LECTURE NOTES ON
REMOTE SENSING & GIS
IV B. Tech II semester (JNTU (A)-R13)

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CIVIL ENGINEERING

OBJECTIVES:

1. *To introduce the students to the basic concepts and principles of various components of remote sensing.*
2. *To provide an exposure to GIS and its practical applications in civil engineering*
3. *Analyze the energy interactions in the atmosphere and earth surface features*

OUTCOMES:

On completion of the course the students will have knowledge on

1. *Principles of Remote Sensing and GIS*
2. *Analysis of RS and GIS data and interpreting the data for modeling applications*

UNIT – IV

GIS SPATIAL ANALYSIS:

Computational Analysis Methods(CAM), Visual Analysis Methods (VAM), Data storage-vector data storage, attribute data storage, overview of the data manipulation and analysis. Integrated analysis of the spatial and attribute data.

TEXT BOOKS:

1 Remote Sensing and GIS by B.Bhatta, Oxford University Press,New Delhi.
2 Fundamentals of remote sensing by gorge Joseph , Universities press, Hyderabad

REFERENCES:

1. Advanced surveying : Total station GIS and remote sensing – Satheesh Gopi – Pearson publication.
2. Remote Sensing and its applications by LRA Narayana University Press 1999.
3. Basics of Remote sensing & GIS by S.Kumar, Laxmi Publications.
4. Remote sensing and GIS by M.Anji Reddy ,B.S.Pubiliications,New Delhi.
5. GIS by Kang – tsung chang, TMH Publications & Co.,

UNIT-4

GIS SPATIAL ANALYSIS:

Spatial analysis is a type of geographical analysis which seeks to explain patterns of human behavior and its spatial expression in terms of mathematics and geometry, that is, locational analysis. Examples include ***nearest neighbor analysis*** and ***Thiessen polygons***. Many of the models are grounded in micro-economics and predict the spatial patterns which should occur, in, for example, the growth of networks and urban systems, given a number of preconditions such as the ***isotropic plain***, ***movement minimization***, and profit maximization. It is based on the tenet that ***economic man*** is responsible for the development of the landscape, and is therefore subject to the usual criticisms of that concept, such as the lack of free will.

New methodologies of spatial analysis include ***geocomputation*** and spatial statistical theory.

Data Storage

There are two approaches of storing data:

1. File based
2. Database

File based approach

File-based system is a collection of application programs that perform services for the users with each program defining and managing its data.

A flat file is an ordinary file where records of the file do not contain any information to communicate the file structure or relationship among the records to the application which is using the file.

Types of File Structure

- Unordered files
- Ordered files
- Index files

Unordered files Also known as heap files, the unordered sequential files have the basic type of organization where records are placed in the file in the order in which they are inserted i.e. new records are inserted at the end of the file.

	Name	Roll-ID	Class	Address
Block1	Ajay Kumar			
	Biren Das			
	Dipak Raj			
Block2	Rina Sharma			
	Prabhat Vij			
	Nira Thakur			
Block3	Tashina Rai			
	Priya Kiran			
New record	Roshan Lal			

Ordered files

The records in such a file can be ordered based on the values of one of their fields known as ordering fields. If the ordering field is the field whose value are distinct for each individual entity of the file, then the field is known as ordering key. Reading the records in order of ordering key values becomes efficient as no sorting is required.

Ordering Field

	Name	Roll-ID	Class	Address
Block1	Ajay Kumar			
	Biren Das			
	Dipak Raj			
Block2	Rina Sharma			
	Prabhat Vij			
	Nira Thakur			
Block3	Tashina Rai			
	Priya Kiran			
	Roshan Lal			

Index Files:

Indexes are additional access structures which are used to speed up the retrieval of the records in response to a search condition. These provide alternative ways of accessing the records without affecting the physical placement of records.

ATTRIBUTE DATA STORAGE

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.

Types of Attribute Data

Attribute data can be store as one of five different field types in a table or database: character, integer, floating, date, and BLOB.

Character Data

The character property (or string) is for text based values such as the name of a street or descriptive values such as the condition of a street. Character attribute data is stored as a series of alphanumeric symbols.

Aside from descriptors, character fields can contain other attribute values such as categories and ranks. For example, a character field may contain the categories for a street: avenue, boulevard, lane, or highway. A character field could also contain the rank, which is a relative ordering of features. For example, a ranking of the traffic load of the street with "1" being the street with the highest traffic.

Character data can be sorted in ascending (A to Z) and descending (Z to A) order. Since numbers are considered text in this field, those numbers will be sorted alphabetically which means that a number sequence of 1, 2, 9, 11, 13, 22 would be sorted in ascending order as 1, 11, 13, 2, 22, 9.

Because character data is not numeric, calculations (sum, average, median, etc.) can't be performed on this type of field, even if the value stored in the field are numbers (to do that, the field type would need to be converted to a numeric field). Character fields can be summarized to produced counts (e.g. the number of features that have been categorized as "avenue").

Numeric Data

Integer and floating are numerical values (see: the difference between floating and integer values). Within the integer type, the is a further division between short and long integer values. As would be expected, short integers store numeric values without fractional values for a shorter range than long integers. Floating point attribute values store numeric values with fractional values. Therefore, floating point values are for numeric values with decimal points (i.e numbers to the right of the decimal point as opposed to whole values).

Numeric values will be sorted in sequentially either in ascending (1 to 10) or descending (10 to 1) order.

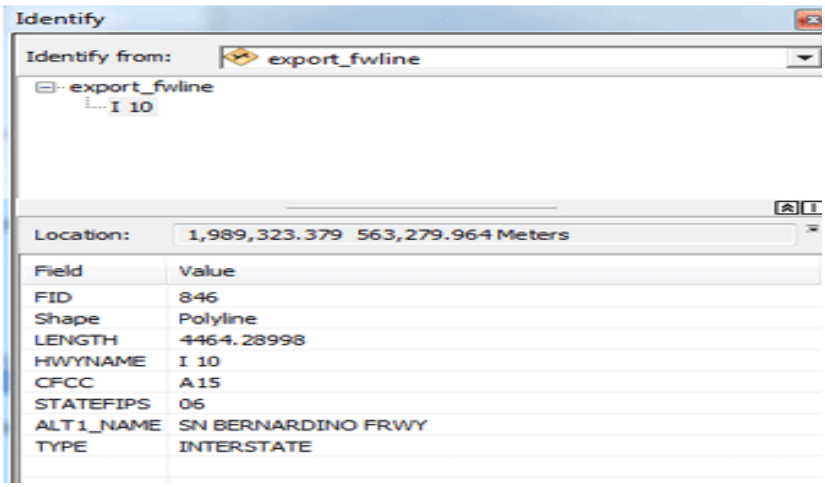
Numerical value fields can have operations performed such as calculating the sum or average value. Numerical field values can be a count (e.g. the total number of students at a school) or be a ratio (e.g. the percentage of students that are girls at a school).

Date/Time Data

Date fields contains date and time values.

BLOB Data

BLOB stands for binary large object and this attribute type is used for storing information such images, multimedia, or bits of code in a field. This field stores object linking and embedding (OLE) which are objects created in other applications such as images and multimedia and linked from the BLOB field



All **GIS software** has been designed to handle spatial data. Spatial data (also called geospatial data) is how geographic information is captured in a GIS.

Vector and raster data are the two primary data types used in GIS. Both vector and raster data have spatial referencing systems. These are latitudes and longitudes that pinpoint positions on Earth.

We know the two main spatial data models are vector and raster data. But what is the difference between raster and vector data? When should data be displayed as a raster or vector

Vector Spatial Data Types

Vector data is not made up of a grid of pixels. Instead, vector graphics are comprised of vertices and paths.The three basic symbol types for vector data are points, lines and polygons (areas). Since the dawn of time, maps have been using symbols to represent real-world features. In GIS terminology, real-world features are called spatial entities.

The cartographer decides how much data needs to be generalized in a map. This depends on scale and how much detail will be displayed in the map. The decision to choose vector points, lines or polygons is governed by the cartographer and scale of the map.

Points as XY Coordinates

Vector points are simply XY coordinates. When features are too small to be represented as polygons, points are used.

For example:

At a regional scale, city extents can be displayed as polygons because this amount of detail can be seen when zoomed in. But at a global scale, cities can be represented as points because the detail of city boundaries cannot be seen.

Vector data are stored as pairs of XY coordinates (latitude and longitude) represented as a point. Attribute information like street name or date of construction could accompany it in a spatial database or table describing its current use.

Lines as Connected Points

Vector lines connect vertices with paths. If you were to connect the dots in a particular order, you would end up with a vector line feature.Lines usually represent features that are linear in nature. Cartographers can use a different thickness of line to show size of the feature. For example, 500 meter wide river may be thicker than a 50 meter wide river.

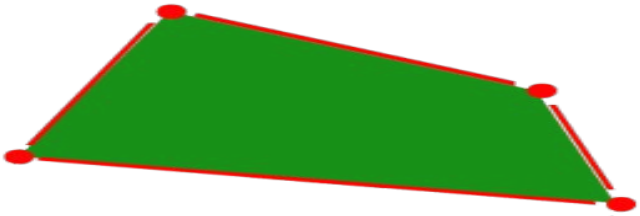
They can exist in the real-world such as roads or rivers. Or they can also be artificial divisions such as regional borders or administrative boundaries.

Points are simply pairs of XY coordinates (latitude and longitude). When you connect each point or vertex with a line in a particular order, they become a vector line feature.

Networks are line data sets but they are often considered to be different. This is because linear networks are topologically connected elements. They consist of junctions and turns with connectivity. If you were to find an optimal route using a traffic line network, it would follow one-way streets and turn restrictions to solve an analysis. Networks are just that smart.

Polygons As Closed Lines

- When a set of vertices are joined in a particular order and closed, they becomes a **vector polygon** feature. In order to create a polygon, the first and last coordinate pair are the same and all other pairs must be unique.
- Polygons represent features that have a two-dimensional area. Examples of polygons are buildings, agricultural fields and discrete administrative areas.
- Cartographers use polygons when the map scale is large enough to be represented as polygons.



Raster Spatial Data Types

Raster data is made up of pixels (also referred to as grid cells). They are usually regularly-spaced and square but they don't have to be. Rasters often look pixelated because each pixel is associated with a value or class.

For example:

Each pixel value in a digital photograph is associated with a red, green and blue value. Or each value in a digital elevation model represents a value of elevation. It could represent anything from thematic categories, heights or spectral value.

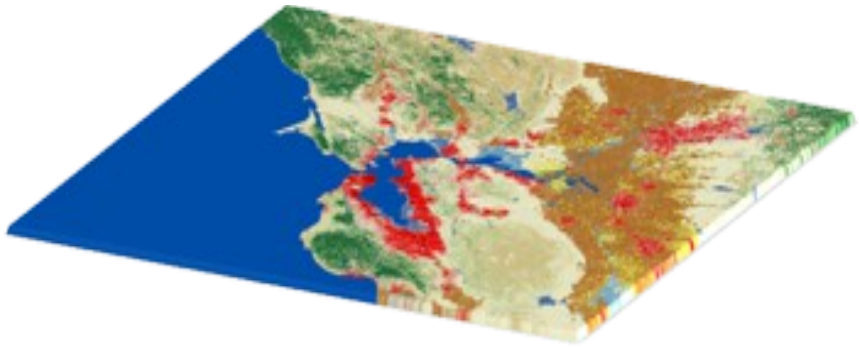
Raster models are useful for storing data that varies continuously, as in an aerial photograph, an elevation surface or a satellite image. But it depends on the cell size for spatial accuracy.

Raster data models can be discrete and continuous.

Discrete rasters

Discrete rasters are also referred to as thematic or categorical raster data. They have distinct themes or categories. For example, one grid cell represents a land cover class or a soil type.

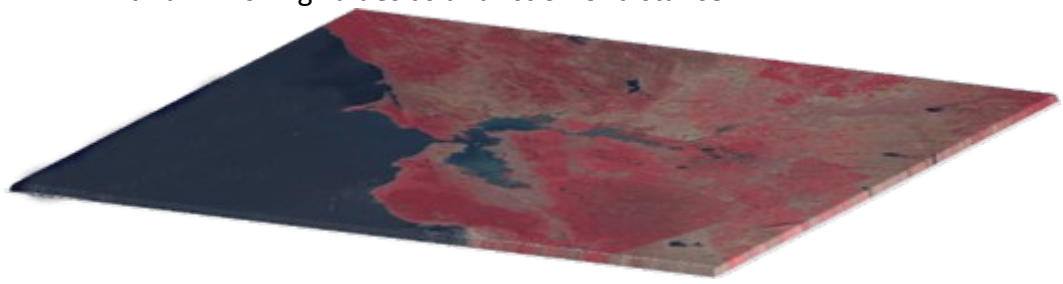
In a discrete raster land cover/use map, you can distinguish each thematic class. Each class can be discretely defined where it begins and ends. Each land cover cell is definable. The land cover class fills the entire area of the cell.Discrete data usually consists of integers to represent classes. For example, the value 1 might represent urban areas, the value 2 represents forest, etc. Political boundaries or ownership are other examples of discrete rasters



Continuous Rasters

Continuous rasters are grid cells with gradual changing data such as elevation, temperature or an aerial photograph. Continuous data is also known as non-discrete or surface data. A continuous raster surface can be derived from a fixed registration point. For example, a digital elevation model is measured from sea level. Each cell represents a value above or below sea level. An aspect cell value is derived from a fixed direction such as north, east, south or west.

Phenomena can gradually vary along a continuous raster from a specific source. For example, a raster depicting an oil spill can show how the fluid moves from high concentration to low concentration. At the source of the oil spill, concentration is higher. It diffuses outwards with diminishing values as a function of distance.



Vector Data Advantages and Disadvantages

Vector Advantages:

- Vector data is not made up of a grid of pixels.
- Instead, vector data is comprised of paths. This means that graphical output is generally more aesthetically-pleasing.
- It gives higher geographic accuracy because data isn't dependent on grid size.
- Topology rules can help data integrity with vector data models.
- Vector data structure is the model of choice for efficient network analysis and proximity operations.

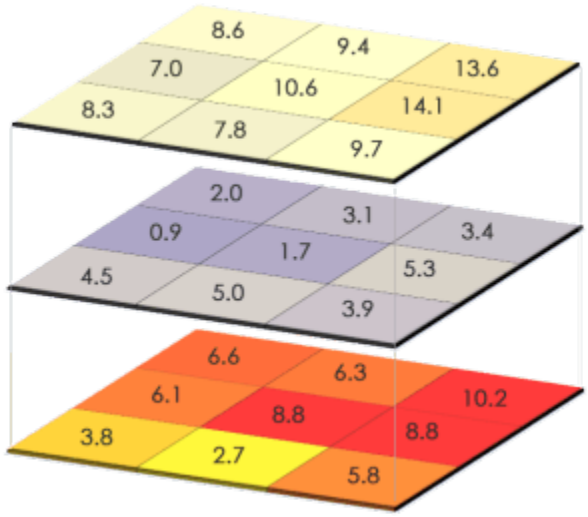
Vector Disadvantages:

- Continuous data is poorly stored and displayed as vectors. In order to display continuous data as a vector, it would require substantial generalization. Although topology is useful for vector data, it is often processing intensive.
- Any feature edits requires updates on topology. With a lot of features, vector manipulation algorithms are complex.

Raster Data Advantages and Disadvantages

Raster Advantages:

- Raster grid format is the natural output of choice of satellite data. Raster positions are simple. With cell size and a bottom-left coordinate, each cell position can be inferred.
- Data analysis with raster data is usually quick and easy to perform. With map algebra, quantitative analysis is intuitive equally with discrete or continuous rasters.



Raster Disadvantages:

- Graphic output and quality is based on cell size. It can have a pixelated look and feel. Linear features and paths are difficult to display and depends on spatial resolution.
- Networks are awkward with raster data. They are difficult to establish. Multiple fields with attribute data is difficulty and maps are often restricted to displaying a single attribute field.
- Raster datasets can become potentially very large because a value must be recorded and stored for each cell in an image. This means that a soil map with 20 classes requires the same amount of storage space as a map showing only one value such as a forest. Resolution increases as the size of the cell decreases. But this comes at a cost for speed of processing and data storage.