6th SEMESTER (MAJOR)

PAPER 604: PRINCIPLES AND APPLICATION OF REMOTE SENSING, GIS AND GPS

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UNIT 2: GEOGRAPHICAL INFORMATION SYSTEM

SPATIAL DATA STRUCTURE

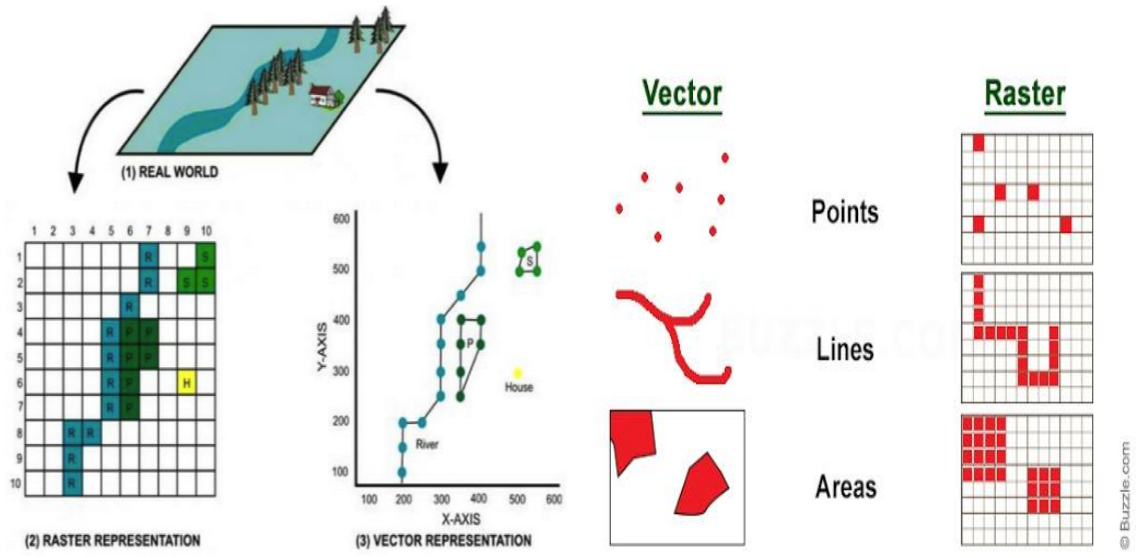
GIS depicts the real world through models involving geometry, attributes, relations, and data quality. Spatial data structures describe the rules that are used to represent geographic data in geographic information systems (GIS). Geographic data includes information about the location, size and shape of objects or phenomena on or near the surface of the earth, as well as their non-spatial characteristics. Geographic data in GIS is represented at several different levels of abstraction, each level depending on those beneath it:

- Conceptual spatial data models describe how geographic objects (for example, rivers) or phenomena are represented in GIS.
- Logical spatial data models describe how geographic data are represented in a database management system (for example, as database tables).
- Spatial data structures describe the methods and formats for physical storage and processing of geographic information in GIS.

Spatial data structures are the core of a GIS and fundamentally affect its performance and capabilities. Thus an understanding of spatial data structures is important in the study of geographic data management. Data structure is divided into two types:

Vector: Vector data structures represent geographic objects or phenomenon as distinct geometries with specific characteristics and may also include topology.

Raster: Raster data structures represent geographic objects or phenomenon as a grid over which a given characteristic varies continuously.



VECTOR DATA STRUCTURE: The basis of the vector model is the assumption that the real world can be divided into clearly defined elements where each element consists of an identifiable object with its own geometry of points, lines, or areas (polygons). In principle, every point on a map and every point in the terrain it represents is uniquely located using two or three numbers in a coordinate system, such as in the northing, easting, and elevation in Cartesian coordinate system.

Vector is a data structure, used to store spatial data. Vector data is comprised of lines or arcs, defined by beginning and end points, which meet at nodes. The locations of these nodes and the topological structure are usually stored explicitly. Features are defined by their boundaries only and curved lines are represented as a series of connecting arcs. Vector storage involves the storage of explicit topology, which raises overheads. A vector based GIS is defined by the vectorial representation of its geographic data. According with the characteristics of this data model, geographic objects are explicitly represented and, within the spatial characteristics, the thematic aspects are associated.

In the vector based model, geospatial data is represented in the form of co-ordinates. In vector data, the basic units of spatial information are points, lines (arcs) and polygons. Each of these units is composed simply as a series of one or more co-ordinate points, for example, a line is a collection of related points, and a polygon is a collection of related lines.

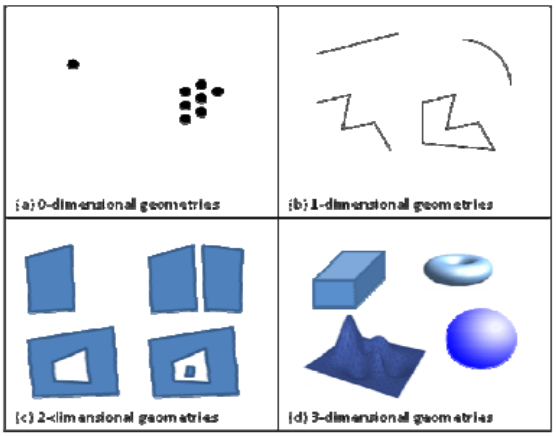
Co-ordinate: Pairs of numbers expressing horizontal distances along orthogonal axes, or triplets of numbers measuring horizontal and vertical distances, or n-numbers along n-axes expressing a precise location in n-dimensional space. Co-ordinates generally represent locations on the earth's surface relative to other locations.

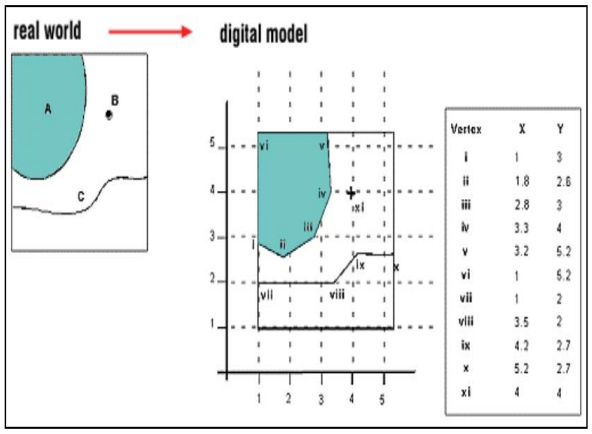
Point: A zero-dimensional abstraction of an object represented by a single X, Y co-ordinate. A point normally represents a geographic feature too small to be displayed as a line or area; for example, the location of a building location on a small-scale map, or the location of a service covers on a medium scale map.

Line: A one-dimensional geometry is a line, arc or string of line segments (sometimes called a polyline) connecting point geometries. It is a set of ordered co-ordinates that represent the shape of geographic features too narrow to be displayed as an area at the given scale (contours, street centrelines, or streams), or linear features with no area (county boundary lines). A line is synonymous with an arc (used synonymously with line).

Polygon: A two-dimensional geometry is a polygon, defined by a sequence of one-dimensional geometries with the same start and end point. Polygons may be simple or complex. Complex polygons may be aggregations of more than one polygon and may have holes, possibly with island geometries inside the holes. It is a feature used to represent areas. A polygon is defined by the lines that make up its boundary and a point inside its boundary for identification. Polygons have attributes that describe the geographic feature they represent.

A **three-dimensional geometry** is a solid, defined by a collection of two-dimensional geometries with a z coordinate (usually representing height relative to a reference point). The solid may also contain holes or be an aggregation of multiple solids.





RASTER DATA STRUCTURE: 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 spatial location of each cell is implicitly contained within the ordering of the matrix, unlike a vector structure which stores topology explicitly. Areas containing the same attribute value are recognised as such, however, raster structures cannot identify the boundaries of such areas as polygons.

Raster data is an abstraction of the real world where spatial data is expressed as a matrix of cells or pixels, with spatial position implicit in the ordering of the pixels. With the raster data model, spatial data is not continuous but divided into discrete units. This makes raster data particularly suitable for certain types of spatial operation, for example overlays or area calculations.

Raster structures may lead to increased storage in certain situations, since they store each cell in the matrix regardless of whether it is a feature or simply 'empty' space.

Grid size and resolution: A pixel is the contraction of the words picture element. It is commonly used in remote sensing to describe each unit in an image. In raster GIS the pixel equivalent is usually referred to as a cell element or grid cell. Pixel/cell refers to the smallest unit of information available in an image or raster map. This is the smallest element of a display device that can be independently assigned attributes such as colour.

raster representation

A	A	A	A	0	0	0	0
A	A	A	A	A	0	0	0
A	A	A	A	0	B	0	0
A	A	A	A	0	0	0	0
A	A	A	0	0	0	C	C
0	0	0	0	0	C	0	0
C	C	C	C	C	0	0	0
0	0	0	0	0	0	0	0

pixel	value
1	A
2	A
3	A
4	A
5	0
6	0
7	0
8	0
9	A
10	A
11	A
12	A
13	A
14	0
15	0
16	0
.	.
.	.
.	.
62	0
63	0
64	0