SPATIAL DATABASES, IMPLEMENTATIONS PLATFORMS FOR SPATIAL DATA

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Abstract

The use of spatial data has a very important role as an advanced technology for implementing GIS systems (Geographic Information Systems), the answer "where" is added to the systems. Spatial data describe the position, shape and orientation of objects in space. Spatial databases are databases that are optimized to store and search for data related to objects in space, including points, lines and polygons.

In this paper we present an overview of spatial databases; their functionalities to store features, display them, perform spatial processing and analysis through a rich set of spatial functions; analyze the advantages of storing data in a spatial database as: attributes and geometry of features are stored together, spatial indexing makes drawing faster at larger scales, spatial queries provide the ability to explore features and their relationships, better data management etc.

Spatial data analysis is a complex subject area, taking elements from a range of academic disciplines and this study will focus also in the spatial data modeling.

Many DBMS Database Management Systems can be used to store spatial data as spatial databases. There are differences in how data is stored and accessed in the supported DBMSs, which affect how you interact with the database and the spatial objects in it, so an important goal of this study is the identification and analyzing the implementations platforms for spatial data, spatial databases.

***Keywords*:** Spatial data, Spatial database, GIS, Spatial Database Management System (SDBMS)

1. Introduction

Spatial Data are in the core of the GIS systems (Geographic Information Systems) as they describe the position, shape and orientation of objects in space. Spatial databases are databases that are optimized to store and search for data related to objects in space, including points, lines and polygons.

In this paper we present an overview of the spatial data, spatial databases, their functionalities to store features, display them, perform spatial processing and analysis through a rich set of spatial functions; analyze the advantages of storing data in a spatial database. Also in this paper we present the DBMS Database Management Systems, evaluated and identified as important platforms for implementing spatial data in spatial databases.

2. GIS Systems

GIS is defined in different ways by different authors: A set of tools to collect, store and find where appropriate, transform and display the spatial data of the real-world (Burrough, 1986). An information technology that stores, analyzes and displays geographic data and not geographic data (Parker, 1988). A database system in which most of the data are spatially indexed, and upon which a set of procedures operated in order to answer queries about spatial entities in the database (Smith 1987). A system as a decision support system involving the integration of spatially referenced data in a problem solving environment (Cowen, 1988). Geographic information system (GIS) is a system for managing, analyzing, and presenting geographic information. GIS includes a set of tools for working with geographic data. GIS is a collection, combination of hardware, computer software and geographic data for capturing, managing, analyzing, and presenting all forms of geographic information. GIS Geographic information system, a system that uses spatial (i.e., geographically referenced) and non-spatial (i.e., attribute) data and includes operations that support spatial analysis. Alternative names: AM/FM (automated mapping and facilities management); geographically referenced information system; land information system; natural resources information system; spatial data management (or handling) system; spatial database.

3. Spatial Data and Spatial Databases

The Geographic Information System (GIS) is the principal technology motivating interest in Spatial Database Management Systems (SDBMS). GIS provides a convenient mechanism for the analysis and visualization of geographic data. Geographic data is spatial data where the underlying frame of reference is the Earth's surface. The GIS provides a rich set of analysis functions which allows a user to affect powerful transformations on geographic data.

Spatial data analysis is a complex field that takes elements from different academic disciplines: Geophysics, mathematics, astronomy and cartography.
Spatial data describes the position, shape, and orientation of objects in space. As in most common applications, we are particularly concerned with describing the position and shape of objects on the earth and this is known as geospatial data. Geospatial data can describe the properties of many different sorts of "objects" on the earth. These objects might be tangible, physical things, or abstract features.
Spatial data provides information that can be used in a wide range of different areas.

A spatial database allows us to store features, display them, or perform geoprocessing and analysis through a rich set of spatial functions. Some of the advantages of storing data in a spatial database are as follows:

- Attributes and geometry of features are stored together.
- Spatial indexing makes drawing faster at larger scales.
- Spatial queries provide the ability to explore features and their relationships.
- You get better data management.

The structure of a spatial database is nothing more than a regular database with support for geometry data types. It typically contains functions to manipulate the geometries and perform spatial queries.
In a spatial database, a table represents a layer, a row is a feature, and a spatial column contains the geometry of the feature.

A spatial reference system consists of a coordinate system (which describes a position using either projected or geographic coordinates), a datum (which describes a model representing the shape of the earth), the prime meridian (which defines the origin from which units are measured), and the unit of measurement. When using projected coordinates, the spatial reference system also defines the properties of the projection used.
A geographic coordinate system defines the position of objects using angular coordinates of latitude and longitude, which are measured from the equator and the prime meridian, respectively.
A projected coordinate system defines the position of objects using Cartesian coordinates, which measure the x and y distance of a point from an origin. These are also referred to as easting and northing coordinates.
Whenever you state a set of coordinates representing a point on the earth, it is essential that you also give details of the associated spatial reference system.

The spatial reference system defines the additional information that allows us to apply the coordinate reference to identify a point on the earth.
For convenience, spatial reference systems may be specified by a single integer identifier, known as a spatial reference identifier (SRID).

Objects on the earth often have complex, irregular shapes and it's difficult for any item of spatial data to define the exact shape of these features. The spatial data represents these objects by using simple, geometrical shapes that approximate their actual shape and position. These shapes are called geometries.
Three main types of geometry that can be used to introduce spatial information: points, lines and polygons.
Point is the most fundamental type of geometry, used to define a singular position in space. A point object is zero-dimensional it does not have length or area.
Lines are defined by one or more points in space which are connected with a straight segment between them. Lines are one dimensional object, have length but no area. They have the following additional characteristics: simple line - is the line that does not intersects itself; line closed - is the line that begins and ends at the same point; ring – is the line that is both simple and closed and represents the perimeter.
A Polygon is a type of surface; that is, a Polygon is a two-dimensional geometry that contains an area of space. The outer extent of the area of space contained within a Polygon is defined by a closed line, called the exterior ring. In contrast to a simple closed line geometry, which only defines those points lying on the ring itself, the polygon defined by a ring contains all of the points that lie either on the line itself, or contained in the area within the exterior ring.

Interiors, Exteriors, and Boundaries
Once you have defined an instance of any of the types of geometry listed in the previous section, you can then classify every point in space into one of three areas relative to that geometry: every location must lie either in the geometry's interior, in its exterior, or on its boundary:
• The interior of a geometry consists of all those points that lie in the space occupied by the geometry. In other words, it represents the "inside" of the geometry.
• The exterior consists of all those points that lie in the area of space not occupied by the geometry. It can therefore be thought of as representing the "outside" of the geometry.
• The boundary of a geometry consists of those points that lie on the "edge" of the geometry in question.
The distinction between these classifications of space becomes very important when considering the relationship between two or more geometries, because these relationships are defined by comparing where particular points lie with respect to the interior, exterior, or boundary of the two geometries in question.

4. Implementations Platforms for Spatial Data

A spatial database is nothing more than a regular database with support for geometry data types. The spatial databese contains functions to manipulate the geometries and perform spatial queries as in a spatial database, a table represents a layer, a row is a feature, and a spatial column contains the geometry of the feature.
We use a spatial database for the same reasons that we use a database for non spatial data:
Speed: Generally speaking, you'll get better performance out of data served from a database than you will from a shapefile. Databases are optimized for serving up large volumes of repetitive data, and spatial data fit this description perfectly.
Multiuser support: Spatial data tends to be reference data, and reference data is generally meant to be shared among many users. Storing the data in a database gives you the added benefits of remote access via a standard interface (JDBC, ODBC, PERL/DBI, and others). It also allows you to add security to the equation— making some data read-only for certain users and blocking others from seeing it altogether.
Querying: This is by far the biggest benefit. Just as traditional databases allow you to perform traditional queries, spatial databases allow performing spatial queries.

Many implementations platforms for spatial data are used, Spatial Database Management Systems (SDBMS) is in the core of the Geographic Information System (GIS).
Database management system providers as Oracle, IBM (DB2), SQL Server, MySQL, PostgreSQL have released spatially enabled relational database management systems (RDBMSs).
These important platforms as below we propose for implementing spatial data in spatial databases as we identified and evaluated.

In the Open Source Spatial Databases world there are currently two options for spatially enabled databases: PostgreSQLwith PostGIS and MySQL. Of the two, PostgreSQL/PostGIS is the most mature and feature rich. MySQL has added basic support for geometries. Although the MySQL implementation contains many of the OGC spatial functions.

Microsoft SQL Server supports spatial data first introduced to SQL Server 2008 and now supported with the release of the 2012.
Spatial data types are included as a core component of the SQL Server database. Spatial operations are integrated into the existing functionality of the SQL Server database engine allowing developers to continue working within a familiar development environment using existing tools. Existing SQL Server databases can be easily enriched by adding spatial data fields to their existing structure without need to migrate data into a new platform.

ArcGIS (ESRI) geodatabase is a collection of geographic datasets of various types held in a common file system folder, a Microsoft Access database, or a multiuser relational DBMS (such as Oracle, Microsoft SQL Server, PostgreSQL, Informix, or IBM DB2). The

geodatabase is a collection of geographic datasets of various types. The geodatabase contains three primary dataset types as feature classes, raster datasets, and tables.
Geodatabase design begins by identifying the data themes to be used, then specifying the contents and representations of each thematic layer.
This involves defining how the geographic features are to be represented for each theme (for example, as points, lines, polygons, or rasters) along with their tabular attributes; how the data will be organized into datasets, such as feature classes, attributes, raster datasets, and so forth; what additional spatial and database elements will be needed for integrity rules, for implementing rich GIS behavior (such as topologies, networks, and raster catalogs), and defining spatial and attribute relationships between datasets.

5. Conclusions

In this paper we presented the concepts and analysis for the spatial data which has a very important role as an advanced technology for implementing GIS systems (Geographic Information Systems). The spatial databases are in the core of the GIS managing the spatial data Spatial Database Management Systems (SDBMS).
Evaluations and analyses show that many platforms are used for the implementation of the spatial data as the following SDBMSs Oracle, IBM (DB2), SQL Server, MySQL, PostgreSQL, ArcGIS in which we identified the features for implementing the spatial data.
There are differences in how data are stored and accessed in the supported DBMSs, which affect how you interact with the database and the spatial objects in it.
SQL Server, Open Source PostgreSQL/PostGIS, ArcGIS we evaluated and identified as important platforms for implementing spatial data in spatial databases.

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