPE(OBJ) = 'POINT';
ID
-----
ATEXT(OBJ)
```

```
102
POINT(10 10)
```

```
1 row selected.
```

```
iSQL> INSERT INTO TB3 VALUES (103, POINTFROMTEXT('GEOMETRYCOLLECTION( POINT(10
10), POINT(30 30), LINESTRING(15 15, 20 20))'));
[ERR-A1019 : Not applicable object type]
```

LINEFROMTEXT

Syntax

```
LINEFROMTEXT( WKT )
```

Description

This function accepts a spatial object in WKT (Well-known Text) format as input and creates and outputs a GEOMETRY object whose subtype is LINESTRING.

If the syntax of the input WKT is not valid, or if the WKT describes a GEOMETRY subtype other than a LINESTRING, this function outputs an error.

This function returns NULL if the value of the WKT argument is NULL.

The SIRD of the created object is 0.

Return Type

```
GEOMETRY
```

Example

```
iSQL> INSERT INTO TB3 VALUES (103, LINEFROMTEXT('LINESTRING(10 10, 20 20, 30
40)'));
1 row inserted.

iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE GEOMETRYTYPE(OBJ) = 'LINESTRING';
ID
-----
ATEXT(OBJ)

103
LINESTRING(10 10, 20 20, 30 40)

1 row selected.

iSQL> INSERT INTO TB3 VALUES (104, LINEFROMTEXT('MULTIPOLYGON(((10 10, 10 20, 20
20, 20 15, 10 10)), ((60 60, 70 70, 80 60, 60 60)))'));
[ERR-A1019 : Not applicable object type]
```

POLYFROMTEXT

Syntax

```
POLYFROMTEXT( WKT[, srid] )
```

Description

This function accepts a spatial object in WKT (Well-known Text) format as input and creates and outputs a GEOMETRY object whose subtype is POINT.

If the syntax of the input WKT is not valid, or if the WKT describes a GEOMETRY subtype other than a POINT, this function outputs an error.

This function returns NULL if the value of the WKT argument is NULL.

The SRID of a created object is 0.

Return Type

GEOMETRY

Example

```
iSQL> INSERT INTO TB3 VALUES (104, POLYFROMTEXT('POLYGON((10 10, 10 20, 20 20, 20
15, 10 10))'));
1 row inserted.
```

```
iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE GEOMETRYTYPE(OBJ) = 'POLYGON';
ID
-----
ATEXT(OBJ)
```

```
104
POLYGON((10 10, 10 20, 20 20, 20 15, 10 10))
```

1 row selected.

```
iSQL> INSERT INTO TB3 VALUES (105, POLYFROMTEXT('MULTILINESTRING((10 10, 20 20),
(15 15, 30 15))'));
[ERR-A1019 : Not applicable object type]
```

```
iSQL> INSERT INTO TB3 VALUES (120, POLYFROMTEXT('POLYGON((10 10, 10 20, 20 20, 20
15, 10 10))', 100));
1 row inserted.
```

```
iSQL> SELECT ID, ASEWKT(OBJ) FROM TB3;
ID          ASEWKT(OBJ)
-----
104          SRID=0;POLYGON((10 10, 10 20, 20 20, 20 15, 10 10))
120          SRID=100;POLYGON((10 10, 10 20, 20 20, 20 15, 10 10))
2 rows selected.
```

ST_POLYGONFROMTEXT

Syntax

```
ST_POLYGONFROMTEXT( TEXT[, srid] )
```

Description

This function accepts a spatial object in WKT (Well-known Text) format or EWKT(Extended Well-Known Text) as input and creates a POLYGON object.

This function returns NULL if the value of the WKT or SRID is NULL.

Unlike POLYFROMTEXT, if the WKT or EWKT describes a spatial object that is not a POLYGON object, this function returns NULL.

If the syntax of the input WKT or EWKT is not valid, an error is occurred.

It can specify the SRID of the created object. In case it is not specified, if the input was WKT the SRID of the object will be 0 and if the input was EWKT it will be the same as the SRID of EWKT.

Return Type

```
GEOMETRY
```

Example

```

iSQL> INSERT INTO TB3 VALUES (121, ST_POLYGONFROMTEXT('POLYGON((10 10, 10 20, 20
20, 20 15, 10 10))'));
1 row inserted.
iSQL> INSERT INTO TB3 VALUES (122, ST_POLYGONFROMTEXT('POLYGON((10 10, 10 20, 20
20, 20 15, 10 10))', 100));
1 row inserted.
iSQL> INSERT INTO TB3 VALUES (123, ST_POLYGONFROMTEXT('MULTILINESTRING((10 10, 20
20), (15 15, 30 15))'));
1 row inserted.
iSQL> INSERT INTO TB3 VALUES (124, ST_POLYGONFROMTEXT('SRID=100;POLYGON((10 10,
10 20, 20 20, 20 15, 10 10))'));
1 row inserted.

iSQL> SELECT ID, ASEWKT(OBJ) FROM TB3;
ID          ASEWKT(OBJ)
-----
121          SRID=0;POLYGON((10 10, 10 20, 20 20, 20 15, 10 10))
122          SRID=100;POLYGON((10 10, 10 20, 20 20, 20 15, 10 10))
123
124          SRID=100;POLYGON((10 10, 10 20, 20 20, 20 15, 10 10))
4 rows selected.
```


MPOINTFROMTEXT

Syntax

```
MPOINTFROMTEXT( WKT )
```

Description

This function accepts a spatial object in WKT (Well-known Text) format as input and creates and outputs a GEOMETRY object whose subtype is MULTIPOINT.

If the syntax of the input WKT is not valid, or if the WKT describes a GEOMETRY subtype other than a MULTIPOINT object, this function outputs an error.

This function returns NULL if the value of the WKT argument is NULL.

The SRID of a created object is 0.

Return Type

```
GEOMETRY
```

Example

```
iSQL> INSERT INTO TB3 VALUES (105, MPOINTFROMTEXT('MULTIPOINT(10 10, 20 20)'));
1 row inserted.
```

```
iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE GEOMETRYTYPE(OBJ) = 'MULTIPOINT';
ID
-----
ATEXT(OBJ)
```

```
105
MULTIPOINT(10 10, 20 20)
```

```
1 row selected.
```

```
iSQL> INSERT INTO TB3 VALUES (106, MPOINTFROMTEXT('LINESTRING(10 10, 20 20, 30
40)'));
[ERR-A1019 : Not applicable object type]
```

MLINEFROMTEXT

Syntax

```
MLINEFROMTEXT( WKT )
```

Description

This function accepts a spatial object in WKT (Well-known Text) format as input and creates and outputs a GEOMETRY object whose subtype is MULTILINESTRING.

If the syntax of the input WKT is not valid, or if the WKT describes a GEOMETRY subtype other than a MULTILINESTRING object, this function outputs an error.

This function returns NULL if the value of the WKT argument is NULL.

The SRID of a created object is 0.

Return Type

GEOMETRY

Example

```
iSQL> INSERT INTO TB3 VALUES (106, MLINEFROMTEXT('MULTILINESTRING((10 10, 20 20),
(15 15, 30 15))'));
1 row inserted.
```

```
iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE GEOMETRYTYPE(OBJ) =
'MULTILINESTRING';
ID
-----
ATEXT(OBJ)
```

```
106
MULTILINESTRING((10 10, 20 20), (15 15, 30 15))
```

```
1 row selected.
```

```
iSQL> INSERT INTO TB3 VALUES (107, MLINEFROMTEXT('POINT(10 10)'));
[ERR-A1019 : Not applicable object type]
```

MPOLYFROMTEXT

Syntax

MPOLYFROMTEXT(WKT)

Description

This function accepts a spatial object in WKT (Well-known Text) format as input and creates and outputs a GEOMETRY object whose subtype is MULTIPOLYGON.

If the syntax of the input WKT is not valid, or if the WKT describes a GEOMETRY subtype other than a MULTIPOLYGON object, this function outputs an error.

This function returns NULL if the value of the WKT argument is NULL.

Return Type

GEOMETRY

Example

```
iSQL> INSERT INTO TB3 VALUES (107, MPOLYFROMTEXT('MULTIPOLYGON(((10 10, 10 20, 20
20, 20 15, 10 10)), ((60 60, 70 70, 80 60, 60 60)))'));
1 row inserted.
```

```
iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE GEOMETRYTYPE(OBJ) = 'MULTIPOLYGON';
ID
-----
ATEXT(OBJ)
```

```
107
MULTIPOLYGON(((10 10, 10 20, 20 20, 20 15, 10 10)), ((60 60, 70 70, 80 60, 60
60)))
```

1 row selected.

```
iSQL> INSERT INTO TB3 VALUES (108, MPOLYFROMTEXT('MULTIPOINT(10 10, 20 20)'));
[ERR-A1019 : Not applicable object type]
```

GEOMCOLLFROMTEXT

Syntax

GEOMCOLLFROMTEXT(WKT)

Description

This function accepts a spatial object in WKT (Well-known Text) format as input and creates and outputs a GEOMETRY object whose subtype is GEOMETRYCOLLECTION.

If the syntax of the input WKT is not valid, or if the WKT describes a GEOMETRY subtype other than a GEOMETRYCOLLECTION, this function outputs an error.

This function returns NULL if the value of the WKT argument is NULL.

Return Type

GEOMETRY

Example

```
iSQL> INSERT INTO TB3 VALUES (108, GEOMCOLLFROMTEXT('GEOMETRYCOLLECTION(POINT(10
10), POINT(30 30), LINESTRING(15 15, 20 20))'));
1 row inserted.
```

```
iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE GEOMETRYTYPE(OBJ) =
'GEOMETRYCOLLECTION';
```

```

ID
-----
ASTEXT(OBJ)

101
GEOMETRYCOLLECTION( POINT(10 10) , POINT(30 30) , LINESTRING(15 15, 20 20) )

108
GEOMETRYCOLLECTION( POINT(10 10) , POINT(30 30) , LINESTRING(15 15, 20 20) )

2 rows selected.

iSQL> INSERT INTO TB3 VALUES (109, GEOMCOLLFROMTEXT('POLYGON((10 10, 10 20, 20
20, 20 15, 10 10))'));
[ERR-A1019 : Not applicable object type]

```

ST_GEOMETRY

Syntax

```
ST_GEOMETRY( WKT )
```

Description

This function accepts a spatial object in WKT (Well-known Text) format as input and creates a GEOMETRY object.

It allows any spatial objects that can be expressed in WKT format.

If the syntax of the input WKT is not valid, or if the WKT describes a GEOMETRY object that is not included in GEOMETRY object collection, this function outputs an error.

This function returns NULL if the value of the WKT argument is NULL. The SRID of the created object is 0.

Return Type

```
GEOMETRY
```

Example

```
iSQL> INSERT INTO TB3 VALUES (110, ST_GEOMETRY('MULTIPOLYGON(((10 10, 10 20, 20
20, 20 15, 10 10)), ((60 60, 70 70, 80 60, 60 60)))'));
1 row inserted.

iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE ID = 110;
ID          ATEXT(OBJ)
-----
110         MULTIPOLYGON(((10 10, 10 20, 20 20, 20 15, 10 10)), ((60 60, 70 70, 80
60, 60 60)))
1 row selected.
```

GEOMFROMWKB**Syntax**

```
GEOMFROMWKB( WKB )
```

Description

This function accepts a spatial object in WKB (Well-Known Binary)⁷ format as input and creates and outputs a GEOMETRY object.

[⁷] For more detailed information on WKB (Well-Known Binary), please refer to GEOMETRY expression format.

Return Type

```
GEOMETRY
```

POINTFROMWKB**Syntax**

```
POINTFROMWKB( WKB )
```

Description

This function accepts a spatial object in WKB (Well-Known Binary) format as input and creates and outputs a GEOMETRY object whose subtype is POINT.

If the input WKB information describes a GEOMETRY subtype other than a POINT, this function returns an error.

Return Type

```
GEOMETRY
```

LINEFROMWKB

Syntax

```
LINEFROMWKB( WKB )
```

Description

This function accepts a spatial object in WKB (Well-Known Binary) format as input and creates and outputs a GEOMETRY object whose subtype is LINESTRING.

If the input WKB information describes a GEOMETRY subtype other than a LINESTRING, this function outputs an error.

Return Type

```
GEOMETRY
```

ST_LINESTRINGFROMWKB

Syntax

```
ST_LINESTRINGFROMWKB( WKB[, SRID] )
```

Description

This function accepts a spatial object in WKB(Well-Known Binary) format or EWKB(Extended Well-Known Binary) format and its SRID as input and creates a LINESTRING object.

This function returns NULL if the value of the WKB or the value of the SRID is NULL.

If the WKB or EWKB describes spatial data type other than LINESTRING, NULL is returned.

If the syntax of the input WKB or EWKB is not valid, it outputs an error.

If the SRID is not specified, the SRID of the created object is the default value 0.

Return Type

```
GEOMETRY
```

POLYFROMWKB

Syntax

```
POLYFROMWKB( WKB )
```

Description

This function accepts a spatial object in WKB (Well-Known Binary) format as input and creates and outputs a GEOMETRY object whose subtype is POLYGON.

If the input WKB information describes a GEOMETRY subtype other than a POLYGON, this function outputs an error.

Return Type

GEOMETRY

MPOINTFROMWKB**Syntax**

```
MPOINTFROMWKB( WKB )
```

Description

This function accepts a spatial object in WKB (Well-Known Binary) format as input and creates and outputs a GEOMETRY object whose subtype is MULTIPOINT.

If the input WKB information describes a GEOMETRY subtype other than a MULTIPOINT object, this function returns an error.

Return Type

GEOMETRY

MLINEFROMWKB**Syntax**

```
MLINEFROMWKB( WKB )
```

Description

This function accepts a spatial object in WKB (Well-Known Binary) format as input and creates and outputs a GEOMETRY object whose subtype is MULTILINESTRING.

If the input WKB information describes a GEOMETRY subtype other than a MULTILINESTRING object, this function returns an error.

Return Type

GEOMETRY

MPOLYFROMWKB**Syntax**

```
MPOLYFROMWKB( WKB )
```

Description

This function accepts a spatial object in WKB (Well-Known Binary) format as input and creates and outputs a GEOMETRY object whose subtype is MULTIPOLYGON.

If the input WKB information describes a GEOMETRY subtype other than a MULTIPOLYGON object, this function returns an error.

Return Type

GEOMETRY

GEOMCOLLFROMWKB**Syntax**

GEOMCOLLFROMWKB(WKB)

Description

This function accepts a spatial object in WKB (Well-Known Binary) format as input and creates and outputs a GEOMETRY object whose subtype is GEOMETRYCOLLECTION.

If the input WKB information describes a GEOMETRY subtype other than a GEOMETRYCOLLECTION, this function returns an error.

Return Type

GEOMETRY

RECTFROMTEXT**Syntax**

RECTFROMTEXT(WKT)

Description

This function creates polygon object by receiving RECTANGLE spacial object in WKT (Well-Known Text) format. If the input WKB information describes a spatial object other than RECTANGLE or the syntax is incorrect, this function returns an error.

This function returns NULL if the value of the WKT argument is NULL.

RECTANGLE represents RECTANGLE with two points (bottom left and top right), RECTANGLE is sotred as a polygon object. RECTANGLE (x1 y1, x2 y2) is same as POLYGON ((x1 y1, x2 y1, x2 y2, x1 y2, x1 y1)).

Return Value

GEOMETRY

Example

```

iSQL> INSERT INTO TB3 VALUES (104, RECTFROMTEXT('RECTANGLE(10 10, 20 20)'));
1 row inserted.
iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE GEOMETRYTYPE(OBJ) = 'POLYGON';
ID
-----
ATEXT(OBJ)
-----
104
POLYGON((10 10, 20 10, 20 20, 10 20, 10 10))

```



```

1 row selected.
iSQL> INSERT INTO TB3 VALUES (105, RECTFROMTEXT('MULTILINESTRING((10 10, 20 20),
(15 15, 30 15))'));
[ERR-A1019 : Inapplicable object type
0001 : INSERT INTO TB3 VALUES (105, RECTFROMTEXT('MULTILINESTRING((10 10, 20 20),
(15 15, 30 15))')]
^  ^
]
```

RECTFROMWKB

Syntax

```
RECTFROMWKB( WKB )
```

Description

This function creates polygon object by receiving RECTANGLE spacial object in WKT (Well-Known Binary) format. If the input WKB information describes a spatial object other than RECTANGLE or the syntax is incorrect, this function returns an error.

RECTANGLE represents RECTANGLE with two points (bottom left and top right), RECTANGLE is sotred as a polygon object. RECTANGLE (x1 y1, x2 y2) is same as POLYGON ((x1 y1, x2 y1, x2 y2, x1 y2, x1 y1)).

Return Value

```
GEOMETRY
```

Example

Creates a polygon object in WKB corresponding to RECTANGLE (1 1, 3 3).

```

iSQL> INSERT INTO TB3 VALUES ( 106,
RECTFROMWKB(BINARY'010800000000000000000000F03F000000000000F03F00000000000008400000
000000000840') );
1 row inserted.
iSQL> SELECT ID, ATEXT(OBJ) FROM TB3 WHERE GEOMETRYTYPE(OBJ) = 'POLYGON';
ID
-----
ATEXT(OBJ)
-----
106
POLYGON((1 1, 3 1, 3 3, 1 3, 1 1))
1 row selected.
```

GEOMFROMEWKT

Syntax

```
GEOMFROMEWKT( EWKT )
```

Description

GEOMETRY object is created by receiving spatial object in EWKT (Extended Well-Known Text) format.

All spatial objects that can be represented in EWKT are allowed to be input.

If the syntax of EWKT is wrong, an error is output.

Return Type

GEOMETRY

Description

```

iSQL> INSERT INTO TB3 VALUES(101,
GEOMFROMEWKT('SRID=101;GEOMETRYCOLLECTION(POINT(10 10), POINT(30 30),
LINESTRING(15 15, 20 20))'));
1 row inserted.
iSQL> SELECT ID, ASEWKT(OBJ) FROM TB3;
ID
-----
ASEWKT(OBJ)

-----
-----
-----
-----

101
SRID=101;GEOMETRYCOLLECTION( POINT(10 10) , POINT(30 30) , LINESTRING(15 15, 20
20)
)

1 row selected.

iSQL> INSERT INTO TB3 VALUES(101, GEOMFROMEWKT('POINT(10 10), SRID=4326'));
[ERR-A101A : Error parsing well-known-text
0001 : INSERT INTO TB3 VALUES(101, GEOMFROMEWKT('POINT(10 10), SRID=102'))
                                     ^
                                     ^
]

```

GEOMFROMEWKB

Syntax

GEOMFROMEWKB(EWKB)

Description

GEOMETRY object is created by receiving spatial object in EWKB format.

Return Type

GEOMETRY

ST_MAKEPOINT**Syntax**

```
ST_MAKEPOINT( x, y )
```

Description

This receives the x and y values and returns the spatial object of POINT.

Return Type

GEOMETRY

Example

```
isql> SELECT ATEXT( ST_MAKEPOINT( 1, 1 ) ) FROM DUAL;
ATEXT(ST_MAKEPOINT(1,1))
-----
POINT(1 1)
1 row selected.
```

ST_POINT**Syntax**

```
ST_POINT( x, y )
```

Description

Same as ST_MAKEPOINT.

Return Type

GEOMETRY

Example

```
isql> SELECT ATEXT( ST_POINT( 1, 1 ) ) FROM DUAL;
ATEXT(ST_POINT(1,1))
-----
POINT(1 1)
1 row selected.
```

ST_MAKELINE

Syntax

```
ST_MAKELINE( GEOMETRY1, GEOMETRY2 )
```

Description

This creates a LineString object by receiving Point, MultiPoint, and LineString objects.

Return Type

```
GEOMETRY
```

Example

```
iSQL> SELECT ATEXT( ST_MAKELINE( GEOMETRY'POINT(1 1)', GEOMETRY'POINT(2 2)' ) )
AS GEOM FROM DUAL;
GEOM
-----
LINESTRING(1 1, 2 2)
1 row selected.

iSQL> SELECT ATEXT( ST_MAKELINE( GEOMETRY'LINESTRING(1 1, 2 2)',
2 GEOMETRY'LINESTRING(3 3, 4 4)' ) ) AS GEOM
3 FROM DUAL;
GEOM
-----
LINESTRING(1 1, 2 2, 3 3, 4 4)

1 row selected.
```

ST_MAKEPOLYGON

Syntax

```
ST_MAKEPOLYGON( GEOMETRY )
```

Description

This function accepts a LineString object as input and creates and outputs a Polygon object. Here, LineString should be in Ring format.

Return Type

```
GEOMETRY
```

Example

```
iSQL> SELECT ATEXT( ST_MAKEPOLYGON( GEOMETRY'LINESTRING( 0 0, 1 1, 1 0, 0 0 ) '
) ) AS GEOM FROM DUAL;
GEOM
```

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

```
1 row selected.
```

ST_POLYGON

Syntax

```
ST_POLYGON( GEOMETRY, SRID )
```

Description

This function is similar to ST_MAKEPOLYGON. This function accepts a LINESTRING object and SRID as input and creates a POLYGON object.

Return Type

```
GEOMETRY
```

Example

```
iSQL> SELECT ST_ASEWKT( ST_POLYGON( GEOMETRY'LINESTRING( 2 2, 3 2, 3 3, 2 3, 2 2
) ', 4326 ) ) AS GEOM FROM DUAL;
GEOM
```

```
-----
SRID=4326;POLYGON((2 2, 3 2, 3 3, 2 3, 2 2))
```

```
1 row selected.
```

ST_COLLECT

Syntax

```
ST_COLLECT( GEOMETRY1, GEOMETRY2 );
```

Description

This function accepts Geometry objects as input and creates a GeometryCollection object. If the input type is the same, the result value is MULTIPOINT, MULTILINESTRING or MULTIPOLYGON. If not, the result is GeometryCollection.

Return Type

GEOMETRY

Example

```

iSQL> SELECT ATEXT( ST_COLLECT( GEOMETRY'POINT( 1 1 )', GEOMETRY'POINT( 2 2 )' )
) AS GEOM FROM DUAL;
GEOM
-----
--
MULTIPOINT(1 1, 2 2)
1 row selected.

iSQL> SELECT ATEXT( ST_COLLECT( GEOMETRY'LINESTRING( 1 1, 2 2 )',
GEOMETRY'LINESTRING( 3 3, 4 4 )' ) ) AS GEOM FROM DUAL;
GEOM
-----
---
MULTILINESTRING((1 1, 2 2), (3 3, 4 4))
1 row selected.

iSQL> SELECT ATEXT( ST_COLLECT( GEOMETRY'POLYGON( ( 0 0, 1 1, 1 0, 0 0 ) )',
GEOMETRY'POLYGON( ( 10 10, 2 2, 2 0, 10 10 ) )' ) ) AS GEOM FROM DUAL;
GEOM
-----
---
MULTIPOLYGON(((0 0, 1 1, 1 0, 0 0)), ((10 10, 2 2, 2 0, 10 10)))
1 row selected.

iSQL> SELECT ATEXT( ST_COLLECT( GEOMETRY'POINT( 1 1 )', GEOMETRY'LINESTRING( 1
1, 2 2 )' ) ) AS GEOM FROM DUAL;
GEOM
-----
---
GEOMETRYCOLLECTION( POINT(1 1) , LINESTRING(1 1, 2 2) )
1 row selected.

```

ST_MAKEENVELOPE

Syntax

ST_MAKEENVELOPE(x1, y1, x2, y2[, SRID=0])

Description

This function returns POLYGON(X1 Y1, X2 Y1, X2 Y2, X1 Y2, X1 Y1) which is the result of the ENVELOPE function that accepts LINESTRING(X1 Y1, X2 Y2) that is constituted of 4 Double type parameters as input. If the SRID was specified in advance, the created object will have the same SRID. If the SRID was not specified, the SRID of the created object will be 0.

Return Type

GEOMETRY

Example

```
iSQL> SELECT ASEWKT( ST_MAKEENVELOPE( 10.9351, 49.3866, 11.201, 49.5138 ) ) AS
POL FROM DUAL;
POL
-----
-----
SRID=0;POLYGON((10.9351 49.3866, 11.201 49.3866, 11.201 49.5138, 10.9351 49.5138,
10.9351 49.3866))
1 row selected.
```

```
iSQL> SELECT ASEWKT( ST_MAKEENVELOPE( 10.9351, 49.3866, 11.201, 49.5138, 104 ) )
AS POL FROM DUAL;
POL
-----
-----
SRID=104;POLYGON((10.9351 49.3866, 11.201 49.3866, 11.201 49.5138, 10.9351
49.5138, 10.9351 49.3866))
1 row selected.
```

ST_REVERSE

Syntax

ST_REVERSE(GEOMETRY)

Description

This function changes the points of the spatial object in reverse order. If the spatial object is EMPTY it returns NULL. If it is a point, it returns the same spatial object as the input. If it is multiple spatial objects it changes the point of each object in reverse order.

Return Type

GEOMETRY

Example

```

iSQL> SELECT ATEXT( ST_REVERSE(GEOMETRY'LINESTRING( 2 2, 3 2, 3 3, 2 3, 2 4 )')
) AS LS FROM DUAL;
LS
-----
---
LINESTRING(2 4, 2 3, 3 3, 3 2, 2 2)
1 row selected.

```

ST_TRANSFORM

Syntax

```

GEOMETRY ST_Transform( GEOMETRY, INTEGER to_srid );
GEOMETRY ST_Transform( GEOMETRY, VARCHAR to_proj4text );
GEOMETRY ST_Transform( GEOMETRY, VARCHAR from_proj4text, VARCHAR to_proj4text );
GEOMETRY ST_Transform( GEOMETRY, VARCHAR from_proj4text, INTEGER to_srid );

```

Description

This function creates new GEOMETRY object by converting the input GEOMETRY object to input coordination. Input/output coordination can be SRID format or PROJ4TEXT format.

Return Type

```
GEOMETRY
```

Constraints

- This function can only be used in Linux operating system running on computers from Intel.
- If one of the input elements is NULL, NULL is returned.
- If input GEOMETRY object is EMPTY, EMPTY GEOMETRY object is returned.
- If the input and output SRID is identical, returned GEOMETRY object and input GEOMETRY object will be identical as well.
- If the input was SRID coordinate system, there should be SRID's Spatial Reference System meta data which can be found in SPATIAL_REF_SYS table.
- PROJ4TEXT is only supported in PROJ library version 4 format.
- If the output coordinate system is PROJ4TEXT, the SRID of the returned GEOMETRY object is 0.
- If the input coordinate system is PROJ4TEXT and the SRID of the GEOMETRY object is 0, the SRID of the returned GEOMETRY object is 0.

Example

```

iSQL> SELECT ST_ASEWKT(ST_TRANSFORM(ST_POINTFROMTEXT(' POINT(958003.59712966
1948254.75875841)', 5178), 4326 )) AS GEOMETRY;
GEOMETRY
-----
-----

```



```
SRID=4326;POINT(127.0246 37.5326)
```

```
1 row selected.
```

```
iSQL> SELECT ST_ASEWKT(ST_TRANSFORM(ST_POINTFROMTEXT('POINT(958003.59712966
1948254.75875841)'), 5178), '+PROJ=LONGLAT +ELLPS=WGS84 +DATUM=WGS84 +NO_DEFS' ))
AS GEOMETRY;
GEOMETRY
```

```
-----
-----
SRID=0;POINT(127.0246 37.5326)
```

```
1 row selected.
```

```
iSQL> SELECT ST_ASEWKT(ST_TRANSFORM(ST_POINTFROMTEXT('POINT(958003.59712966
1948254.75875841)'), '+PROJ=TMERC +LAT_0=38 +LON_0=127.5 +K=0.9996 +X_0=1000000
+Y_0=2000000 +ELLPS=BESSEL +UNITS=M +NO_DEFS', '+PROJ=LONGLAT +ELLPS=WGS84
+DATUM=WGS84 +NO_DEFS' )) AS GEOMETRY;
GEOMETRY
```

```
-----
-----
SRID=0;POINT(127.0246 37.5326)
```

```
1 row selected.
```

```
iSQL> SELECT ST_ASEWKT(ST_TRANSFORM(ST_POINTFROMTEXT('POINT(958003.59712966
1948254.75875841)'), '+PROJ=TMERC +LAT_0=38 +LON_0=127.5 +K=0.9996 +X_0=1000000
+Y_0=2000000 +ELLPS=BESSEL +UNITS=M +NO_DEFS', 4326 )) AS GEOMETRY;
GEOMETRY
```

```
-----
-----
SRID=0;POINT(127.0246 37.5326)
```

```
1 row selected.
```

Dimensionally Extended Nine Intersection Model(DE - 9IM)

Spatial Relational Operators in the Dimensionally Extended Nine Intersection Model(DE - 9IM)

The “Simple Features for SQL” specification, proposed by the OGC, sets forth the Dimensionally Extended Nine-Intersection Model (DE-9IM). This model is used to test whether a spatial topological relationship exists between two spatial objects.

The DE-9IM describes the following kinds of spatial relationships:

- Equal
- Disjoint
- Intersects
- Touches
- Crosses

- Within
- Contains
- Overlaps

These are described in greater detail later in this section.

The Dimensionally Extended Nine-Intersection Model is used to determine whether a relationship exists between the interior, boundary, or exterior of one spatial object and the interior, boundary, or exterior of another spatial object. Thus, there are nine possible relationships between two spatial objects, and these nine possibilities can be arranged in a 3x3 matrix.

For a given spatial object a , $I(a)$, $B(a)$ and $E(a)$ respectively represent the interior, boundary and exterior of the spatial object. $\text{dim}(x)$ returns the number of dimensions of the relationship between the spatial objects. The return value can be one of -1, 0, 1 or 2.

If $\text{dim}(x)$ returns -1, the two spatial objects do not intersect each other.

For example, the intersection between the boundaries of two Polygons can consist of Points and LineStrings. In this case, $\text{dim}(B(a) \cap B(b))$ returns the greater number of dimensions between Points, which have zero dimensions, and LineStrings, which have one dimension; that is, it returns a value of 1.

The Dimensionally Extended Nine-Intersection Matrix (DE-9IM), which includes all nine possible combinations described above, is shown in the following table.

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

[Table 2-2] DE - 9IM

The result returned by a spatial relational operator can be tested by comparing it with the above pattern matrix, which shows all of the possible values according to the DE-9IM. The pattern matrix contains the allowable values for each intersection. These values are as follows:

T: An intersection must exist

$$\text{dim} \in (0, 1, 2)$$

F: An intersection must not exist.

$$\text{dim} = -1$$

* : It does not matter whether an intersection exists.

$$\text{dim} \in (-1, 0, 1, 2)$$

0: An intersection must exist, and it must be 0-dimensional.

$$\text{dim} = 0$$

1 An intersection must exist, and it must be 1-dimensional.

```
dim = 1
```

2 An intersection must exist, and it must be 2-dimensional.

```
dim = 2
```

For example, the pattern matrix for the DISJOINT operator, which tests whether two spatial objects have no intersection between them, is as follows:

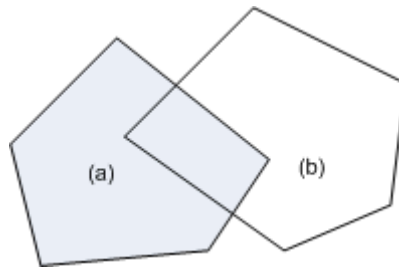
	I(geometry2)	B(geometry2)	E(geometry2)
I(geometry1)	F	F	*
B(geometry1)	F	F	*
E(geometry1)	*	*	*

[Table 2-3] The Pattern Matrix for the DISJOINT Operator

In order for two spatial objects to have the DISJOINT relationship in between, there must be no intersections between the interiors or boundaries of the two objects. The other conditions do not matter, i.e. relationships involving the exterior of either object are not important. The above pattern matrix can be expressed in string form as shown below: FF*FF***

When expressed in string form in this way, the relationship can be tested using the RELATE operator.

The following figure shows the DE-9IM pattern matrix for two overlapping Polygons (a) and (b).



[Figure 2-9] The DE-9IM pattern matrix for two overlapping Polygons

	I(b)	B(b)	E(b)
I(a)	2	1	2
B(a)	1	0	1
E(a)	2	1	2

As noted above, the DE-9IM sets forth 8 kinds of spatial relationships that can exist between two spatial objects. These are defined below:

Operation	Description
DISJOINT(a, b)	$a \cap b = \emptyset$

Operation	Description
TOUCHES(a, b)	$(I(a) \cap I(b) = \emptyset) \wedge (a \cap b) \neq \emptyset$
WITHIN(a, b)	$(a \cap b = a) \wedge (I(a) \cap E(b) \neq \emptyset)$
CONTAINS(a, b)	WITHIN(b, a)
OVERLAPS(a, b)	$(\dim(I(a)) = \dim(I(b)) = \dim(I(a) \cap I(b))) \wedge (a \cap b \neq a) \wedge (a \cap b \neq b)$
CROSSES(a, b)	$(\dim(I(a) \cap I(b)) < \max(\dim(I(a)), \dim(I(b)))) \wedge (a \cap b \neq a) \wedge (a \cap b \neq b)$
INTERSECTS(a, b)	NOT DISJOINT(a, b)
EQUALS(a, b)	$(\dim(I(a)) = \dim(I(b))) \wedge (\dim(B(a)) = \dim(B(b))) \wedge (\dim(E(a)) = \dim(E(b)))$

[Table 2-4] Definition of Spatial Relational Operations

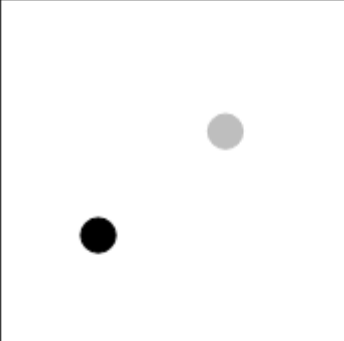

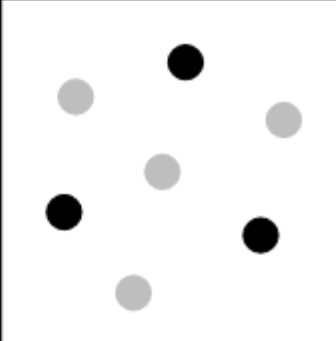






Topological Predicates and Corresponding Pattern Matrices

Altibase provides operators for testing for each of the relationships set forth in the DE-9IM. These are described below.

DISJOINT

This operator tests whether two spatial objects have no intersection in between. The definition of the operator and the DE-9IM pattern matrix string passed to the RELATE operator are as follows:

```
DISJOINT(a, b)
⇔ (I(a) ∩ I(b) = ∅) ∧ (I(a) ∩ B(b) = ∅) ∧ (B(a) ∩ I(b) = ∅) ∧ (B(a) ∩ B(b) = ∅)
⇔ RELATE(a, b, 'FF*FF* * * *')
```










		
POINT/POINT	POINT/MultiPoint	MultiPoint/MultiPoint
		
Point/LineString	MultiPoint/LineString	Polygon/LineString
		
Point/Polygon	LineString/Polygon	Polygon/Polygon

[Figure 2-10] Examples of a spatial object for a DISJOINT relationship

TOUCHES

This operator tests whether two spatial objects touch each other at one or more points. The definition of the operator and the DE-9IM pattern matrix string passed to the RELATE operator are as follows:

```
TOUCHES(a, b)
⇔ (I(a) ∩ I(b) = ∅) ∧ (B(a) ∩ I(b) ≠ ∅) ∨ (I(a) ∩ B(b) ≠ ∅) ∨ (B(a) ∩ B(b) ≠ ∅)
⇔ RELATE (a, b, 'FT*****') ∨ RELATE (a, b, 'F**T*****') ∨ RELATE
(a, b, 'F***T*****')
```

		
POINT/POINT	POINT/MultiPoint	MultiPoint/MultiPoint
		
Point/LineString	MultiPoint/LineString	Polygon/LineString
		
Point/Polygon	LineString/Polygon	Polygon/Polygon

[Figure 2-11] Examples of a spatial object for a TOUCHES relationship

WITHIN

This operator tests whether the first spatial object completely includes the second spatial object. The definition of the operator and the DE-9IM pattern matrix string passed to the RELATE operator are as follows:

```

WITHIN(a, b)
⇔ (I(a) ∩ I(b) ≠ ∅) ∧ (I(a) ∩ E(b) = ∅) ∧ (B(a) ∩ E(b) = ∅)
⇔ RELATE (a, b, 'TF*F*****')

```

Point/MultiPoint	MultiPoint/MultiPoint	MultiPoint/Polygon
Point/LineString	MultiPoint/LineString	LineString/LineString
LineString/LineString	LineString/Polygon	Polygon/Polygon

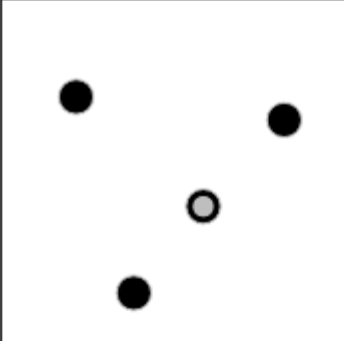
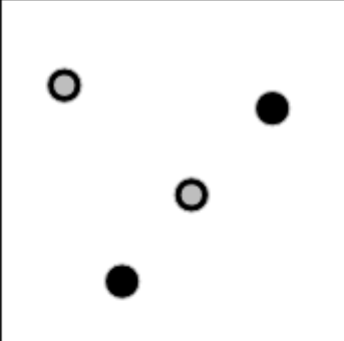
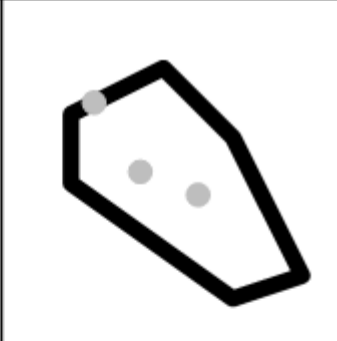
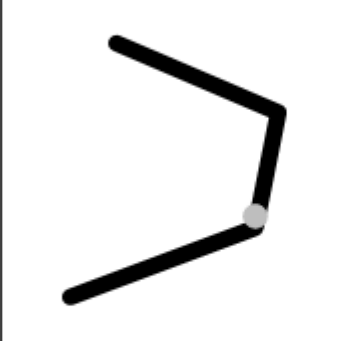
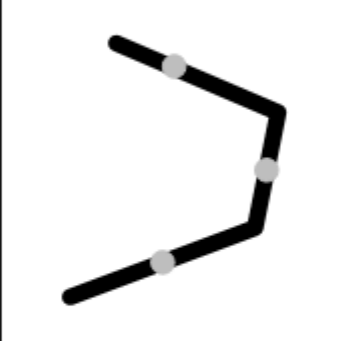
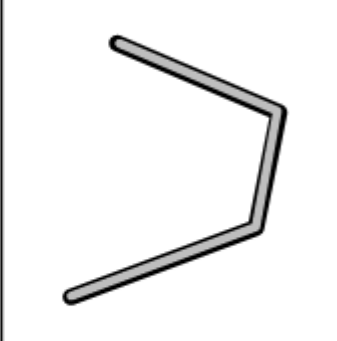


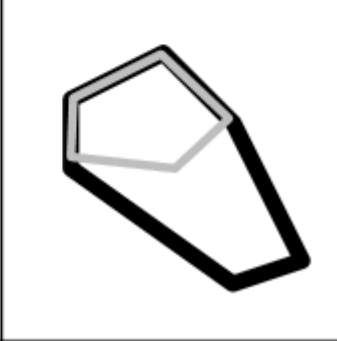
[Figure 2-12] Examples of a spatial object for a TOUCHES relationship

In the above figure, the grey spatial object represents spatial object a and the black spatial object represents spatial object b.

CONTAINS

This operator tests whether the second spatial object completely includes the first spatial object. This operator is the reverse of the WITHIN operator. The definition of the operator is as follows:

`CONTAINS(a, b) ⇔ WITHIN(b, a)`

		
MultiPoint/Point	MultiPoint/MultiPoint	Polygon/MultiPoint
		
LineString/Point	LineString/MultiPoint	LineString/LineString
		
Polygon/Point	Polygon/LineString	Polygon/Polygon

[Figure 2-13] Examples of a spatial object for a CONTAINS relationship

In the above figure, the black spatial object represents spatial object a and the grey spatial object represents spatial object b. In all cases, spatial object a contains spatial object b.

OVERLAPS

This operator tests whether two spatial objects having the same number of dimensions include only a part of each other. The OVERLAPS relationship is defined differently depending on the spatial objects in question: Polygon and Polygon, LineString and LineString, Point and Point. The OVERLAPS relationship between LineString and LineString is as follows:

OVERLAPS(a, b)

$\Leftrightarrow (\dim(I(a) \cap I(b)) = 1) \wedge (I(a) \cap E(b) \neq \emptyset) \wedge (E(a) \cap I(b) \neq \emptyset)$

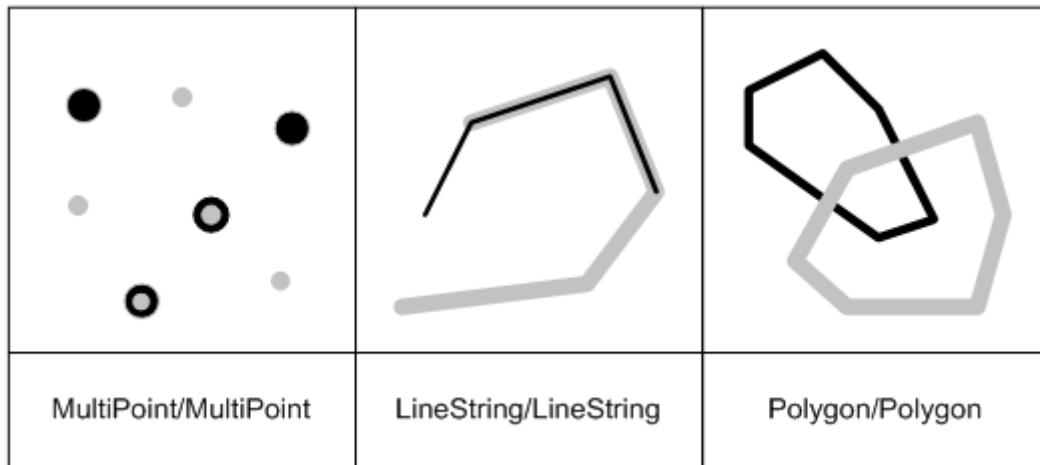
$\Leftrightarrow \text{RELATE}(a, b, '1*T**T**')$

The OVERLAPS relationship between other kinds of spatial objects is defined as follows:

OVERLAPS(a, b)

$\Leftrightarrow (I(a) \cap I(b) \neq \emptyset) \wedge (I(a) \cap E(b) \neq \emptyset) \wedge (E(a) \cap I(b) \neq \emptyset)$

$\Leftrightarrow \text{RELATE}(a, b, 'T*T**T**')$



[Figure 2-14] Examples of a spatial object for a OVERLAPS relationship

CROSSES

This operator tests whether two spatial objects intersect each other. Additionally, it can also be used to test for an intersection between two LineStrings. The CROSSES relationship is defined differently depending on the spatial objects in question: Point and LineString, Point and Polygon, LineString and LineString, LineString and Polygon.

The CROSSES relationship between LineString and LineString is defined as follows:

CROSSES(a, b)

$\Leftrightarrow (\dim(I(a) \cap I(b)) = 0)$

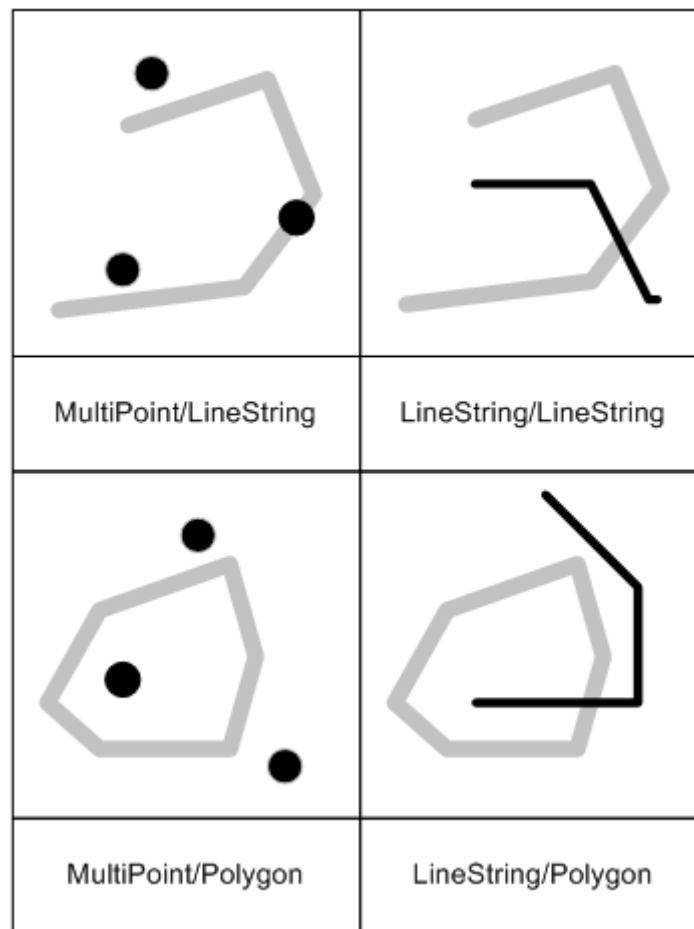
$\Leftrightarrow \text{RELATE}(a, b, '0*****')$

The CROSSES relationship between other combinations of object subtypes is defined as follows:

CROSSES(a, b)

$\Leftrightarrow (I(a) \cap I(b) \neq \emptyset) \wedge (I(a) \cap E(b) \neq \emptyset)$

$\Leftrightarrow \text{RELATE}(a, b, 'T*T*****')$



[Figure 2-15] Examples of a spatial object for a CROSSES relationship



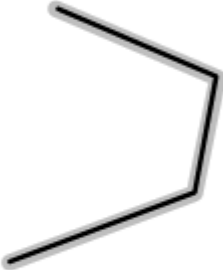



INTERSECTS

The definition of this operator is as follows:

```
INTERSECTS(a, b) ⇔ ! DISJOINT(a, b)
```

EQUALS

This operator tests whether two spatial objects are topologically identical. The following figure shows examples of the EQUALS relationship between spatial objects:

	
Point/Point	MultiPoint/MultiPoint
	
LineString/LineString	MultiLineString/ MultiLineString
	
Polygon/Polygon	MultiPolygon/MultiPolyg on

[Figure 2-16] Examples of a spatial object for a EQUALS relationship

Spatial Relational Operators in Altibase SQL

This section describes the spatial relational operators that are available in Altibase.

EQUALS

Syntax

```
EQUALS( GEOMETRY1, GEOMETRY2 )
```

Description

EQUALS returns TRUE if the two GEOMETRY objects are topologically identical, and FALSE if they differ.

Return Type

BOOLEAN

Example

```
iSQL> SELECT a.F1, b.F1 FROM TB1 a, TB1 b WHERE EQUALS(a.F2, b.F2);
```

F1	F1
101	101
102	102
103	103
104	104
105	105
106	106
107	107
108	108

8 rows selected.

NOTEQUALS**Syntax**

NOTEQUALS(GEOMETRY1, GEOMETRY2)

Description

NOTEQUALS is opposite to EQUALS.

Return Type

BOOLEAN

Example

```
iSQL> SELECT a.F1, b.F1 FROM TB1 a, TB1 b WHERE NOTEQUALS(a.F2, b.F2) AND
GEOMETRYTYPE(a.F2) = 'POLYGON';
```

F1	F1
105	100
105	101
105	102
105	103
105	104
105	106
105	107
105	108
105	109
106	100
106	101

```

106      102
106      103
106      104
106      105
106      107
106      108
106      109
18 rows selected.

```

DISJOINT

Syntax

```
DISJOINT( GEOMETRY1, GEOMETRY2 )
```

Description

DISJOINT returns TRUE if there is no intersection between the two GEOMETRY objects, and FALSE otherwise. DISJOINT returns the opposite of the value returned by INTERSECTS.

Return Type

```
BOOLEAN
```

Example

```

iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE DISJOINT(TB1.F2, TB2.F2) AND
GEOMETRYTYPE(TB1.F2) = 'POLYGON';
F1      F1
-----
105      207
105      208
105      209
106      201
106      202
106      203
106      204
106      206
106      207
106      208
106      209
11 rows selected.

```

INTERSECTS

Syntax

```
INTERSECTS( GEOMETRY1, GEOMETRY2 )
```

Description

INTERSECTS returns TRUE if the two GEOMETRY objects intersect each other, and FALSE if they do not intersect each other.

INTERSECTS returns the opposite of the value returned by DISJOINT.

Return Type

BOOLEAN

Example

```
iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE INTERSECTS(TB1.F2, TB2.F2) ;
F1          F1
-----
102          205
103          205
104          205
105          201
105          202
105          203
105          204
105          205
105          206
106          205
107          205
108          205
12 rows selected.
```

TOUCHES**Syntax**

TOUCHES(GEOMETRY1, GEOMETRY2)

Description

TOUCHES returns TRUE when the two GEOMETRY objects contact each other at one or more points, and FALSE otherwise.

Return Type

BOOLEAN

Example

```

iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE TOUCHES(TB1.F2, TB2.F2);
F1          F1
-----
102          205
103          205
105          201
105          202
105          203
105          204
108          205
7 rows selected.

```

NOTTOUCHES**Syntax**

```
NOTTOUCHES( GEOMETRY1, GEOMETRY2 )
```

Description

NOTTOUCHES is opposite to TOUCHES.

Return Type

```
BOOLEAN
```

Example

```

iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE NOTTOUCHES(TB1.F2, TB2.F2) AND
GEOMETRYTYPE(TB1.F2) = 'POLYGON';
F1          F1
-----
105          200
105          201
105          202
105          203
105          204
105          205
105          206
105          207
105          208
105          209
106          200
106          201
106          202
106          203
106          204
106          205
106          206
106          207
106          208
106          209

```

20 rows selected.

CROSSES

Syntax

```
CROSSES( GEOMETRY1, GEOMETRY2 )
```

Description

CROSSES returns TRUE when two GEOMETRY objects having different numbers of dimensions intersect each other, and FALSE otherwise.

Additionally, CROSSES is also used to test for an intersection between two LINESTRINGS.

Return Type

BOOLEAN

Example

```
iSQL> SELECT a.F1, b.F1 FROM TB1 a, TB1 b WHERE CROSSES(a.F2, b.F2);
F1          F1
-----
102         108
1 row selected.
```

NOTCROSSES

Syntax

```
NOTCROSSES( GEOMETRY1, GEOMETRY2 )
```

Description

NOTCROSSES is opposite to CROSSES.

Return Type

BOOLEAN

Example

```
iSQL> SELECT a.F1, b.F1 FROM TB1 a, TB1 b WHERE NOTCROSSES(a.F2, b.F2) AND
GEOMETRYTYPE(a.F2) = 'POLYGON';
F1          F1
-----
105         100
105         101
105         102
105         103
105         104
105         105
105         106
```



```

105      107
105      108
105      109
106      100
106      101
106      102
106      103
106      104
106      105
106      106
106      107
106      108
106      109
20 rows selected.

```

WITHIN

Syntax

```
WITHIN( GEOMETRY1, GEOMETRY2 )
```

Description

WITHIN returns TRUE if the first GEOMETRY object is completely included in the second GEOMETRY object, and FALSE otherwise.

Return Type

```
BOOLEAN
```

Example

```

iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE WITHIN(TB1.F2, TB2.F2);
F1      F1
-----
106      205
1 rows selected.

```

NOTWITHIN

Syntax

```
NOTWITHIN( GEOMETRY1, GEOMETRY2 )
```

Description

NOTWITHIN is opposite to WITHIN.

Return Type

```
BOOLEAN
```

Example

```

iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE NOTWITHIN(TB1.F2, TB2.F2) AND
GEOMETRYTYPE(TB1.F2) = 'POLYGON';
F1          F1
-----
105         200
105         201
105         202
105         203
105         204
105         205
105         207
105         208
105         209
106         200
106         201
106         202
106         203
106         204
106         205
106         206
106         207
106         208
106         209
19 rows selected.

```

CONTAINS**Syntax**

```
CONTAINS( GEOMETRY1, GEOMETRY2 )
```

Description

CONTAINS returns TRUE if the first GEOMETRY object completely includes the second GEOMETRY object, and FALSE otherwise.

Return Type

```
BOOLEAN
```

Example

```

iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE CONTAINS(TB1.F2, TB2.F2);
F1          F1
-----
105         206
1 row selected.

```

NOTCONTAINS

Syntax

```
NOTCONTAINS( GEOMETRY1, GEOMETRY2 )
```

Description

NOTCONTAINS is opposite to CONTAINS.

Return Type

```
BOOLEAN
```

Example

```
iSQL> SELECT a.F1, b.F1 FROM TB1 a, TB1 b WHERE NOTCONTAINS(a.F2, b.F2) AND
GEOMETRYTYPE(a.F2) = 'POLYGON';
```

F1	F1
105	100
105	101
105	102
105	104
105	106
105	107
105	108
105	109
106	100
106	109

10 rows selected.

OVERLAPS

Syntax

```
OVERLAPS( GEOMETRY1, GEOMETRY2 )
```

Description

OVERLAPS returns TRUE if two GEOMETRY objects include only part, but not all, of each other, and FALSE otherwise.

Return Type

```
BOOLEAN
```

Example

```

iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE OVERLAPS(TB1.F2, TB2.F2);
F1          F1
-----
105         205
107         205
3 rows selected.

```

NOTOVERLAPS**Syntax**

```
NOTOVERLAPS( GEOMETRY1, GEOMETRY2 )
```

Description

NOTOVERLAPS is opposite to OVERLAPS.

Return Tyoe

```
BOOLEAN
```

Example

```

iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE NOTOVERLAPS(TB1.F2, TB2.F2) AND
GEOMETRYTYPE(TB1.F2) = 'POLYGON';
F1          F1
-----
105         200
105         201
105         202
105         203
105         204
105         205
105         206
105         207
105         208
105         209
106         200
106         201
106         202
106         203
106         204
106         208
106         209
17 rows selected.

```

RELATE

Syntax

```
RELATE( GEOMETRY1, GEOMETRY2 , patterns )
```

Description

RELATE returns TRUE if the relationship between two GEOMETRY objects matches the given pattern matrix string, and FALSE otherwise.

Return Type

```
BOOLEAN
```

Example

```
iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE RELATE(TB1.F2, TB2.F2,
'T**F*****');
F1          F1
-----
105          206
1 rows selected.
```

```
iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE RELATE(TB1.F2, TB2.F2,
'T*T***T**');
F1          F1
-----
104          205
105          205
107          205
3 rows selected.
```

NOTRELATE

Syntax

```
NOTRELATE( GEOMETRY1, GEOMETRY2 , patterns )
```

Description

NOTRELATE is opposite to RELATE.

Return Type

```
BOOLEAN
```

Example

```
iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE NOTRELATE(TB1.F2, TB2.F2,
'T*T***T**') AND GEOMETRYTYPE(TB1.F2) = 'POLYGON';
F1          F1
-----
105          201
```

```

105      202
105      203
105      204
105      205
105      206
105      207
105      208
105      209
106      201
106      209
11 rows selected.

```

ISMBRINTERSECTS

Syntax

```
ISMBRINTERSECTS( GEOMETRY1, GEOMETRY2 );
```

Description

ISMBRINTERSECTS returns TRUE if the MBRs (Minimum Bounding Rectangles) of the two GEOMETRY objects intersect each other, and FALSE otherwise.

Return Type

```
BOOLEAN
```

Example

```

iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE ISMBRINTERSECTS(TB1.F2, TB2.F2) ;
F1      F1
-----
102      205
103      205
104      205
105      201
105      202
105      203
105      204
105      205
105      206
105      207
105      208
106      205
107      205
108      205
14 rows selected.

```

ISMBRWITHIN

Syntax

```
ISMBRWITHIN( GEOMETRY1, GEOMETRY2 );
```

Description

ISMBRWITHIN returns TRUE if the minimal bounding rectangle of the first GEOMETRY object is completely included within that of the second GEOMETRY object, and FALSE otherwise.

Return Type

```
BOOLEAN
```

Example

```
iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE ISMBRWITHIN(TB1.F2, TB2.F2);
F1          F1
-----
106         205
1 rows selected.
```

ISMBRCONTAINS

Syntax

```
ISMBRCONTAINS( GEOMETRY1, GEOMETRY2 );
```

Description

ISMBRCONTAINS returns TRUE if the minimal bounding rectangle of the first GEOMETRY object completely includes that of the second GEOMETRY object, and FALSE otherwise.

Return Type

```
BOOLEAN
```

Example

```
iSQL> SELECT TB1.F1, TB2.F1 FROM TB1, TB2 WHERE ISMBRCONTAINS(TB1.F2, TB2.F2);
F1          F1
-----
105         201
105         206
2 rows selected.
```

Reserved Words

The following words have been set aside as reserved words in Spatial SQL, and thus cannot be used as the names of tables, columns, users, or other database objects.

```
AREA
```

```
ASBINARY
```

ASTEXT	BOUNDARY
BUFFER	CENTROID
CONTAINS	CONVEXHULL
COORDX	COORDY
CROSSES	DIFFERENCE
DIMENSION	DISJOINTS
DISTANCE	ENDPOINT
ENVELOPE	EQUALS
EXTERIORRING	GEOMCOLLFROMTEXT
GEOMCOLLFROMWKB	GEOMETRY
GEOMETRYCOLLECTION	GEOMETRYLENGTH
GEOMETRYN	GEOMETRYTYPE
GEOMFROMTEXT	GEOMFROMWKB
INTERIORRINGN	INTERSECTION
INTERSECTS	ISCLOSED
ISEMPTY	ISRING
ISSIMPLE	LINEFROMTEXT
LINEFROMWKB	LINESTRING
MLINEFROMTEXT	MLINEFROMWKB
MPOINTFROMTEXT	MPOINTFROMWKB
MPOLYFROMTEXT	MPOLYFROMWKB
MULTILINESTRING	MULTIPOINT
MULTIPOLYGON	NUMGEOMETRIES
NUMINTERIORRING	NUMPOINTS
OVERLAPS	POINT
POINTFROMTEXT	POINTFROMWKB
POINTN	POINTONSURFACE
POLYFROMTEXT	POLYFROMWKB
POLYGON	RELATE
RECTFROMTEXT	RECTFROMWKB
ST_GEOMETRY	STARTPOINT
SYMDIFFERENCE	TOUCHES
UNION	WITHIN
X	Y
MINX	MINY
MAXX	MAXY
ISVALID	

3. Spatial Application Development

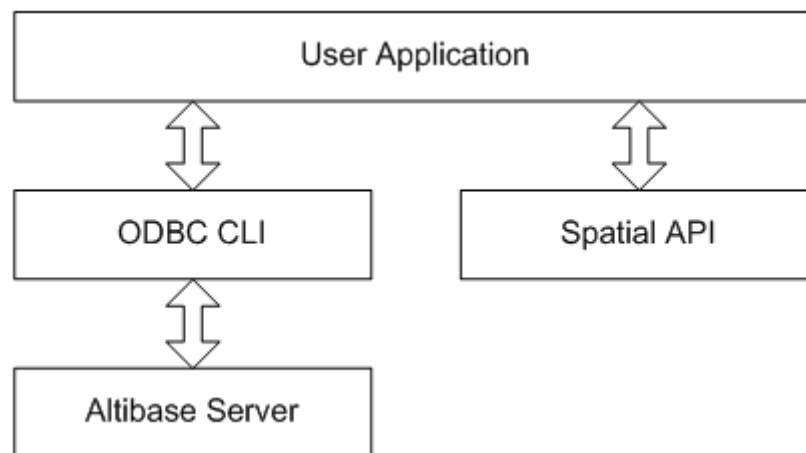
This chapter describes the Spatial API, which can be used by an application developer to access spatial data.

Using the Spatial API

This section describes how to use the Spatial API. For more information on the ODBC CLI, please refer to the *CLI User's Manual*.

The Relationship between the Spatial API and the ODBC CLI

The Spatial API is a library that is useful for accessing spatial objects via the ODBC CLI. It is used together with the ODBC CLI to write an ODBC application that uses spatial objects. As shown in the following diagram, the Spatial API is not directly called using the ODBC CLI, nor is it used to access an Altibase server directly. Rather, it is used alongside the ODBC CLI and an Altibase server to create and interpret spatial data.

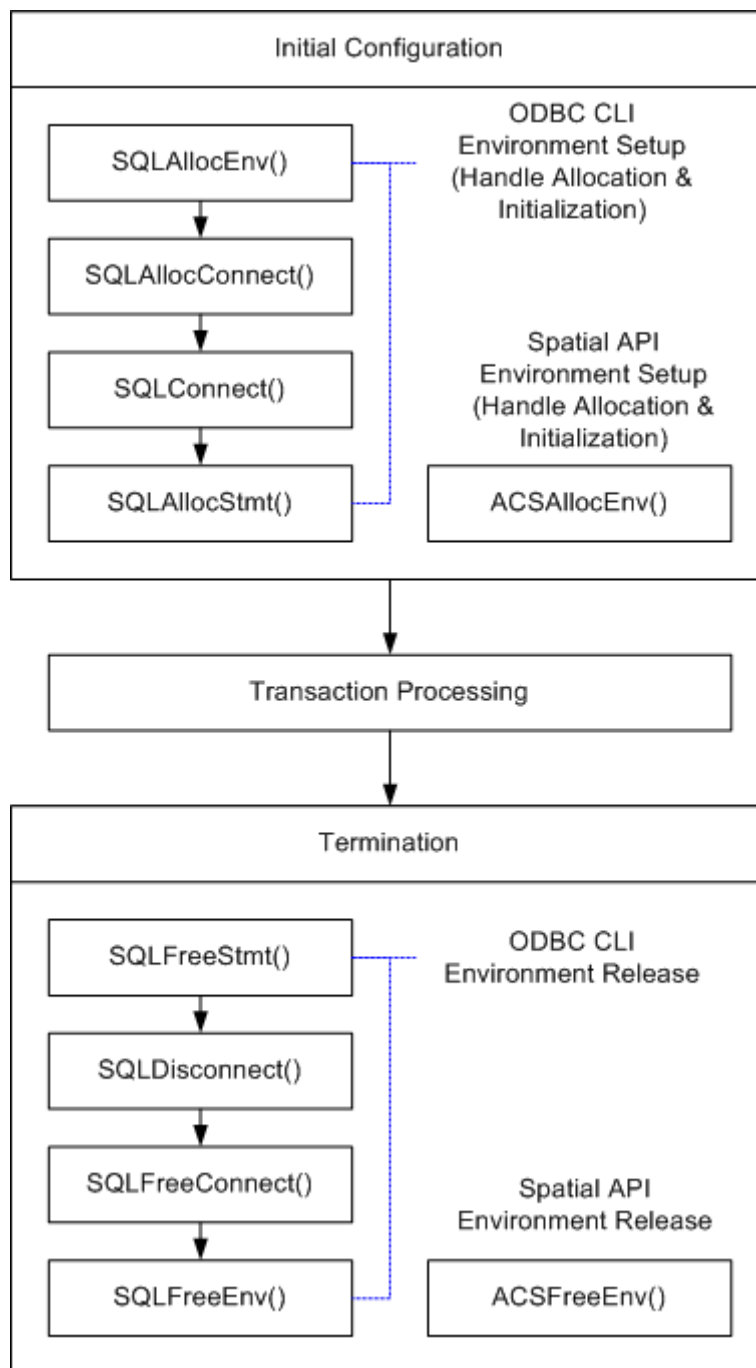


Basic Usage

As shown in the following diagram, a typical ODBC application can be divided into 3 stages. The Spatial API is called between these stages.

- Initial Configuration
- Transaction Processing
- Termination

Certain tasks, such as processing diagnostic messages, are conducted throughout an application, and thus do not fall into only one of the above three stages.

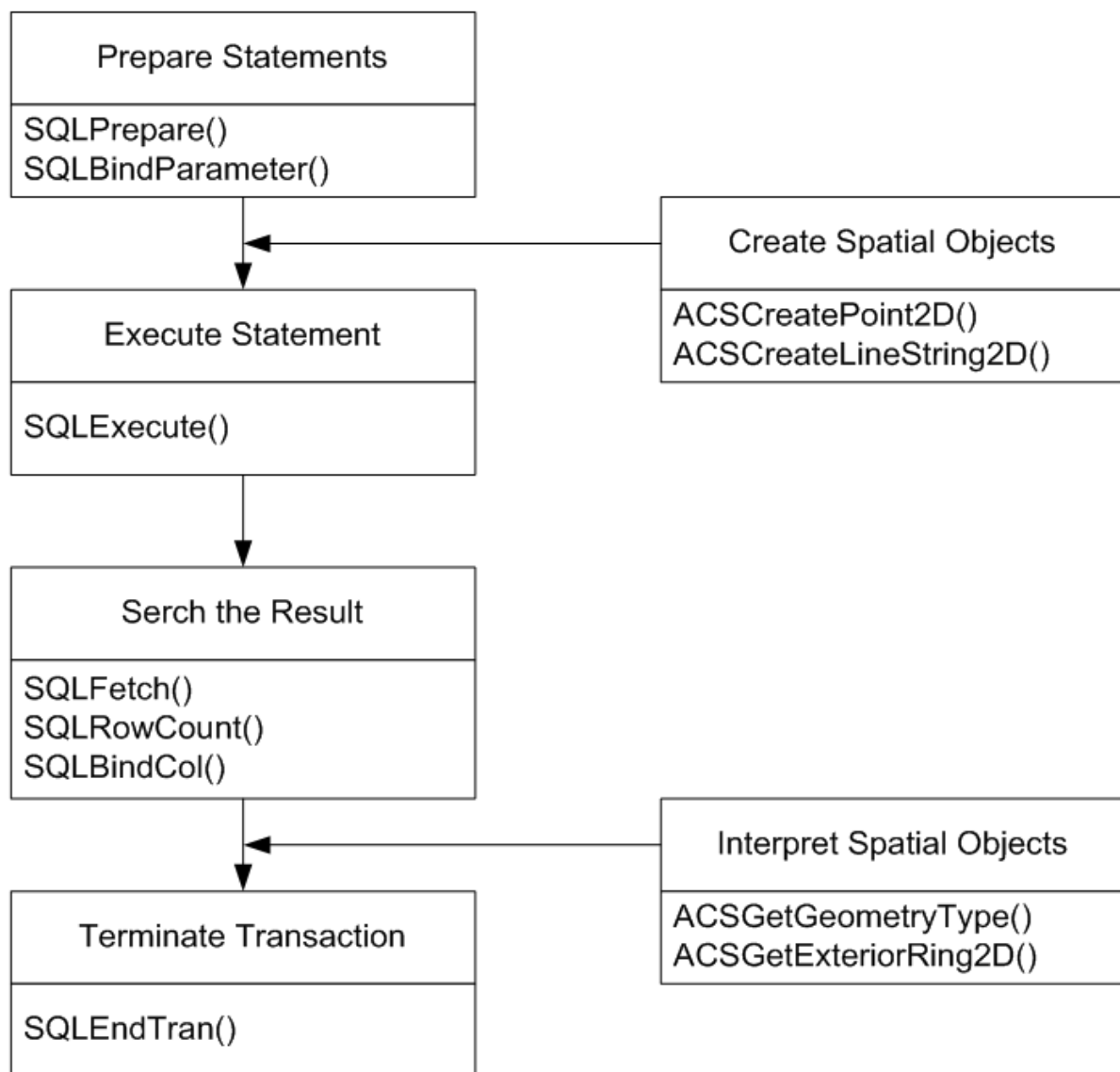


Initial Configuration

In this stage, environment settings are made, and connection handles are allocated and initialized. The handles that must be allocated during the initial configuration include those that are needed to call the Spatial API. The order in which the Spatial API or the ODBC API is initialized is irrelevant.

Transaction Processing

in the following diagram. Between ODBC calls, spatial object creation and search functions are called in order to manipulate spatial objects.



Termination

After the handles that were allocated to the application are terminated and allocated memory freed, the application itself is terminated.

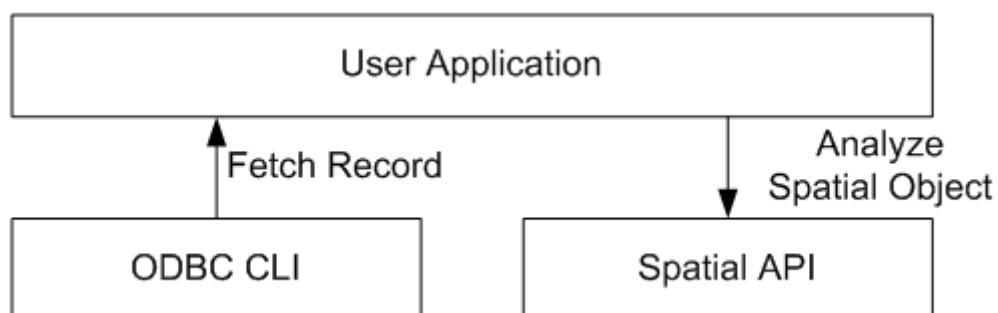
Examples of Application Programming

Search for Spatial Object

The general method of querying spatial objects is shown below.

The ODBC CLI is used to execute a SELECT statement to search for records.

The Spatial API is used to interpret the GEOMETRY type columns in the retrieved records.



A sample application in which spatial objects are queried can be found at:

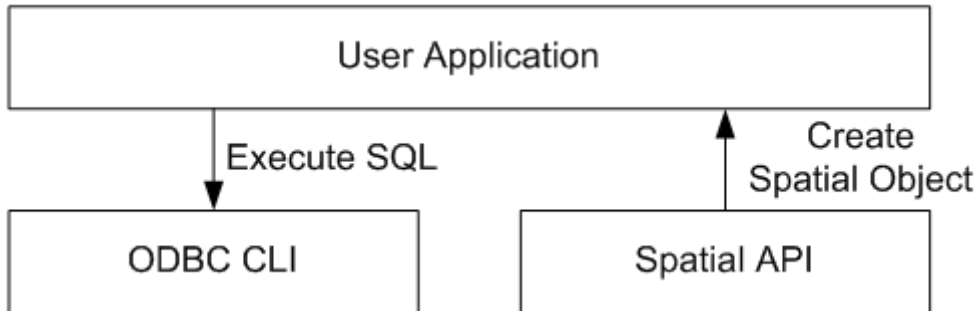
```
$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp
```

Inserting, Updating, and Deleting Spatial Objects

Generally, spatial objects are inserted, updated and deleted as shown below.

First, the Spatial API is used to create a spatial object.

Then, the ODBC CLI is used to execute an INSERT, UPDATE or DELETE statement.



Sample applications in which spatial objects are inserted, updated and deleted can be found at:

- `$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp`
- `$ALTIBASE_HOME/sample/SPATIAL/deleteObject.cpp`
- `$ALTIBASE_HOME/sample/SPATIAL/updateObject.cpp`

Data Types and Functions for Use with the Spatial API

The Names of Basic Data Types

To ensure compatibility with C data types across platforms, the basic data types that are available in the Spatial API use the names of corresponding ODBC data types, or aliases for those types. The exact data type definitions can be checked by viewing the contents of:

`$ALTIBASE_HOME/include/acsTypes.h`

The following table provides a brief description of each of the basic data types:

ODBC Type	Alias Name	Meaning
SQLSCHAR	SChar	8-bit signed char
SQLCHAR	UChar	8-bit unsigned char
SQLSMALLINT	SShort	16-bit signed small integer
SQLUSMALLINT	UShort	16-bit unsigned small integer
SQLINTEGER	SInt	32-bit signed integer
SQLUINTEGER	UInt	32-bit unsigned integer
SQLBIGINT	SLong	64-bit signed big integer
SQLUBIGINT	ULong	64-bit unsigned big integer
SQLREAL	SFloat	32-bit signed float number

ODBC Type	Alias Name	Meaning
SQLDOUBLE	SDouble	64-bit signed double float number
SQLLEN	vSLong	32-bit signed integer on 32-bit platform 64-bit signed integer on 64-bit platform
SQLULEN	vULong	32-bit unsigned integer on 32-bit platform 64-bit unsigned integer on 64-bit platform

[Table 3-1] The Names of Basic Data Types

The Structure of Spatial Data Types

The names of the spatial object data structures that are stored internally in the Altibase server have the prefix “std” (which stands for “Spatio-Temporal Datatype”). Each data structure is stored, managed and interpreted in the same way on the server as it is in client applications

The definitions of these data structures can be checked by viewing the contents of:
\$ALTIBASE_HOME/include/stdNativeTypes.i

Object Type	Member	Type	Meaning
stdPoint2DType	mType	UShort	= 2001
	mByteOrder	SChar	Byte order
	mPadding	SChar	Padding byte for memory alignment
	mSize	UInt	The size of the object, including the header
	mMBR	stdMBR	Minimum boundary rectangle
	mPoint	stdPoint2D	Point

[Table 3-2] The Structure of Spatial Data Types

The Name of API Functions

The names of the Spatial API functions have the prefix “ACS”, which signifies “Altibase Call-level Spatial”.

These functions are classified as follows, and are described in corresponding sections:

- Handle & Error Management Functions
- Spatial Object Creation Functions

Refer to \$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp file.

- Spatial Object Querying Functions

Refer to \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp file.

- Endian Functions

The interface for each function can also be checked directly by viewing the following file:

```
$ALTIBASE_HOME/include/ulsAPI.i
```

Handle & Error Management Functions

ACSAAllocEnv

This function allocates and initializes a handle, which is required in order to use the Spatial API.

Syntax

```
ACSRETURN ACSAllocEnv( ACSHENV * aHandle );
```

Argument

Data Type	Argument	Input/Output	Description
ACSHENV *	aHandle	Output	This is a pointer to an environment handle.

Return Value

```
ACS_SUCCESS
ACS_INVALID_HANDLE
```

Description

A handle must be allocated in order to use the Spatial API in client applications. One of the functions of this environment handle is to manage information about errors that occur during the use of the Spatial API.

Diagnosing Errors

If this function returns ACS_INVALID_HANDLE, either NULL was input for the aHandle function argument, or else there is insufficient memory to allocate the environment handle.

Related Function

```
ACSFreeEnv
```

Example

```
ACSHENV sAcEnv;
if ( ACSAllocEnv(&sAcEnv) != ACS_SUCCESS )
{
    printf("ACSAllocEnv error!!\n");
    exit(-1);
}
```

ACSTreeEnv

This function terminates a Spatial API handle.

Syntax

```
ACSRETURN ACSTreeEnv( ACSHEMV aHandle );
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHEMV	aHandle	Input	This is an environment handle.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
```

Description

This function returns the memory that was obtained for an environment handle using ACSAllocEnv().

Related Function

```
ACSAllocEnv
```

Example

```
ACSHEMV sAcEnv;
...
ACSTreeEnv( sAcEnv );
```

ACS_Error

This function is used to retrieve error information after a call to a Spatial API function fails.

Syntax

```
ACSRETURN ACS_Error(    ACSHEMV    aHandle,
                        SQLINTEGER * aErrorCode,
                        SQLCHAR    ** aErrorMessage,
                        SQLSMALLINT * aErrorMessageLength );
```

Argument

Data Type	Argument	Input/Output	Description
ACSHEMV	aHandle	Input	This is an environment handle.

Data Type	Argument	Input/Output	Description
SQLINTEGER*	aErrorCode	Output	This is a pointer to a buffer in which the error code is returned.
SQLSCHAR **	aErrorMessage	Output	This is a pointer to a buffer in which the error message is returned.
SQLSMALLINT*	aErrorMessageLength	Output	This is a pointer to a buffer containing the size of the returned error message, in bytes.

Return Values

ACS_SUCCESS
ACS_INVALID_HANDLE

Description

This function is used to retrieve error information after a call to a Spatial API function fails.

Related Function

ACSA1locEnv

Example

```

ACSHENV      sAcEnv;
SQLINTEGER    sAcErrNo;
SQLSCHAR      * sErrMsg;
SQLSMALLINT    sMsgLength;
...
if( ACSCreatePoint2D( sAcEnv,
sGeoBuffer,
sGeoBufferSize,
& sPoint,
0,
& sGeomSize )!= ACS_SUCCESS )
{
    if( ACSError( sAcEnv,
& sAcErrNo,
& sErrMsg,
& sMsgLength ) == ACS_SUCCESS )
    {
        printf( "ERROR(%d) : %s\n", sErrNo, sErrMsg );
    }
}

```


Spatial Object Creation Functions

ACSCreatePoint2D

This function is used to create a POINT spatial object in 2-dimensional space.

Syntax

```
ACSRETURN ACSCreatePoint2D(
    ACSHENV
    stdGeometryType
    SQLLEN
    stdPoint2D
    SQLINTEGER
    SQLLEN
    aHandle,
    * aBuffer,
    aBufferSize,
    * aPoint,
    aSRID,
    * aObjLength );
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType *	aBuffer	Output	This is a pointer to a buffer in which to store the data for the Point object to be created.
SQLLEN	aBufferSize	Input	This is the maximum size of aBuffer, in bytes.
stdPoint2D *	aPoint	Input	This is a pointer to information about the location of the Point object to be created.
SQLINTEGER	aSRID	Input	This is the spatial reference system ID of the input spatial object aPoint (reserved for future use).
SQLLEN *	aObjLength	Output	This is a pointer to a buffer in which the size of the spatial object that was created is returned.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to create a POINT spatial object as a GEOMETRY type from location data stored in the stdPoint2D structure. The definition of the stdPoint2D structure can be checked in the \$ALTIBASE_HOME/include/stdNativeTypes.i file.

If aBuffer is NULL, only the size of the spatial object that was created is returned in aObjLength.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F5(332277)	Insufficient Buffer Space	This error code indicates that the spatial object to be created is larger than the input buffer.

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp

ACSCreateLineString2D

This function is used to create a LINESTRING spatial object in 2-dimensional space.

Syntax

```
ACSRETURN ACSCreateLineString2D( ACSHENV          aHandle,
                                stdGeometryType * aBuffer,
                                SQLLEN          aBufferSize,
                                SQLINTEGER      aNumPoints,
                                stdPoint2D     * aPoints,
                                SQLINTEGER      aSRID,
                                SQLLEN          * ObjLength);
```

Argument

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType *	aBuffer	Output	This is a pointer to a buffer in which to store the data for the LineString object to be created.
SQLLEN	aBufferSize	Input	This is the maximum size of aBuffer, in bytes.
SQLINTEGER	aNumPoints	Input	This is the number of points in the object to be created.
stdPoint2D *	aPoints	Input	This is an array of Points in which to hold the coordinates of the points of the object to be created.
SQLINTEGER	aSRID	Input	This is the spatial reference system ID of the input spatial object aPoints (reserved for future use)

Data Type	Argument	Input/Output	Description
SQLLEN *	aObjLength	Output	This is a pointer to a buffer in which the size of the spatial object that was created is returned.

Return Value

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to create a LINESTRING spatial object as a GEOMETRY type from input Points.

If aBuffer is NULL, only the size of the spatial object to be created will be returned in aObjLength.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL parameter	This error code indicates a NULL function argument.
0x511F5(332277)	Insufficient Buffer Space	This error code indicates that the spatial object to be created is larger than the input buffer.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNumPoints must be 2 or greater.

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp

ACSCreateLinearRing2D

This function is used to create a LINEARRING spatial object in 2-dimensional space.

Syntax

```
ACSRETURN ACSCreateLinearRing2D(
    ACSHENV          aHandle,
    stdLinearRing2D * aBuffer,
    SQLLEN           aBufferSize,
    SQLINTEGER        NumPoints,
    stdPoint2D       * aPoints,
    SQLLEN           * aObjLength);
```

Arguments

Data Type	Argument	Input/Out	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdLinearRing2D *	aBuffer	Output	This is a pointer to a buffer in which to store the data for the LinearRing object to be created.
SQLLEN	aBufferSize	Input	This is the maximum size of aBuffer, in bytes.
SQLINTEGER	aNumPoints	Input	This is the number of points in aPoints.
stdPoint2D *	aPoints	Input	This is an array of Points in which to hold the coordinates of the points of the object to be created.
SQLLEN *	aObjLength	Output	This is a pointer to a buffer in which the size of the spatial object that was created is returned.

Return Values

ACS_SUCCESS
 ACS_INVALID_HANDLE
 ACS_ERROR

Description

This function is used to create a LINEARRING spatial object in 2-dimensional space from input Points. The created LINEARRING object has the stdLinearRing2D structure, and is subsequently used to create a Polygon GEOMETRY object.

If aBuffer is NULL, only the size of the spatial object to be created will be returned in aObjLength.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F5(332277)	Insufficient Buffer Space	This error code indicates that the spatial object to be created is larger than the input buffer.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNumPoints must be 2 or greater.

Related Function

ACSCreatePolygon2D

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp

ACSCreatePolygon2D

This function is used to create a POLYGON spatial object in 2-dimensional space..

Syntax

```
ACSRETURN ACSCreatePolygon2D(
    ACSHENV          aHandle,
    stdGeometryType * aBuffer,
    SQLLEN           aBufferSize,
    SQLINTEGER        aNumRings,
    stdLinearRing2D ** aRings,
    SQLINTEGER        aSRID,
    SQLLEN           * aObjLength);
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType*	aBuffer	Output	This is a pointer to a buffer in which to store the data for the spatial object to be created.
SQLLEN	aBufferSize	Input	This is the maximum size of aBuffer, in bytes.
SQLINTEGER	aNumRings	Input	This is the number of rings in aRings.
stdLinearRing2D**	aRings	Input	This is an array of pointers to the Ring type objects that the Polygon will comprise.
SQLINTEGER	aSRID	Input	This is the spatial reference system ID of the input spatial object aRings (reserved for future use).
SQLLEN *	aObjLength	Output	This is a pointer to a buffer in which the size of the spatial object that was created is returned.

Return Value

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to create a Polygon GEOMETRY object from input LinearRings stored in a stdLinearRing2D structure. The definition of the stdLinearRing2D structure can be checked in the \$ALTIBASE_HOME/include/stdNativeTypes.i file.

If aBuffer is NULL, only the size of the spatial object that was created is returned in aObjLength.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F5(332277)	Insufficient Buffer Space	This error code indicates that the spatial object to be created is larger than the input buffer.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNumRings must be 1 or greater.

Related Function

```
ACSCreateLinearRing2D
```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp

ACSCreateMultiPoint2D

This function is used to create a MULTIPOINT spatial object in 2-dimensional space.

Syntax

```
ACSRETURN ACSCreateMultiPoint2D(
    ACSHENV
    stdGeometryType
    SQLLEN
    SQLINTEGER
    stdPoint2DType
    SQLLEN
    aHandle,
    * aBuffer,
    aBufferSize,
    aNumPoints,
    ** aPoints,
    * aObjLength);
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType *	aBuffer	Output	This is a pointer to a buffer in which to store the data for the spatial object to be created.
SQLLEN	aBufferSize	Input	This is the maximum size of aBuffer, in bytes.
SQLINTEGER	aNumPoints	Input	This is the number of Point objects in aPoints.
stdPoint2DType **	aPoints	Input	This is an array of pointers to the Point objects that the MultiPoint object consists of.
SQLLEN *	aObjLength	Output	This is a pointer to a buffer in which the size of the spatial object that was created is returned.

Return Values

ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR

Description

This function is used to create a MultiPoint GEOMETRY object from the input Point objects.

If aBuffer is NULL, only the size of the spatial object that was created is returned in aObjLength.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F5(332277)	Insufficient Buffer Space	This error code indicates that the spatial object to be created is larger than the input buffer.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNumPoints must be 1 or greater.

Related Function

ACSCreatePoint2D

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp

ACSCreateMultiLineString2D

This function is used to create a MULTILINESTRING spatial object in 2-dimensional space.

Syntax

```

ACSRRETURN ACSCreateMultiLineString2D(
    ACSHEENV          aHandle,
    stdGeometryType * aBuffer,
    SQLLEN            aBufferSize,
    SQLINTEGER         aNumLineStrings,
    stdLineString2DType ** aLineStrings,
    SQLLEN             * aObjLength );

```

Arguments

Data Type	Argument	Input/Output	Description
ACSHEENV	aHandle	Input	This is an environment handle.
stdGeometryType *	aBuffer	Output	This is a pointer to a buffer in which to store the data for the spatial object to be created.
SQLLEN	aBufferSize	Input	This is the maximum size of aBuffer, in bytes.
SQLINTEGER	aNumLineStrings	Input	This is the number of LineStrings in aLineStrings.
stdLineString2DType **	aLineStrings	Input	This is an array of pointers to the LineString objects that the MultiLineString object consists of.
SQLLEN *	aObjLength	Output	This is a pointer to a buffer in which the size of the spatial object that was created is returned

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to create a MultiLineString GEOMETRY object from the input LineString objects.

If aBuffer is NULL, only the size of the spatial object that was created is returned in aObjLength.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F5(332277)	Insufficient Buffer Space	This error code indicates that the spatial object to be created is larger than the input buffer
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNumLineStrings must be 1 or greater.

Related Function

```
ACSCreateLineString2D
```

Example

\$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp파일을 참고하기 바란다.

ACSCreateMultiPolygon2D

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp

Syntax

```
ACSRETURN ACSCreateMultiPolygon2D( ACSHENV          aHandle,
                                   stdGeometryType    * aBuffer,
                                   SQLLEN              aBufferSize,
                                   SQLUINTEGER         aNumPolygons,
                                   stdPolygon2DType    ** aPolygons,
                                   SQLLEN              * aObjLength );
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType *	aBuffer	Output	This is a pointer to a buffer in which to store the data for the spatial object to be created.
SQLLEN	aBufferSize	Input	This is the maximum size of aBuffer, in bytes.
SQLINTEGER	aNumPolygons	Input	This is the number of Polygons in aPolygons.
stdPolygon2DType **	aPolygons	Input	This is an array of pointers to the Polygon objects that the MultiPolygon object consists of.
SQLLEN *	aObjLength	Output	This is a pointer to a buffer in which the size of the spatial object that was created is returned.

Return Values

ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR

Description

This function is used to create a MultiPolygon GEOMETRY object from the input Polygon objects.

If aBuffer is NULL, only the size of the spatial object that was created is returned in aObjLength.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F5(332277)	Insufficient Buffer Space	This error code indicates that the spatial object to be created is larger than the input buffer.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNumPoints must be 1 or greater.

Related Function

```
ACSCreatePolygon2D
```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp

ACSCreateGeomCollection2D

This function is used to create a GEOMETRYCOLLECTION spatial object in 2-dimensional space.

Syntax

```
ACSRETURN ACSCreateGeomCollection2D( ACSHENV          aHandle,
                                     stdGeometryType    * aBuffer,
                                     SQLLEN              aBufferSize,
                                     SQLINTEGER          aNumGeometries,
                                     stdGeometryType    ** aGeometries,
                                     SQLLEN              * aObjLength);
```

Argument

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle
stdGeometryType *	aBuffer	Output	This is a pointer to a buffer in which to store the data for the spatial object to be created.
SQLLEN	aBufferSize	Input	This is the maximum size of aBuffer, in bytes.
SQLINTEGER	aNumGeometries	Input	This is the number of spatial objects in aGeometries.
stdGeometryType **	aGeometries	Input	This is an array of pointers to the spatial objects that the GeometryCollection object consists of.
SQLLEN *	aObjLength	Output	This is a pointer to a buffer in which the size of the spatial object that was created is returned.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to create a GEOMETRYCOLLECTION spatial object from the input GEOMETRY objects.

If aBuffer is NULL, only the size of the spatial object that was created is returned in aObjLength.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F5(332277)	Insufficient Buffer Space	This error code indicates that the spatial object to be created is larger than the input buffer.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNumLineStrings must be 1 or greater.

Related Functions

```

ACSCreatePoint2D
ACSCreateLineString2D
ACSCreatePolygon2D
ACSCreateMultiPoint2D
ACSCreateMultiLineString2D
ACSCreateMultiPolygon2D

```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/insertObject.cpp

Spatial Object Querying Functions

ACSGetGeometryType

This function is used to determine the type of a spatial object.

Syntax

```

ACSRETURN ACSGetGeometryType( ACSHENV          aHandle,
                               stdGeometryType * aGeometry,
                               stdGeoTypes    * aGeoType );

```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType *	aGeometry	Input	This is a pointer to a spatial object.

Data Type	Argument	Input/Output	Description
stdGeoTypes *	aGeoType	Output	This is a pointer to a buffer in which the type of the input spatial object is returned.

Return Value

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to determine the type of a spatial object.

The type of a spatial object is one of the following:

```
typedef enum stdGeoTypes
{
    STD_UNKNOWN_TYPE           = 0,
    STD_POINT_2D_TYPE          = 2001,
    STD_LINESTRING_2D_TYPE     = 2003,
    STD_POLYGON_2D_TYPE        = 2005,
    STD_MULTIPPOINT_2D_TYPE     = 2011,
    STD_MULTILINESTRING_2D_TYPE = 2013,
    STD_MULTIPOLYGON_2D_TYPE    = 2015,
    STD_GEOCOLLECTION_2D_TYPE   = 2020,
    STD_NULL_TYPE               = 9990, // Null Geometry Object
    STD_EMPTY_TYPE              = 9991  // Empty Geometry Object
} stdGeoTypes;
```

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetGeometrySize

This function is used to determine the amount of storage space that a spatial object occupies.

Syntax

```
ACSRETURN ACSGetGeometrySize( ACSHENV          aHandle,
                               stdGeometryType * aGeometry,
                               SQLLEN          * aGeomSize );
```

Arguments

Data Type	Argument	Input/Out	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType *	aGeometry	Input	This is a pointer to the spatial object.
SQLLEN *	aGeomSize	Output	This is a pointer to a buffer in which the amount of storage space occupied by the input spatial object will be returned

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to determine the amount of storage space that a spatial object occupies.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Example

```

ACSHENV          sAcSEnv;
stdGeometryType * sSubObj;
SQLLEN           sGeomSize;
...
if( ACSGetGeometryType( sAcSEnv, sSubObj, & sGeomSize )
== ACS_SUCCESS )
{
    printf( "Geometry Size = %d\n", sGeomSize );
}
else
{
    exit(-1);
}

```

ACSGetGeometrySizeFromWKB

This function is used to determine the size of a GEOMETRY object. It is used before a spatial object in WKB (Well-Known Binary) format is converted to a GEOMETRY object.

Syntax

```

ACSRETURN ACSGetGeometrySizeFromWKB(
                                ACSHENV          aHandle,
                                SQLCHAR          * aWKB,
                                SQLUINTEGER      aWKBLength,
                                SQLLEN           * aSize );

```

Arguments

Data Type	Argument	Input/Out	Description
ACSHENV	aHandle	Input	This is an environment handle.
SQLCHAR *	aWKB	Input	This is a string for a spatial object in WKB format.
SQLUINTEGER	aWKBLength	Input	This is the length of aWKB, in bytes.
SQLLEN *	aSize	Output	This is a pointer to a buffer in which the size of the GEOMETRY object is returned.

Return Values

```

ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR

```

Description

This function is used to determine the size of a GEOMETRY object. It is used before a spatial object in WKB (Well-Known Binary) format is converted to a GEOMETRY object.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x511FC(332284)	Invalid WKB	This error message indicates that the format of the specified WKB is not valid.

Example

```

ACSHENV          sAcSEnv;
SQLCHAR          * sWKB;
SQLINTEGER        sWKBLength;
SQLLEN           sSize;
...
if( ACSGetGeometryType( sAcSEnv, sWKB, sWKBLength, & sSize )
    == ACS_SUCCESS )
{
    printf( "Geometry Size = %d\n", sSize );
}
else
{
    exit(-1);
}

```

ACSGetNumGeometries

This function is used to determine the number of child spatial objects in a compound spatial object, such as a MultiPoint, MultiLineString, MultiPolygon or GeometryCollection object.

Syntax

```

ACSRETURN ACSGetNumGeometries( ACSHENV          aHandle,
                                stdGeometryType * aGeometry,
                                SQLINTEGER        *aNumGeometries);

```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType *	aGeometry	Input	This is a pointer to a spatial object.

Data Type	Argument	Input/Output	Description
SQLINTEGER *	aNumGeometries	Output	This is a pointer to a buffer in which the number of child spatial objects that the input compound spatial object consists of is returned.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to determine the number of child spatial objects in a compound spatial object, such as a MultiPoint, MultiLineString, MultiPolygon or GeometryCollection object.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL parameters	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function

Related Function

```
ACSGetGeometryN
```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetGeometryN

This function is used to get the Nth child spatial object in a compound spatial object, such as a MultiPoint, MultiLineString, MultiPolygon or GeometryCollection object.

Syntax

```
ACSRETURN ACSGetGeometryN( ACSHENV          aHandle,
                           stdGeometryType * aGeometry,
                           SQLINTEGER      anth,
                           stdGeometryType ** aSubGeometry );
```

Arguments

Data Type	Argument	Input/Out	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType *	aGeometry	Input	This is a pointer to a spatial object whose child object is to be retrieved.
SQLINTEGER	aNth	Input	This indicates which of the compound spatial object's child spatial objects is to be retrieved. The child spatial objects of a compound spatial object are numbered starting at 1.
stdGeometryType **	aSubGeometry	Output	This is a pointer to a pointer to a buffer in which the child spatial object is returned.

Return Values

ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR

Description

This function is used to get the Nth child spatial object in a compound spatial object, such as a MultiPoint, MultiLineString, MultiPolygon or GeometryCollection object.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNth must satisfy the expression: $1 \leq aNth \leq$ (the number of child objects in aGeometry)
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Related Function

```
ACSGetNumGeometries
```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetExteriorRing2D

This function is used to return the exterior ring ("ExteriorRing") of a Polygon object.

Syntax

```
ACSRETURN ACSGetExteriorRing2D(
    ACSHENV          aHandle,
    stdPolygon2DType * aPolygon,
    stdLinearRing2D  ** aLinearRing );
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdPolygon2DType *	aPolygon	Input	This is a pointer to the Polygon object whose ExteriorRing is to be returned.
stdLinearRing2D **	aLinearRing	Output	This is a pointer to a pointer to a buffer in which the returned ExteriorRing is stored.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to return the exterior ring of a Polygon object. An ExteriorRing is the outermost LinearRing of a Polygon object. A Polygon object has only one ExteriorRing.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.

ErrorCode	Description	Notes
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function. The type of aPolygon must be STD_POLYGON_2D_TYPE.

Related Functions

```

ACSGetNumInteriorRing2D
ACSGetInteriorRingNPolygon2D
ACSGetNumPointsLinearRing2D
ACSGetPointsLinearRing2D
ACSGetPointNLinearRing2D

```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetNumInteriorRing2D

This function is used to determine the number of interior rings ("InteriorRing") in a Polygon object.

Syntax

```

ACSRETURN ACSGetNumInteriorRing2D( ACSHENV      aHandle,
                                   stdPolygon2DType * aPolygon,
                                   SQLINTEGER      * aNumInterior );

```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdPolygon2DType *	aPolygon	Input	This is a pointer to the Polygon object for which it is desired to know the number of InteriorRings.
SQLINTEGER *	aNumInterior	Output	This is a pointer to a buffer in which the number of InteriorRings is returned.

Return Values

```

ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR

```

Description

This function is used to determine the number of interior rings ("InteriorRing") in a Polygon object. A Polygon can have 0 or more InteriorRings.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Related Functions

```

ACSGGetExteriorRing2D,
ACSGGetInteriorRingNPolygon2D
ACSGGetNumPointsLinearRing2D
ACSGGetPointsLinearRing2D
ACSGGetPointNLinearRing2D

```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGGetInteriorRingNPolygon2D

This function is used to return the Nth InteriorRing of a Polygon object.

Syntax

```

ACSRETURN ACSGetInteriorRingNPolygon2D(
    ACSHENV          aHandle,
    stdPolygon2DType * aPolygon,
    SQLINTEGER        anth,
    stdLinearRing2D   ** aLinearRing );

```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdPolygon2DType *	aPolygon	Input	This is a pointer to the Polygon object whose Nth InteriorRing is to be returned.

Data Type	Argument	Input/Output	Description
SQLINTEGER	aNth	Input	This indicates which InteriorRing to return.
stdLinearRing2D**	aLinearRing	Output	This is a pointer to a pointer to a buffer in which to return the InteriorRing.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to return the Nth InteriorRing of a Polygon object. A Polygon can have 0 or more InteriorRings.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNth must satisfy the following expression: $1 \leq aNth \leq$ (the number of InteriorRings in aPolygon)
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Related Functions

```
Spatial Object Not
SupportedACSGetExteriorRing2D
ACSGetNumInteriorRing2D
ACSGetNumPointsLinearRing2D
ACSGetPointsLinearRing2D
ACSGetPointNLinearRing2D
```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetNumPointsLineString2D

This function is used to determine the number of Points that a LineString object consists of.

Syntax

```
ACSRETURN ACSGetNumPointsLineString2D(
    ACSHENV          aHandle,
    stdLineString2DType * aLineString,
    SQLINTEGER       * aNumPoints );
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is a pointer to an environment handle.
stdLineString2DType *	aPolygon	Input	This is a pointer to the LineString object for which it is desired to know the number of Points.
SQLINTEGER*	aNumPoints	Output	This is a pointer to a buffer in which the number of Points is returned.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to determine the number of Points that a LineString object consists of. A LineString must have at least two Points.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.

ErrorCode	Description	Notes
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Related Functions

ACSGetPointsLineString2D
ACSGetPointNLineString2D

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetPointNLineString2D

This function is used to return the Nth Point in a LineString object.

Syntax

```
ACSRETURN ACSGetPointNLineString2D(
                                ACSHENV          aHandle,
                                stdLineString2DType * aLineString,
                                SQLUIINTEGER      aNth,
                                stdPoint2D        * aPoint );
```

#####

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdLineString2DType *	aPolygon	Input	This is a pointer to the LineString object whose Nth Point is to be returned.
SQLUIINTEGER	aNth	Input	This indicates which Point to return.
stdPoint2D *	aPoint	Output	This is a pointer to a buffer in which to return the Point.

Return Values

ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR

Description

This function is used to return the Nth Point in a LineString object.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNth must satisfy the following expression: $1 \leq aNth \leq$ (the number of Points in the input LineString)
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Related Functions

```
ACSGetNumPointsLineString2D
ACSGetPointsLineString2D
```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetPointsLineString2D

This function returns an array of Points that constitute a LineString object.

Syntax

```
ACSRETURN ACSGetPointsLineString2D( ACSHENV          aHandle,
                                     stdLineString2DType * aLineString,
                                     stdPoint2D          ** aPoints );
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdLineString2DType *	aPolygon	Input	This is a pointer to the LineString object for which the pointer to the array of Points will be returned.

Data Type	Argument	Input/Output	Description
stdPoint2D **	aPoints	Output	This is a pointer to a pointer to a buffer in which to return the Points.

Return Values

ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR

Description

This function returns an array of Points that constitute a LineString object.

Diagnosing

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Related Functions

ACSGetNumPointsLineString2D
ACSGetPointNLineString2D

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetNumPointsLinearRing2D

This function is used to determine the number of Points that a LinearRing object consists of.

Syntax

```
ACSRETURN ACSGetNumPointsLinearRing2D(
    ACSHENV          aHandle,
    stdLinearRing2DType * aLinearRing,
    SQLINTEGER        * aNumPoints );
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdLinearRing2DType *	aPolygon	Input	This is a pointer to the LinearRing object for which it is desired to know the number of Points.
SQLINTEGER*	aNumPoints	Output	This is a pointer to a buffer in which the number of Points is returned.

Return Values

ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR

Description

This function is used to determine the number of Points that a LinearRing object consists of. A LinearRing must have at least two Points.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameters	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Related Functions

ACSGetPointsLinearRing2D
ACSGetPointNLinearRing2D

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetPointNLinearRing2D

This function is used to get the Nth Point of a LinearRing object.

Syntax

```
ACSRETURN ACSGetPointNLinearRing2D( ACSHENV          aHandle,
                                     stdLinearRing2DType * aLinearRing,
                                     SQLINTEGER          aNth,
                                     stdPoint2D          * aPoint );
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdLinearRing2DType *	aPolygon	Input	This is a pointer to the LinearRing object whose Nth Point is to be returned.
SQLINTEGER	aNth	Input	This indicates which Point to return.
stdPoint2D *	aPoint	Output	This is a pointer to a buffer in which the Point is returned.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to get the Nth Point of a LinearRing object.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.
0x511F8(332280)	Invalid Input Value	This error code indicates that an input value is not valid. The value of aNth must satisfy the expression: 1 <= aNth <= (the number of Points in LinearRing)

ErrorCode	Description	Notes
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Related Functions

```
ACSGetNumPointsLinearRing2D
ACSGetPointsLinearRing2D
```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

ACSGetPointsLinearRing2D

This function returns the array of Points that constitute a LineString object.

Syntax

```
ACSRETURN ACSGetPointsLineString2D( ACSHENV          aHandle,
                                     stdLineString2DType * aLineString,
                                     stdPoint2D          ** aPoints );
```

Arguments

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdLineString2DType *	aPolygon	Input	This is a pointer to the LinearrRing object for which the pointer to the array of Points will be returned.
stdPoint2D **	aPoints	Output	This is a pointer to a pointer to a buffer in which to return the Points.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function returns the array of Points that constitute a LineString object.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.
0x511FB(332283)	Spatial Object Not Supported	This error code indicates that the type of the input spatial object is not supported for use with this function.

Related Functions

```
ACSGetNumPointsLineString2D
ACSGetPointNLineString2D
```

Example

Sample code can be found at: \$ALTIBASE_HOME/sample/SPATIAL/selectObject.cpp

Endian Functions

ACSEndian

This function is used to forcibly convert the Endian of a spatial object.

Syntax

```
ACSRETURN ACSEndian(      ACSHENV      aHandle,
                          stdGeomeryType * aGeometry );
```

Arguments

Data Type	Argument	Input/Out	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeomeryType *	aGeometry	Input/Output	This is a pointer to the spatial object whose Endian is to be converted.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to forcibly convert the Endian of a spatial object.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Data Type	This error code indicates that the input spatial object is not valid

Related Function

ACSAdjustByteOrder

ACSAdjustByteOrder

This function is used to convert the Endian of a spatial object to that of the corresponding platform.

Syntax

```
ACSRETURN ACSAdjustByteOrder( ACSHENV          aHandle,
                             stdGeomeryType    * aGeometry );
```

Arguments

Data Type	Arguments	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType*	aGeometry	Input/Output	This is a pointer to the spatial object whose Endian is to be converted.

Return Values

```
ACS_SUCCESS
ACS_INVALID_HANDLE
ACS_ERROR
```

Description

This function is used to convert the Endian (i.e. byte order) of a spatial object to that of the corresponding platform. If the byte order of a spatial object is different from that of a client host, the byte order of the spatial object is converted so that it is the same as that of the client. If the byte order of the client and the spatial object are the same to begin with, then no conversion is performed.

Diagnosing Errors

If this function returns ACS_ERROR, use ACSError() to check the information related to the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL Parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.

Related Function

ACSEndian

ACSGetGeometrySRID

This function convert the endian of the spatial object to the same as the platform

Syntax

```
ACSRETURN ACSGetGeometrySRID( ACSHENV aHandle,
                               stdGeometryType * aGeometry,
                               SQLINTEGER * aSRID );
```

Argument

Data Type	Argument	Input/Output	Description
ACSHENV	aHandle	Input	This is an environment handle.
stdGeometryType*	aGeometry	Input	This is a pointer to a spatial object.
SQLINTEGER *	aSRID	Output	This is a pointer to buffer to get SRID of input spatial object.

Return Values

ACS_SUCCESS
ACS_ERROR

Description

This function is used to get the SRID of a spatial object.

Diagnosing Errors

If the function returns ACS_ERROR, the information obtained from ACSError can be used to identify the error.

ErrorCode	Description	Notes
0x5101C(331804)	NULL parameter	This error code indicates a NULL function argument.
0x511F9(332281)	Invalid Spatial Object	This error code indicates that the input spatial object is not valid.

Example

```

ACSHENV sAcEnv;
stdGeometryType * sSubObj;
SQLINTEGER sSRID;
...
if ( ACSGetGeometrySRID( sAcEnv, sSubObj, &sSRID ) == ACS_SUCCESS )
{
    printf( "SRID=%d\n", sSRID );
}
else
{
    exit(-1);
}

```

Appendix A. Limitations on the Use of Spatial Data in Altiabase

With the expansion of Altiabase into the realm of spatial data, inevitably some of Altiabase's extensive functionality lacks support for use with spatial data. The current limitations are explained in detail in this Appendix.

Limitations on GEOMETRY Type Columns

Constraints

In Altiabase, the use of various kinds of constraints is supported to ensure the validity of data.

Currently, the only constraint that can be applied to GEOMETRY type columns is the NOT NULL constraint. None of the other constraints can be used with spatial data.

SRID (Spatial Reference Identifier)

SRID (Spatial Reference Identifier) is an identifier specified to identify a spatial object. SRID can be applied to GEOMETRY column, and SRID can be assigned to GEOMETRY object that inserts into table.

The SRID of the GEOMETRY object INSERTing into the table must match or equal zero to the SRID of the corresponding column. If the SRID of column or object, the default value of 0.

The SRID of a column can be changed by using the ALTER TABLE MODIFY COLUMN statement. In this case, the SRID of all objects inserted into column must match or be 0.

Example

```
CREATE TABLE T1 (I1 GEOMETRY);
INSERT INTO T1 VALUES(GEOMETRY'POINT(1 1)');
INSERT INTO T1 VALUES(GEOMETRY'SRID=99;POINT(1 1)');

-- FAIL
isql> ALTER TABLE T1 MODIFY COLUMN I1 SRID 100;
[ERR-31461 : Invalid SRID datatype.]

-- SUCCESS
isql> ALTER TABLE T1 MODIFY COLUMN I1 SRID 99;
Alter success.
```

Indexes

The R-Tree index is provided for use in indexing spatial data. The R-Tree index cannot be created with the UNIQUE attribute, and cannot be created on the basis of multiple columns.

If a NOT NULL constraint does not exist on a column composing an R-Tree index, caution is required as the result can differ depending on whether or not the R-Tree index is used for query execution. The leaf node of an R-Tree index contains neither the NULL nor EMPTY value. Therefore, neither the NULL nor EMPTY value affects queries which use an R-Tree index as below.

```

CREATE TABLE T1 (I1 GEOMETRY) TABLESPACE SYS_TBS_DISK_DATA;
CREATE INDEX T1_I1_IDX ON T1(I1);
INSERT INTO T1 VALUES (NULL);

iSQL> SELECT /*+ index(t1, T1_I1_IDX) */ count(*) from T1;
COUNT
-----
0
1 row selected.

```

However, if the full scan hint is specified in a query as below, the query result is affected by the NULL or EMPTY value stored in the column of an R-Tree index.

```

iSQL> SELECT /*+ full scan(T1) */ count(*) from T1;
COUNT
-----
1
1 row selected.

```

Triggers

The same limitations that apply to the use of triggers with stored procedures also apply to the use of triggers with spatial data. Additionally, the value of a GEOMETRY type column, including the so-called “before-image” and “after-image” values, cannot be used in a trigger.

Stored Procedures

GEOMETRY type data cannot be used as stored procedure parameters or as local variables within stored procedures.

Stored Functions

GEOMETRY Type cannot be used for parameter, return type, and local variable.

Appendix B. Spatial Schema

This Appendix provides a reference for the table schema and data used in the examples throughout this manual.

Sample Table Information

Purpose

The information on the sample tables that are used to help explain the syntax and functionality of Altibase Spatial SQL is provided here.

Schema

Table TB1

Primary Key: F1

Initial Number of Records: 10

Column Name	Data Type	Description
F1	INTEGER	Identifier
F2	GEOMETRY	Spatial data

TB2 Table

Primary Key: F1

Initial Number of Records: 10

Column Name	Data Type	Description
F1	INTEGER	Identifier
F2	GEOMETRY	Spatial data

TB3 Table

Primary Key: ID

Initial Number of Records: 0

Column Name	Data Type	Description
ID	INTEGER	Identifier
OBJ	GEOMETRY	Spatial data

Sample Data

The results of execution of the SQL statements in the examples in this manual are based on the following initial sample data:

TB1 Table

```
CREATE TABLE TB1 (F1 INTEGER PRIMARY KEY, F2 GEOMETRY);
CREATE INDEX RT_IDX_TB1 ON TB1(F2) ;

INSERT INTO TB1 VALUES (100, NULL);
INSERT INTO TB1 VALUES (101, GEOMETRY'POINT(1 1)');
INSERT INTO TB1 VALUES (102, GEOMETRY'MULTIPOINT(1 1, 2 2)');
INSERT INTO TB1 VALUES (103, GEOMETRY'LINESTRING(1 1, 2 2)');
INSERT INTO TB1 VALUES (104, GEOMETRY'MULTILINESTRING((1 1, 2 2), (3 3, 4 5))');
INSERT INTO TB1 VALUES (105, GEOMETRY'POLYGON((0 0, 10 0, 10 10, 0 10, 0 0 ))');
INSERT INTO TB1 VALUES (106, GEOMETRY'POLYGON((3 5, 7 5, 7 9, 3 9, 3 5 ), ( 4 6,
4 8 , 6 8, 6 6 , 4 6 ))');
INSERT INTO TB1 VALUES (107, GEOMETRY'MULTIPOLYGON(((1 1, 2 1, 2 2, 1 2, 1 1)),
((3 3, 3 5, 5 5, 5 3, 3 3)))');
INSERT INTO TB1 VALUES (108, GEOMFROMTEXT('GEOMETRYCOLLECTION(POINT(1 1),
LINESTRING(2 2, 3 3))'));
INSERT INTO TB1 VALUES (109, BOUNDARY(GEOMETRY'POINT(10 10)'));

iSQL> SELECT F1 FROM TB1 ;
F1
-----
100
101
102
103
104
105
106
107
108
109
10 rows selected.
```

TB2 Table

```
CREATE TABLE TB2 (F1 INTEGER PRIMARY KEY, F2 GEOMETRY);
CREATE INDEX RT_IDX_TB2 ON TB2(F2) ;

INSERT INTO TB2 VALUES (200, NULL);
INSERT INTO TB2 VALUES (201, GEOMETRY'POINT(10 10)');
INSERT INTO TB2 VALUES (202, GEOMETRY'MULTIPOINT(10 10, 20 20)');
INSERT INTO TB2 VALUES (203, GEOMETRY'LINESTRING(10 10, 20 20, 30 40)');
INSERT INTO TB2 VALUES (204, GEOMETRY'MULTILINESTRING((10 10, 20 20), (15 15, 30
15))');
INSERT INTO TB2 VALUES (205, GEOMETRY'POLYGON((2 2, 12 2, 12 12, 2 12 ))');
INSERT INTO TB2 VALUES (206, GEOMETRY'POLYGON((8 3, 9 3, 9 5, 8 5, 8 3 ),( 8.2
3.2, 8.2 4.8, 8.8 4.8 , 8.8 3.2 ,8.2 3.2 ))');
INSERT INTO TB2 VALUES (207, GEOMETRY'MULTIPOLYGON(((10 10, 10 20, 20 20, 20 15,
10 10)), ((60 60, 70 70, 80 60, 60 60)))');
```

```
INSERT INTO TB2 VALUES (208, GEOMFROMTEXT('GEOMETRYCOLLECTION( POINT(10 10),
POINT(30 30), LINESTRING(15 15, 20 20))'));
INSERT INTO TB2 VALUES (209, BOUNDARY(GEOMETRY'POINT(10 10)'));
```

```
iSQL> SELECT F1 FROM TB2;
F1
-----
200
201
202
203
204
205
206
207
208
209
10 rows selected.
```

TB3 Table

```
CREATE TABLE TB3(ID INTEGER PRIMARY KEY, OBJ GEOMETRY);
CREATE INDEX RT_IDX_TB3 ON TB3(OBJ) ;
```

Appendix C. Geometry Reference Tables

This Appendix discusses how to install and use the SPATIAL_REF_SYS and GEOMETRY_COLUMNS meta tables, which satisfy the OGC standard, and additionally outlines the limitations related to their use.

Geometry Reference Tables

The geometry reference tables are used to manage Spatial Reference IDs (SRIDs) and the Spatial Reference System (SRS).

Limitation

- The GEOMETRY_COLUMNS and SYSTEM_.SYS_GEOMETRIES tables are generic meta tables and are used only for reference.

GEOMETRY_COLUMNS

The GEOMETRY_COLUMNS meta table is used to define and manage SRIDs (Spatial Reference IDs) for GEOMETRY type columns.

This table is a synonym of the SYSTEM_.SYS_GEOMETRY_COLUMNS_ meta table.

Column name	Type	Description
F_TABLE_SCHEMA	VARCHAR(128)	This is the name of the owner of the table.
F_TABLE_NAME	VARCHAR(128)	This is the name of the table.
F_GEOMETRY_COLUMN	VARCHAR(128)	This is the name of the GEOMETRY type column.
COORD_DIMENSION	INTERGER	This is the number of dimensions of the GEOMETRY type object stored in the GEOMETRY type column.
SRID	INTERGER	This is the Spatial Reference Identifier.

SPATIAL_REF_SYS

The SPATIAL_REF_SYS meta table is used to manage information about Spatial Reference Identifiers (SRIDs) and the corresponding Spatial Reference System (SRS).

This table is a synonym of the SYSTEM_.USER_SRS meta table.

To read Spatial Reference System meta data into SPATIAL_REF_SYS table, the ADD_SPATIAL_REF_SYS and DELETE_SPATIAL_REF_SYS procedures must be used.

Column name	Type	Description
SRID	INTEGER	This is an internally used Spatial Reference Identifier.
AUTH_NAME	VARCHAR(256)	This is a standard name.

Column name	Type	Description
AUTH_SRID	INTERGER	This is a standard Spatial Reference Identifier.
SRTEXT	VARCHAR(2048)	This is a description of the Spatial Reference System in OGC-WKT form.
PROJ4TEXT	VARCHAR(2048)	This is information for use with PROJ4.

Related Stored Procedures

ADD_SPATIAL_REF_SYS

Syntax

```
SYS_SPATIAL.ADD_SPATIAL_REF_SYS( SRID in integer,
                                AUTH_NAME in varchar(256),
                                AUTH_SRID in integer,
                                SRTEXT in varchar(2048),
                                PROJ4TEXT in varchar(2048) );
```

Description

This registers Spatial Reference System meta data in the SPATIAL_REF_SYS_BASE table.

Parameters

Name	I/O	Data Type	Description
SRID	IN	INTEGER	This is an ID in the database of the Spatial Reference System.
AUTH_NAME	IN	VARCHAR(256)	This is the name of the standard used in the Spatial Reference System.
AUTH_SRID	IN	INTEGER	This is an ID of the Spatial Reference System as defined by the standard.
SRTEXT	IN	VARCHAR(2048)	This is Well-Known Text expression of Spatial Reference System.
PROJ4TEXT	IN	VARCHAR(2048)	This is information used for PROJ4.

Return Value

Because this is a stored procedure, no result is returned.

Exception

No exception

DELETE_SPATIAL_REF_SYS

Syntax

```
SYS_SPATIAL.DELETE_SPATIAL_REF_SYS( SRID in integer,  
                                     AUTH_NAME in varchar(256) );
```

Description

This procedure deletes the meta table of the geometry column registered in the GEOMETRY_COLUMNS_BASE table.

Parameters

Name	I / O	Data Type	Description
SRID	IN	INTEGER	This is an ID in the database of the Spatial Reference System.
AUTH_NAME	IN	VARCHAR(256)	This is a name of the standard used in the Spatial Reference System.

Return Type

Because this is a stored procedure, no result is returned.

Exceptiong

No exception