18BGE66S - Fundamentals of GIS

Syllabus, UNIT – II: GIS data: Spatial and Non-Spatial - Sources– Data structure: Raster and Vector

There are two components to GIS data: spatial information (coordinate and projection information for spatial features) and attribute data. Attribute data is information appended in tabular format to spatial features. The spatial data is the where and attribute data can contain information about the what, where, and why. Attribute data provides characteristics about spatial data.
Raster and Vector data model and structures

Geographic Information System is a computer system for capturing, storing, quiering, analyzing and displaying the geographical data. The GIS can be grouped to computer system, GIS software, Brain ware and infracture. Since late 1960's computer have been used to store and process geographic data. The Geographically referenced data distinguished GIS from other information system. Geographically referenced data describe both the location and characteristics of spatial features on the earth surface. GIS therefore involves two geographic data component.

The GIS model can be split into two parts

1. A Model of spatial form and
2. A model of Spatial Process.

The model of spatial form represents the structure and distribution of features in geographical space.

In order to model spatial process, the interaction between these features must be abstraction. By applying this abstraction process the GIS designer moves from the position of observing the geographical complexities of the real world to one of the stimulating them in the computer. These processes involved into

a. Identifying the spatial features from the real world that are of interest in the context of an application and choosing how to represent them in the conceptual model.
b. Representing the conceptual model by an appropriate spatial model.
c. Selecting an appropriate spatial data model within the computer.

Spatial Definition

Spatial data describes the location and shape of geographic features, and their spatial relationship to the features. The information contained in the spatial database is held in the form of digital co-ordinates which describe the spatial features it mainly depends on the latitude and longitude of the feature.

Spatial Entity

Spatial data describe the spatial situation of objects concerning their form and their relative situation in space. Usually, the spatial relation of individual points, lines or areas is made via the integration in a coordinate system resulting in the relation to the real world and the metrics. Geometry data can be available as raster data (pixel) or vector data (polygons / areas, lines, sites)

Spatial Data can be encoded using following spatial entities. They are

The Spatial data can be represented through using

1. The Point
2. The Line
3. The Area
4. Network
5. The Surface

Spatial Data Model

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Computers require unambiguous instructions on how to turn data about spatial entities into graphical representations. This process is the second stage in designing and implanting a data model. At

present there are trwo main ways in which computers can be display spatial entities. There are two method of spatial data model. They are

1. Raster Data Model
2. Vector Data Model

The Raster Data Model:

The Raster data model is one of the important spatial data model described as tessellation. In the raster world individual cells are used as the building block for creating images of point, line, area, and network and surface entities.

- In the raster data model the basic building block is the individual grid cell, and the shape and character of an entity is created by the grouping of cells. The size of the grid cell is very important as it Raster is a method for the storage, Processing and display of spatial data.

- Each area is divided into rows and columns, which form a regular grid structure. Each cell must be rectangular in shape, but not necessarily square.
- Each cell within this matrix contains location co-ordinates as well as an attribute value. The origin of rows and column is at the upper left corner of the grid.
- Rows function as the "y"coordinate and column as"x"coordinate in a two dimensional system. A cell is defined by its location in terms of rows and columns.

Vector Data Model

A vector spatial data model uses two dimensional Cartesian [x, y] co-ordinates to store the shape of spatial entity. In the vector spatial data can be represented by using point. It is the basic building blocks from which all spatial entities are constructed. The simplest spatial entity, the point is represented by a single co-ordinate pair. Line and area entities are constructed by connecting a series of points into chains and polygons. The more complex the shape of a line or area feature the greater the number of points required representing it.

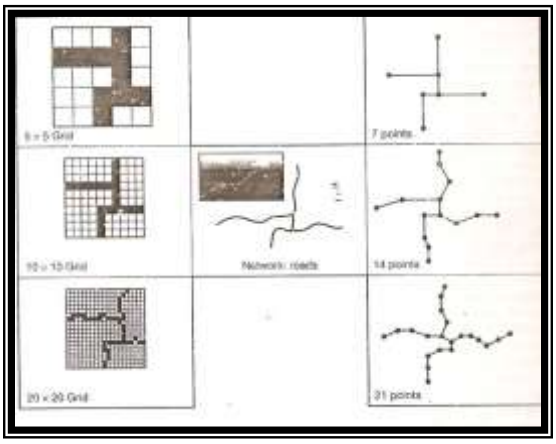
Spatial Data Structure

Data structures provide the information that the computer requires to reconstruct the spatial data model in digital form. There are many different data structure in use in GIS. Based on that the spatial data structures can be classified according to whether they are used to structure raster or vector data structure.

Raster Data Structures

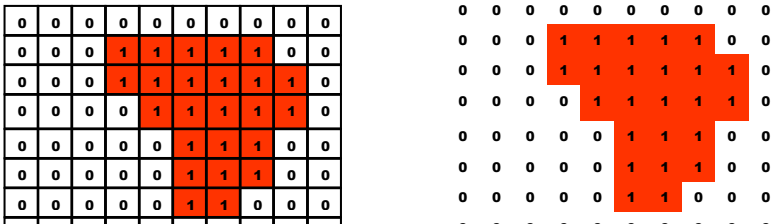
In the raster data model, each location is represented as a cell. The matrix of cells, organized into rows and columns, is called a grid.

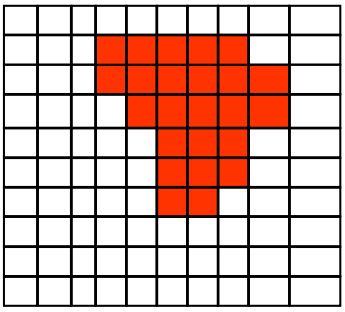
Each row contains a group of cells with values representing a geographic phenomenon. Cell values are numbers, which represent nominal data such as land- use classes, measures of light intensity or relative measures. The cells in each line of the image are mirrored by an equivalent row of numbers in the file structure.



Effects of chaining resolution in the vector and raster data model

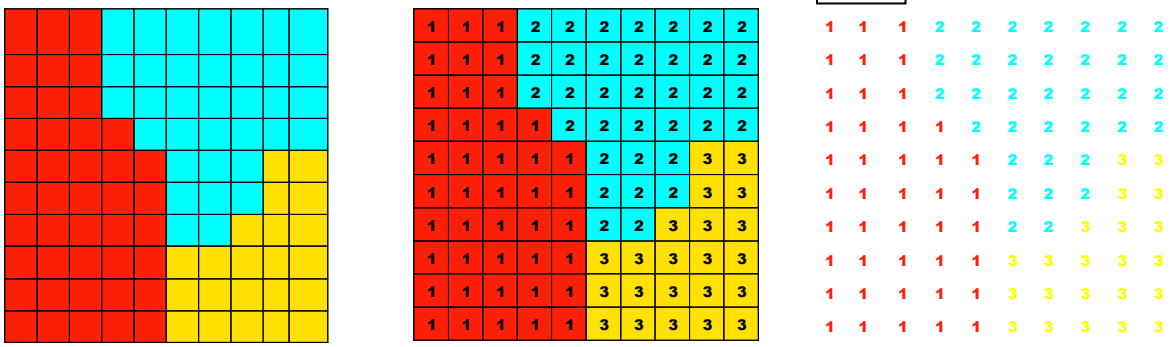
In a simple raster data structure, such as different spatial features must be stored as a separate data layers. However, if the entities do not occupy the same geographical location then it is possible to store them all in a single layer, with an entity code given to each cell.





Entitv Model Cell Value File Structure

This figure shows the different land use can be coded in a raster layer. The values 1, 2 and 3 have been used to classify the raster cells according to the land use present at a given location. The values 1 represents residential area; 2 forest; and 3; farm land.



Entitv Model Cell Value File Structure

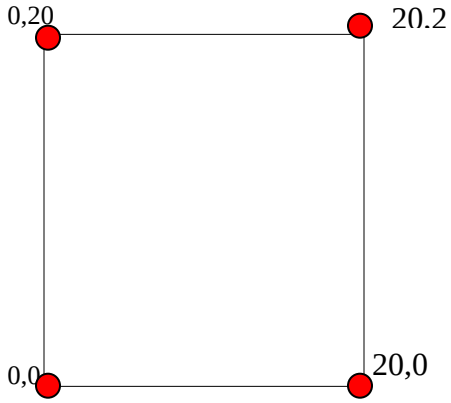
One of the major problems with raster data sets their size, because a value must be recorded and stored for each cell in an image. Thus a complex image made up of a mosaic of different features requires the same amount of storage space as a similar raster map showing the location of a single forest. To solve the problem in raster data model the compression or compaction methods are used for the real world representation.

Vector Data Structure

The simplest vector data structure that can be used to produce a graphical image in the computer is a file containing (x,y) coordinate pairs that represent the location of individual point features.

The limitation of simple vector data structures start to emerge when more complex spatial entities are considered.

In the vector data all points in the data structure must be numbered sequentially and contain an explicit reference which record which points are associated with which polygon. This is known as Point Dictionary- Borrough 1986.



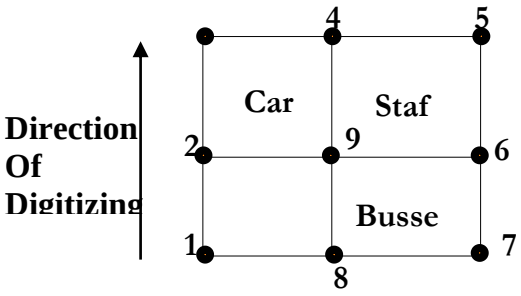
Spaghetti File	
X	**Y**
0	**0**
0	**20**
20	**0**
0	**0**
20	**20**

The vector data structure mainly ensure the following points. They are

- No node or line segment is duplicated;
- Line segment and nodes can be referenced to more than one polygon;
- All polygon have the unique identifiers
- Polygon can be adequately represented.

The following diagram shows the vector data structure

Point Dictionary Of Vector Data Structure



Polygon	
I	Point
Cars Staff Busse	1,2,3,4,8 ,9 4,5,6,9

Point		
ID	X	
1 2 3 4 . . 9	0 0 0 1 0 . . 1 0	0 1 0 1 0 2 0 . .

- In vector structure topology is concerned with connectivity between entities and not their physical shape.
- Boundaries are identified through network of arcs, checking polygons for closure, and linking arcs into polygons.
- The area of polygon can calculated and unique identification numbers are attached.
- This identifier would allow non spatial information to be linked to a specific polygon.

Comparison of raster and vector data models

The vector data model defines boundaries. There are no boundaries defined in the raster data model.

- The vector model represents location as x,y coordinates in a Cartesian coordinate system. The raster model represents location as cells, also in a Cartesian coordinate system. Rater data store rows and columns of cell values.
- The vector model represents features with well-defined boundaries; the raster model represents a more generalized view. The raster model can also represent gradual transition between features and surfaces, such as soil classification and elevation.
- The primary focus of the vector data model is the geographic feature; the primary focus of the raster data model is location.

- The vector model represents feature shape accurately; the raster model represents rectangular areas and thus is more generalized and less accurate.
- The vector model is used for high-quality cartography and where accuracy and precision are important, such as for cadastral (property) applications. The raster data model is useful for image/picture storage and is well suited to many spatial modeling operations such as modeling surface storm runoff and forest fire spread.
- The overlay operation examines two datasets to determine what geographic features exist at the same location. Overlaying vectors is a complex operation; the nature of the raster data model allows simple and fast overlays.

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