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Internal Assessment Test 3 – May. 2018

Sub:	Geographic Information system				Sub Code:	10CV844	Branch:	CIVIL
Date:	23-05-18	Duration:	90 min's	Max Marks: 50	Sem/Sec:	VIII		OBE

Attempt any 5 questions

		MARKS	CO	RBT
1.	Write short notes on (1) Digitizers (2) Scanners	[10]	CO4	L2
2.	What is Conceptual modeling? Explain some conceptual models of spatial data.	[10]	CO3	L2
3.	Explain some encoding and compression methods for raster data model with illustrations.	[10]	CO5	L2
4.	Explain about Database positioning system.	[10]	CO1	L3
5.	Write short notes on (1) Virtual GIS (2) Network analysis	[10]	CO2	L3
6.	What are Geo-relational models? Explain two examples.	[10]	CO1	L2

Solutions:

1. Digitizers / digitizing:

   - Digitizers convert analog or physical input into digital images. In addition to the tablet itself, digitizers have an input stylus that acts as a pen. Mode of input does vary---earlier models relied on simple pressure and electrical impulses, while more advanced designs offer better accuracy with lasers and even camera pens.
   - A digitizing table is a built-in electronic mesh, which can sense the position of a cursor. To transmit the x-,y- coordinates of a point to the connected computer, the operator simply clicks on a button on the cursor after lining up the cursor's coss hair with the point.
   - Digitizing line features can follow either point mode (operator selects points to digitize) or stream mode (lines are digitized at a preset time or distance interval).
   - As a polygon is a series of lines, digitizing polygon features is the same as digitizing line features.

   Scanners

   - Scanning is a digitizing method that converts an analog map into a scanned file, which is then converted to vector format through tracing.
   - Tracing (vectorization) involves line thinning, line extraction and topological reconstruction.
   - A scanner converts an analog map into a scanned image file in raster format. Pixel size depends on scanning resolution, often set at 300 dpi for digitizing. A digital image of the map is produced by moving an electronic detector across the map surface.
   - The movement of either the scanner or the map builds up a digital two-dimensional image of the map. The map to be scanned can be mounted either on a flat bed, or on a rotating drum.
   - The scanners incorporate a source of illumination on a movable arm (usually light emitting diodes or a stabilised fluorescent lamp) and a digital camera with high-

resolution lamp. The camera is usually equipped with special sensors called Charged Coupled Devices (CCDs) arranged in an array. These are semi-conductor devices that translate the photons of light falling on their surface into counts of electrons, which are then recorded as a digital value.

- There are two types of scanners:
  1. Flatbed scanners (cheap and simple)
  2. Rotating drum scanners (high quality and large format scanners)
     Sensor moves along the axis of rotation

2. A conceptual model is a type of abstraction that uses logical concepts and hides the details of implementation and data storage. It uses logical concepts, which may be easier for most users to understand. It supports data input, manipulation and result presentation.Many GIS are organized as a collection of themes. Each theme represents the values of a unique attribute of the geographic space. A theme may independently partition, decompose, and fragment the continuous space for a particular value (or value range) of the attribute. The partitions and fragments of space within each theme are often stored within the database and can be treated as entities or objects. The GIS data models can be categorized into field based models and object-based models. Field-based models see the world as a continuous surface (layer) over which features (e.g., elevation) vary. Layer algebra provides a field-based view. It defines a set of operations that can manipulate different layers to produce new layers. The object-based model treats the world as a surface littered with recognizable objects (e.g., cities, mountains, rivers), which exist independent of their locations. GraphDB, GODOT, Worboy, OGIS and GeoOOA are some attempts to model GIS using the object-based approach. A vector data structure is a computer implementation of an object-based ontology, while a raster data structure is an field-based implementation. Conceptual models of spatial information (examples):

   a. **EER model**: The extended entity–relationship model is a high-level or conceptual data model incorporating extensions to the original entity–relationship (ER) model, used in the design of databases. It was developed to reflect more precisely the properties and constraints that are found in more complex databases, such as geographic information systems (GIS). An entity relationship model, also called an ER diagram, is a graphical representation of entities and their relationships to each other, typically used in computing in regard to the organization of data within databases or information systems.

   b. **Graph DB**: Represents a framework of objects as classes that are partitioned into three kinds of classes: simple classes, link classes, and path classes. Objects of a simple class have an object type and an object identity and can have attributes whose values are either of a data type (e.g. integer, string) or of an object type (that is, an attribute may contain a reference to another object). They are nodes of the database graph – the whole database can also be viewed as a single graph. Objects of a link class additionally contain two distinguished references to source and target objects (belonging to simple classes), which makes them edges of the database graph. An object of a path class contains additionally a list of references to node and edge objects which form a path over the database graph.

3. Storage of raster data so that they can be used and processed by the computer.

3 common structures:

1. Cell-by-cell encoding:
   - Simplest
   - Raster stored as a matrix, cell values written into a file by row and column
   - Ideal if the cell values of a raster change continuously. Eg, DEM
   - Inefficient if raster contains many redundant values

2. Quad-tree:
    - Instead of working along one row at a time, quad tree uses **recursive decomposition** to divide a raster into a hierarchy of quadrants.
    - **recursive decomposition:** continuous sub-division until every quadrant in a quad tree contains only one cell value
    - Contains nodes and branches (sub-divisions)
    - Node: quadrant
    - Depending on the cell value, a node can be a leaf node or a non-leaf node (quadrant having diff. Cell values)
    - Non-leaf node is thus a branch point: quadrant is subject to subdivision
    - Leaf node is a quadrant having same cell values, thus is an end point.
    - After subdivision is complete, next step is to code the 2-D feature using quad-tree and spatial indexing method.
    - Regional quad tree is an efficient method for storing area data, especially if the data contains a few catagories.

    - Also a spatial index method

3. Run-length encoding:
    - Raster with many repetitive cell values can be more efficiently stored using RunLengthEncoding
    - Records cell values by row or by group (adjacent cells with same cell value)
    - For each row, starting cell and the end cell denote the length of the group ('run') that falls within the polygon
    - A method for encoding as well as compressing raster data (lossless)

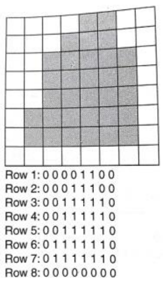
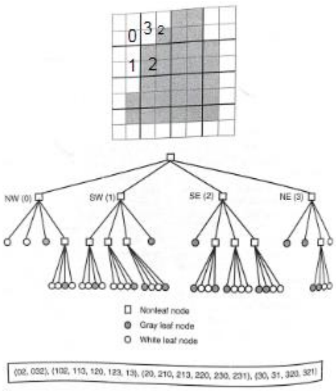


Figure 5.8
The cell-by-cell data structure records each cell value by row and column. The gray cells have the cell value of 1.



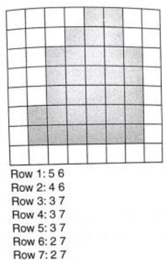


Figure 5.9
The run-length encoding method records the gray cells by row. Row 1 has two adjacent gray cells in columns 5 and 6. Row 1 is therefore encoded with one run, beginning in column 5 and ending in column 6. The same method is used to record other rows.

4. A spatial database is a database that is optimized to store and query data that is related to objects in space, including points, lines and polygons. Storing spatial data in a standard database would require excessive amounts of space. Queries to retrieve and analyze spatial data from a standard database would be long and cumbersome leaving a lot of room for error. Spatial databases provide much more efficient storage, retrieval, and analysis of spatial data. While typical databases can understand various numeric and character types of data, additional functionality needs to be added for databases to process spatial data types. spatial databases can perform a wide variety of spatial operations like:

    a. **Spatial Measurements**: Finds the distance between points, polygon area, etc.

    b. **Spatial Features**: Modify existing features to create new ones, for example by providing a buffer around them, intersecting features, etc.

c. **Spatial Predicates**: Allows true/false queries such as 'is there a residence located within a mile of the area we are planning to build the landfill?

d. **Constructor Functions**: Creates new features with an SQL query specifying the vertices (points of nodes) which can make up lines. If the first and last vertex of a line are identical the feature can also be of the type polygon (a closed line).

e. **Observer Functions**: Queries which return specific information about a feature such as the location of the center of a circle.

5. Virtual GIS: a system with truly immersive capability for navigating and understanding complex and dynamic terrain-based databases. It provides the means for visualizing terrain models consisting of elevation and imagery data, along with GIS raster layers, protruding features, buildings, vehicles, and other objects.
   - It is available in both window-based and virtual reality versions and in both cases provide a direct manipulation, visual interface for accessing the GIS data.
   - Virtual GIS can be used almost anywhere a traditional GIS can be used. e.g., urban planning, evaluation of vegetation, soil, waterway, or road patterns, flood planning, and many other tasks. In addition, it has the ability to have detailed 3D views and to jump to a different location to check the view.
   - Some other interesting and useful applications include that the emergency service providers could get immediate 3D views of the areas where they must respond and, with the addition of appropriate event information in the GIS database, could also see where there are obstructions along their routes due to construction or heavy traffic.
   - Defence battlefield strategy visualisations will be built on highly accurate terrain visualizations with up-to-the minute placements of military units and groups of personnel, display of current conditions for roads and bridges, visualization of weather effects or chemical clouds, display of military symbols and tactics, and much else.
   - Virtual GIS is implemented using the Simple Virtual Environment (SVE) toolkit , a device independent library which provides mechanisms and software tools for developing virtual environment applications.
   - SVE is based on the Silicon Graphics GL graphics library, and Virtual GIS has been run on a number of different hardware systems with GL support, including Hewlett Packard workstations.
   - Virtual GIS can be used either with a workstation window-based interface, or with an immersive virtual reality interface. In the immersive environment, users wear a headmounted display (HMD) and hold a three dimensional mouse controller, with six degree-of-freedom trackers attached to both the HMD and 3D mouse.
   - This, Virtual GIS is a highly integrated, efficient real-time 3D GIS for visualizing geographical data. The system features an immersive interface, significant visualization and GIS functionality, and provides sophisticated management of the large complex datasets typical of geographical data.

     Network analysis: The movement of people, the transportation and distribution of goods and services, the delivery of resources and energy, and the communication of information all occur through definable network systems.
     - A network is a system of interconnected linear features through which resources are transported or communication is achieved.
     - There are two types of networks:
       - Utility networks: including water mains, sewage lines, and electrical circuits. These networks are generally directed.
       - Transportation networks: including roads, railroads, and flight paths. These networks are generally undirected.
     - Some common network analysis problems are:

- finding the shortest path between two points: In a network of streets, the "shortest" route can either refer to different variables, such as: distance, time, and monetary cost (such as purchasing a plane ticket).
- Travelling salesman: reaching every point in a network in the most efficient way possible.
- Network partition:- dividing and sharing of regions in a network to zones or subcategories. These regions are sized based on proximity to specific points in a network. This is common for fire stations in metropolitan areas.
- Transportation modelling:-network flow equilibrium models, travel demand models, trip generation and distribution, as well as activity-based models and transportation/land-use interaction models.

- In order for you to perform a network analysis in a GIS program, there are following basic steps:
  - **Organizing the Network Analysis Settings**:- enabling the Network Analysis extension and displaying the Network Analysis toolbar before any analysis.
  - **Adding a Dataset to Your GIS Program**:- creating a dataset network in which you can perform an analysis.
  - **Creating the Network Analysis Layer**:-Layers contain an in-memory classes where inputs, properties, and results can be stored. In the case of performing network analysis, the layer has to be connected to a network dataset. This layer has to be created and added to the dataset before the analysis can be performed. E.g, route analysis layer, closest facility analysis layer, service area analysis layer, OD cost matrix analysis layer, vehicle routing problem analysis layer, location-allocation analysis layer.
  - **Imputing Network Analysis Features and Records**:-adding features, or objects, to our dataset input. Network analysis objects are features and records used as input and output during network analysis.These objects can include barriers, routes, facilities, or other man-made structures that will influence the end analysis. When these objects are added, setting the properties for the network analysis layer will further define the function of the input.
  - **Performing the Analysis**.

6. Geo-relational models: Stores spatial and attribute data separately in a split system: spatial data (geo) in graphic files, and attribute data (relational) in a relational database. This model uses the feature label or ID to link the two components, which must be synchronised so that they can be queried, analysed and displayed in unison.

   a. Coverage: a georelational data model that stores vector data—it contains both the spatial (location) and attribute (descriptive) data for geographic features. Coverages use a set of feature classes to represent geographic features. Each feature class stores a set of points, lines (arcs), polygons, or annotation (text). Coverages can have topology, which determines the relationships between features. Coverage is stored as a directory within which each feature class is stored as a set of files.

   b. A shapefile is a simple, non-topological format for storing the geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas). Although the shapefile treats a point as a pair of coordinates, a line as series of points and polygon as a series of lines, no files describe the spatial relationship between these geometric objects. (No topology!!) Shapefile polygons actually have duplicate arcs for the shared boundaries and can overlap each other.