LECTURE – 02

DATA MODELS IN GIS

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- Data Models
- Vector Data Model
- Raster Data Model
- Web Resources for GIS Data

Data Models

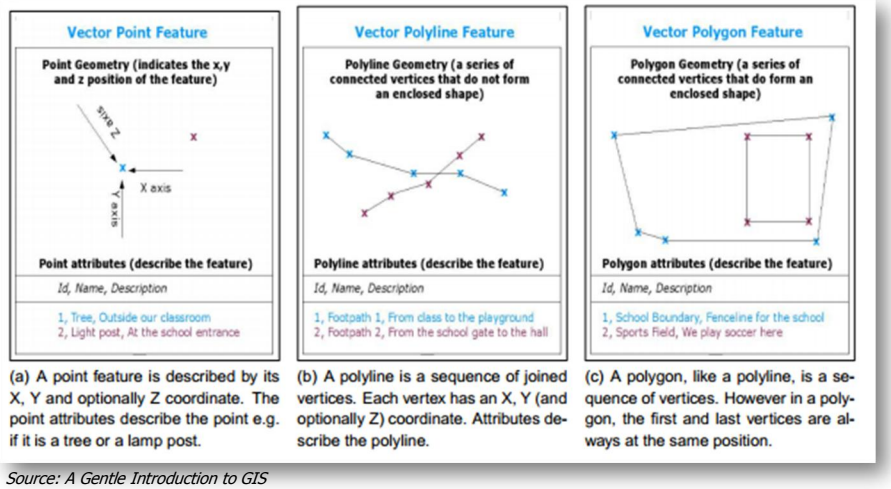
- **Data Model**
  - A data model is a method used to represent real world object in a computer.
  - Two most common data models in GIS are:
    1. Vector Data Model
    2. Raster Data Model

Vector Data Model

- **Vector Data Model**
  - Vector data is used to define objects with distinct boundaries, such as roads, parks, and land parcels.
  - In order to accurately represent these objects, a GIS provides different geometries to use depending on the object you are trying to represent.
  - The three geometries are:
    - Points
    - Polylines
    - Polygons

Vector Data Model

Vector Data Model



(a) A point feature is described by its X, Y and optionally Z coordinate. The point attributes describe the point e.g. if it is a tree or a lamp post.

(b) A polyline is a sequence of joined vertices. Each vertex has an X, Y (and optionally Z) coordinate. Attributes describe the polyline.

(c) A polygon, like a polyline, is a sequence of vertices. However in a polygon, the first and last vertices are always at the same position.

Source: A Gentle Introduction to GIS

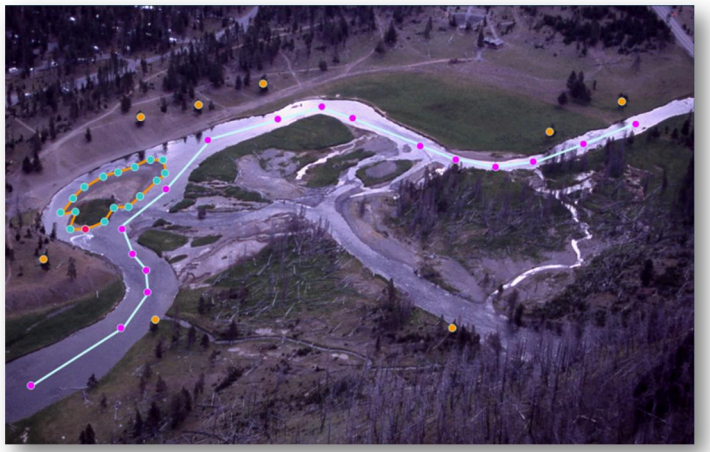
Vector Data Model

Real World Features

Source: Harvard Mapping Division

Vector Data Model

- Real World Features Represented by Vector Data Model



Source: Harvard Mapping Division

Vector Data Model

- **Point Feature**
  - Choice of Using Point Feature is usually depends upon:
    - Scale (how far away are you from the feature),
    - Convenience (it takes less time and effort to create point features than polygon features), and
    - the type of feature (some things like telephone poles just don't make sense to be stored as polygons)

Vector Data Model

- **Polyline Feature**
  - A polyline is used to show the geometry of linear features such as roads, rivers, contours, footpaths, flight paths, etc.
  - Sometimes we have special rules for polylines in addition to their basic geometry.
    - For example contour lines should never cross over each other.
    - Similarly, polylines used to store a road network should be connected at intersections.
    - In some GIS applications you can set these special rules for a feature type (e.g. roads) and the GIS will ensure that these polylines always comply to these rules.

Vector Data Model

- **Polygon Feature**
  - Polygon features are enclosed areas like dams, islands, country boundaries and so on.
  - Like polyline features, polygons are created from a series of vertices that are connected with a continuous line.
    - However because a polygon always describes an enclosed area, the first and last vertices should always be at the same place!
  - Polygons often have shared geometry - boundaries that are in common with a neighboring polygon. Many GIS applications have the capability to ensure that the boundaries of neighboring polygons exactly coincide.

Vector Data Model

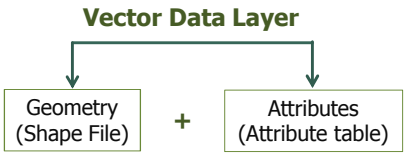
- **Attributes**
  - It describes the additional information or characteristics of vector data model.
    - For example a road polyline may have attributes that describe whether it is surfaced with gravel or tar, how many lanes it has, whether it is a one way street, and so on.
    - For a polygon, such as dam, the attributes may include depth and water quality, etc.

Vector Data Model

- **Vector Data in Layers**
  - Most GIS applications group vector features into layers. Features in a layer have the same geometry type (e.g. they will all be points) and the same kinds of attributes (e.g. information about what species a tree is for a trees layer).
  - For example if you have recorded the positions of all the footpaths in your school, they will usually be stored together on the computer hard disk and shown in the GIS as a single layer.
  - This is convenient because it allows you to hide or show all of the features for that layer in your GIS application with a single mouse click.

Vector Data Model

- **Vector Data in Layers**
  - Most Common Data Formats:
    - .shp (shape file)
    - .kml/.kmz (Keyhole Markup Language – Google Earth™ File Format)
    - .gpx (GPS Handset File Format)
  - In summary:

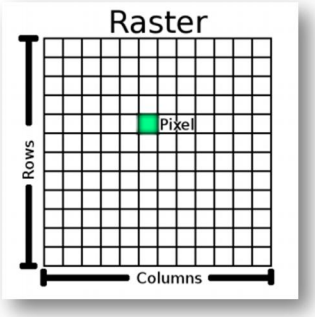


Vector Data Model

- **What Can We Do with Vector Data in GIS?**
  - Vector data can be used for spatial analysis in GIS.
  - For example:
    - which houses are within the 100 year flood level of a river?
    - where is the best place to put a hospital so that it is easily accessible to as many people as possible?
    - which learners live in a particular suburb?

Raster Data Model

- A raster dataset is composed of rows (running across) and columns (running down) of pixels (also know as cells).
- Each pixel represents a geographical region, and the value in that pixel represents some characteristic of that region.



Raster Data Model

- Raster data is used in a GIS application when we want to display information that is continuous across an area and cannot easily be divided into vector features.
- Not every object or phenomena has distinct boundaries.
- Precipitation, heat from a forest fire, and satellite imagery are all examples of features and phenomena with a continuous surface, without a defined outline.
- A GIS represents this information using a raster data model.

Raster Data Model

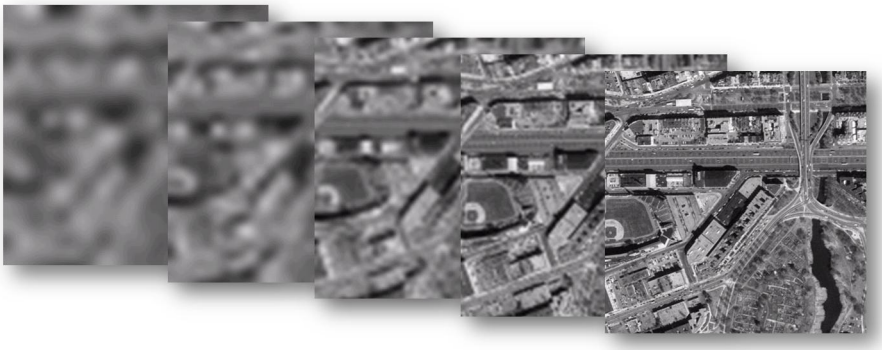
- Sources of Raster Data
  - Aerial Photography
  - Satellite Imagery

Raster Data Model

- Example of Raster Data Model

Raster Data Model

- Spatial Resolution
  - Every raster layer in a GIS has pixels (cells) of a fixed size that determine its spatial resolution.



Low Resolution (30m) → **High Resolution (0.5m)**

Raster Data Model

- Spatial Resolution
  - SPOT5 satellites: 10m x 10m
  - MODIS satellites: 500m x 500m
  - Aerial Photography: 60cm x 60cm
- In raster data that is computed by spatial analysis (such as the rainfall map), the spatial density of information used to create the raster will usually determine the spatial resolution.
  - For example if you want to create a high resolution average rainfall map, you would ideally need many weather stations in close proximity to each other.

Raster Data Model

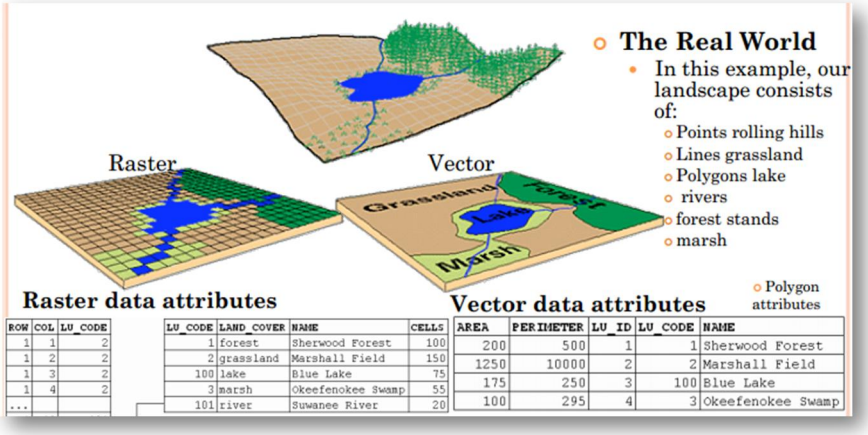
- Spectral Resolution
  - The number of bands (RGB) in a raster image is called spectral resolution.
  - Grayscale images have only one band type.
- Common Data Formats
  - .jpeg
  - .tif

Raster Data Model

- What Can We Do with Raster Data in GIS?
  - Raster data can be used to model water flow over the land surface.
  - This information can be used to calculate where watersheds and stream networks exist, based on the terrain.
  - Raster data is also very important for disaster management. Analysis of Digital Elevation Models (a kind of raster where each pixel contains the height above sea level) can then be used to identify areas that are likely to be flooded.
  - This can then be used to target rescue and relief efforts to areas where it is needed the most.

Raster Data Model

- Vector and Raster Data Representation



ROW	COL	LU_CODE
1	1	2
1	2	2
1	3	2
1	4	2
...		

LU_CODE	LAND_COVER	NAME	CELLS
1	forest	Sherwood Forest	100
2	grassland	Marshall Field	150
100	lake	Blue Lake	75
3	marsh	Okeefenokee Swamp	55
101	river	Suwanee River	20

AREA	PERIMETER	LU_ID	LU_CODE	NAME
200	500	1	1	Sherwood Forest
1250	10000	2	2	Marshall Field
175	250	3	100	Blue Lake
100	295	4	3	Okeefenokee Swamp

Web Resources for GIS Data

- Data for GIS operations can be obtained from:
  - **USGS** (www.usgs.gov)
    - DEMs, Topographic Maps, Hazards Maps, Earthquake Data, etc.
  - **OpenStreetMap** (www.openstreetmap.org)
    - Vector data
  - **Google Earth™**
    - Vector data, raster data

References

- ESRI
- QGIS Training Manual
- Harvard Mapping Division
- A Gentle Introduction to GIS