Geographic Information Systems (GIS) is a powerful tool used to collect, store, analyze and visualize geographic data. This week's topic, geographic data models and structures, is an important component that forms the basis of GIS. Modeling and structuring geographic data is essential for accurately representing, storing and processing data. In this section, we will focus on vector and raster data structures, database management systems (DBMS) and the concept of topology.

Vector Data Structures

Vector data structures are used to represent geographic objects in a precise and detailed manner. Vector data is basically classified into three main formats: point, line, and polygon.

Point Data

Point data is used to represent a specific location. Each point has a specific coordinate pair (x, y).

Examples: A city center, trees, wells.

Line Data

Line data are linear features created by connecting two or more points. Lines represent geographical objects such as roads, rivers, borders.

Each line consists of connections between points.

Examples: Roads, railways, rivers.

Polygon Data

Polygon data are polygons that represent enclosed areas. A polygon consists of lines where the start and end points meet.

Polygons represent geographical objects such as land use areas, water bodies, building areas.

Examples: Lakes, parks, building foundations.

Vector data is suitable for geographic analysis that requires high accuracy and detail. However, complex geometry and large data sets may require more resources in terms of processing and storage.

Raster Data Structures

Raster data structures are used to represent geographic data in a regular grid format. Raster data consists of small squares called cells or pixels. Each cell represents a specific area and contains the value of that area (e.g. elevation, temperature, vegetation).

pixel

Pixel is the basic unit of raster data. Each pixel represents a specific value.

Pixel size determines the resolution of raster data. Smaller pixels mean higher resolution and more detail.

cell

Cell is another term used in raster data and has the same meaning as pixel. The cells are arranged in a regular grid.

Each cell is placed according to a specific geographical coordinate system, and these coordinates determine the location of the cell.

Raster data is suitable for analysis of continuous data (e.g. temperature, altitude, humidity). It is also widely used in representing remote sensing data such as satellite images and aerial photographs.

Database Management Systems (DBMS) and GIS

Database management systems (DBMS) are software systems used to store, manage and access geographic data. In GIS, DBMS enables efficient management of large and complex data sets.

Database Types

Relational Databases: These are databases in which data is organized in tabular form and linked together by relationships. Examples: PostgreSQL, MySQL, Oracle.

NoSQL Databases: Databases with flexible data models and are suitable for big data and dynamic data structures. Examples: MongoDB, Cassandra.

GIS and DBMS Integration

GIS software works integrated with DBMS, allowing geographical data to be stored, questioned and analyzed.

Example: PostGIS is used for storing and processing geographic data as an extension of the PostgreSQL database.

Data Accuracy and Integrity

DBMS provides various mechanisms to ensure the accuracy and integrity of data. These mechanisms ensure that data is consistent, reliable and up-to-date.

Concept of Topology and Topological Relations

Topology is a mathematical concept that describes the spatial relationships of geographical objects. In GIS, topology provides information about how geographic objects are connected and interact with each other.

Topological Relations

Connection: The joining of two or more lines or polygons at a point.

Neighborhood: Two or more objects share a common boundary.

Enclosure: The complete enclosing of a polygon by another polygon or line.

Topological Rules

Topological rules are used to ensure the accuracy and consistency of geographic data. These rules ensure that data is structured in an orderly and logical manner.

Examples: Lines not intersecting, polygons not overlapping, points within a certain range.

Topological Data Models

In GIS, topological data models are used to store and manage the topological relationships of geographic objects. These models allow geographic data to be subjected to more complex analysis.

Examples: Coverage and Geodatabase data models used in ArcGIS.

Conclusion

This week, we focused on geographic data models and structures, one of the core components of GIS. Export vector and raster