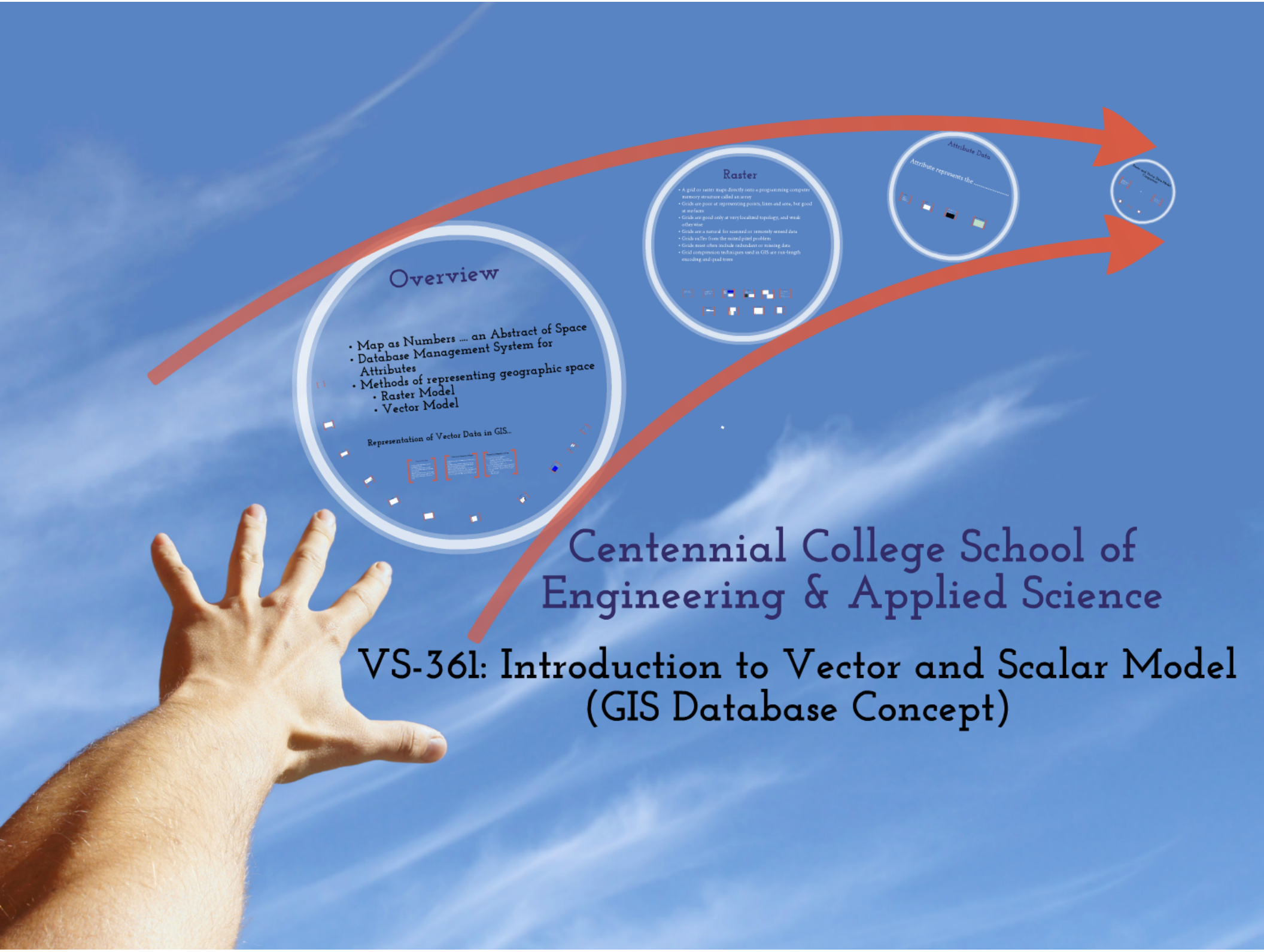


Centennial College School of Engineering & Applied Science

VS-361: Introduction to Vector and Scalar Model (GIS Database Concept)

Centennial College School of Engineering & Applied Science

VS-361: Introduction to Vector and Scalar Model (GIS Database Concept)

Overview

- Map as Numbers …. an Abstract of Space
- Database Management System for Attributes
- Methods of representing geographic space
  - Raster Model
  - Vector Model

Representation of Vector Data in GIS…

Maps as Numbers

- GIS requires that both data and maps be represented as number
- The GIS places data into the computer's memory in a physical data structure (i.e. files and directories)
- Files can be written in binary or as ASCII text
- Binary is faster to read and smaller, ASCII can be read humans and edited but uses more space

Maps as an Abstraction of Space

- Spatial features can be represented as point, lines, areas, or surfaces
- Some phenomena or objects are selected for inclusion, others are not spatial features and there attributes are simplified, aggregated, and classified
- When we want to enter this data into a GIS, certain decisions need to be made based upon how the data can be entered into a computer (geocoding Vs drawing)
- How do you get simple spatial concepts into the computer

Representing Geographic Features

- How do we describe geographical features?
  - by recognizing two types of data:
    - spatial data which describes location (where)
    - attribute data which specifies characteristics at that location (what and how much)
- How do we represent these digitally in a GIS?
  - by using relational Data Base Management Systems(DBMS)
  - by grouping into layers based on similar characteristics (e.g. hydrography, elevation, water lines, sewer lines, etc) and using either:
    - vector data model
    - raster data model

GIS are driven by spatial data.....

Two basic spatial(coordinate/geometric) data model exist

VECTOR: Based on geometry of

- Points
- Lines
- Polygons

RASTER : based on geometry of

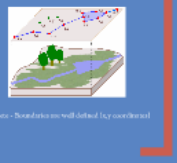
Grid cells (images, bitmaps, DEM)

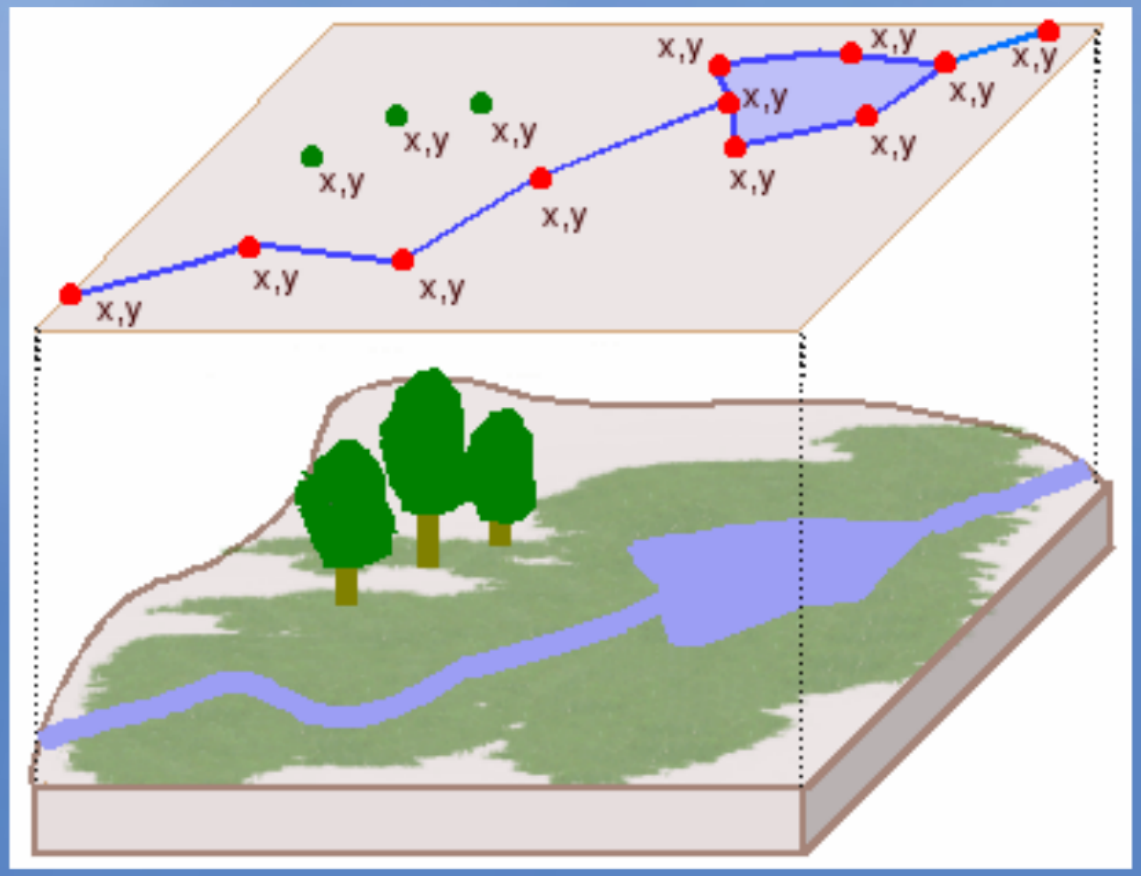
Vector data model

The vector data storage method uses shapes to represent features.

You have learned that there are three basic feature shapes.

Point Line Polygon





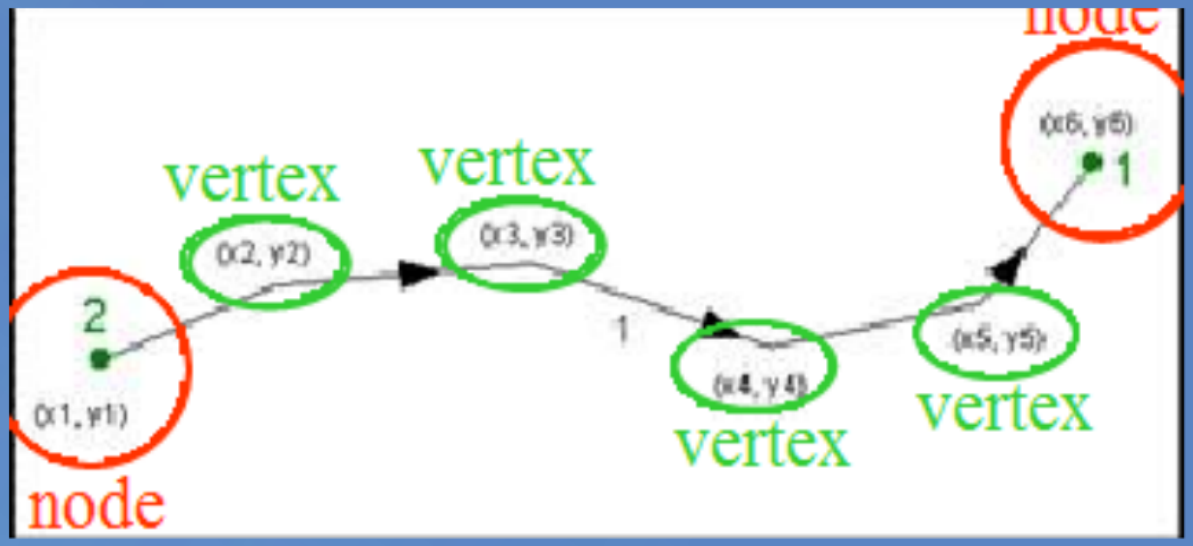
Discrete - Boundaries are well defined (x,y coordinates)

Point

A feature's shape is defined by its location coordinates.

One set of coordinates defines a point feature.

Line



Line stars and end at nodes –here Line #1 goes from node #2 to #1

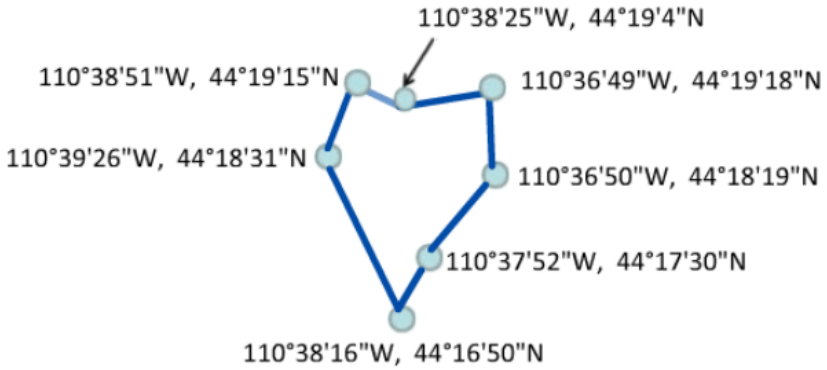
Vertices determines shape of line

Nodes and vertices are stored as coordinate pairs

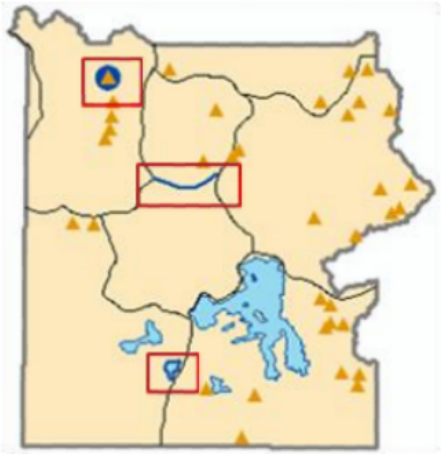
Polygon

Multiple sets of coordinates that are connected and closed define a polygon feature.

The beginning and ending coordinates for a polygon are the same.

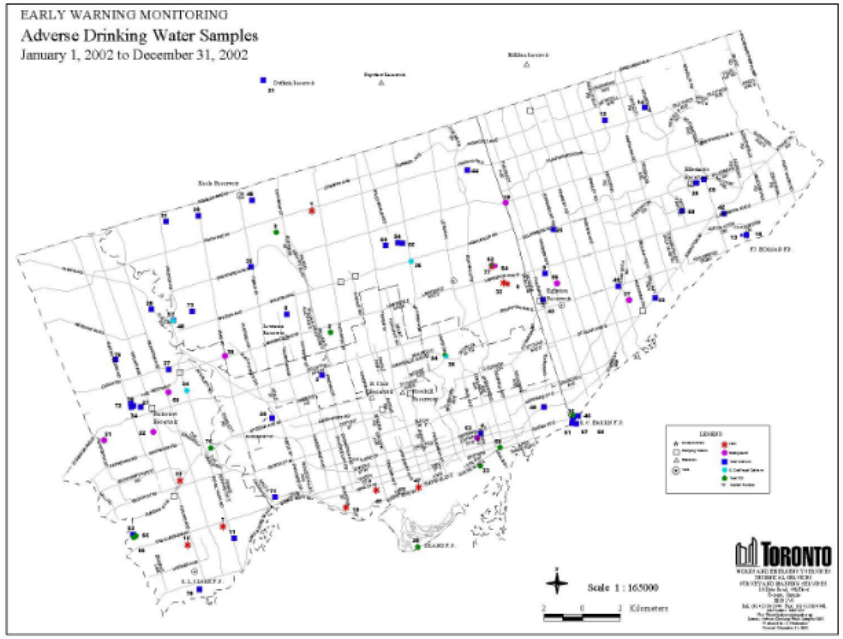


Vector data is very useful for representing features that have distinct boundaries, like mountain peaks, roads, and lakes.



POINT REPRESENTATION

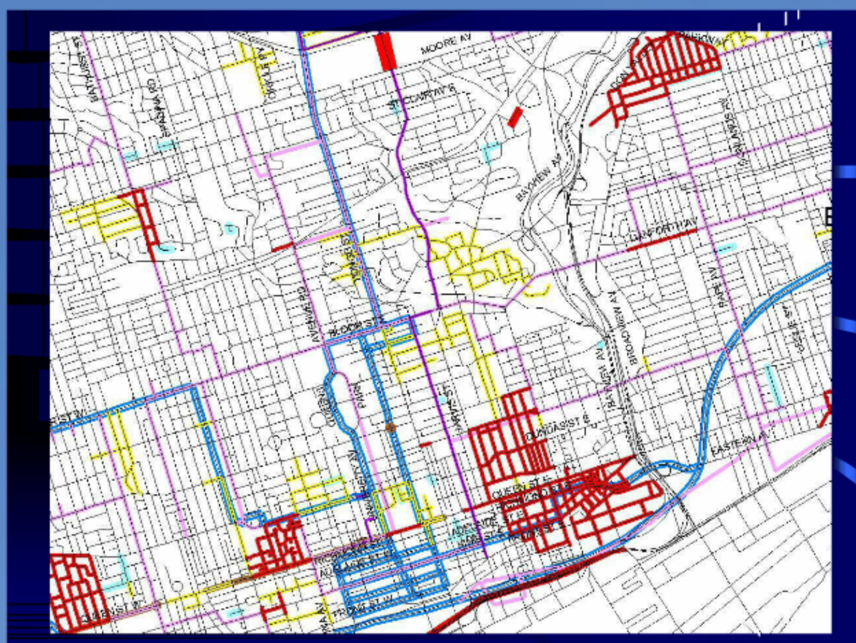
Vector Data .....



- Nature of the feature: the reality suggests a point (it is not linear in nature, does not occupy an area):
  - GPS Location
  - hydrant
  - rare plant location
  - seep location…
- Typically used for small scale representation.
- Relative positioning and density of features is important.
- Polygons can be represented as centroids - -a special kind of point.

LINE REPRESENTATION

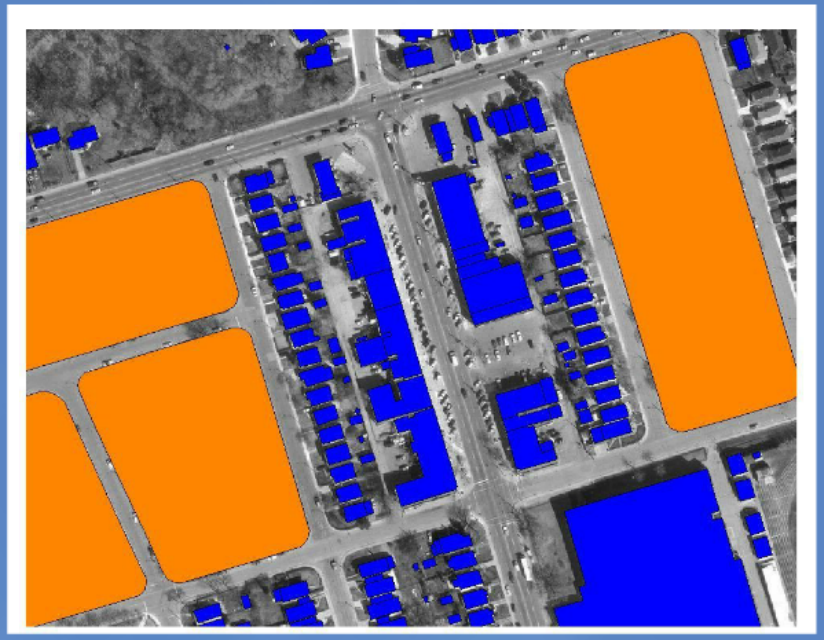
Vector Data ….



- Nature of the feature, the reality is the feature is linear:
  - Kinematic GPS Path
  - extent of rare plant community
  - seep drainage …
- Used at all scales, although may appear as a point at extreme small scales.
- Networks are typically represented as single lines with events associated with segments of the network, e.g. Capital Works Projects associated with street segments.
- Networks typically have traces performed to determine paths and routes.

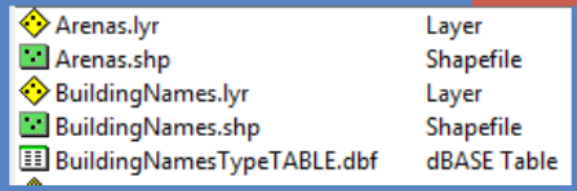
POLYGON REPRESENTATION

Vector Data ....



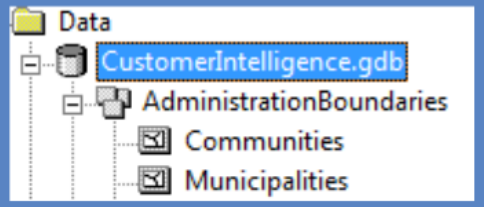
- Nature of the feature, it occupies an area.
  - GPS Location
  - rare plant community
  - area of seepage
- Typically used at mid to large scales (dependent on the size of the feature/polygon).
- Often the relative location of a second feature is important, e.g. hydrants (points) located in a road allowance (polygon).
- Polygons can be represented as centroids --a special kind of point.

ArcView shapefiles



- Preferred vector format in ArcView
- Display quickly
- Fully editable (coordinate and tabular) in ArcView
- Simple in structure
- Data sets are either point or line or polygon

ESRI Geodatabase



- Based on shapefile data model
- Multiple data sets stored ina relational database file
- Stored in MS Access database or higher-end database
- Separate points, line, and polygon data sets are stored within the same Geodatabase

ASCII coordinate data

Easy to obtain from a variety of sources

- GPS
- Traverse (survey)
- Direct reading from maps

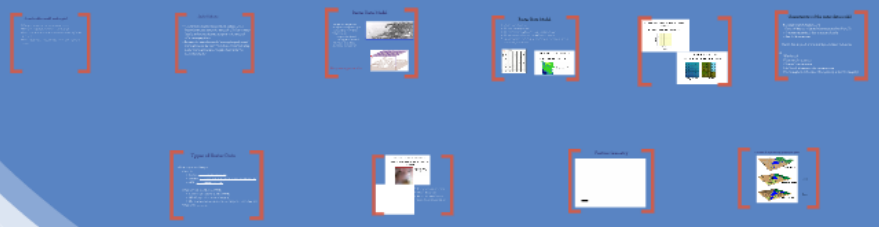
Characteristics of the vector data model:

+ Features are positioned accurately
+ Shape of features can be represented correctly
+ Features are represented discretely (no fuzzy boundaries)

- Not good for representing spatially continues phenomena ex: precipitation measurement, forest cover, animal home range
- Potential complex data structure (specially for polygons can lead to long processing time for analytical operations)

Raster

- A grid or raster maps directly onto a programming computer memory structure called an array
- Grids are poor at representing points, lines and area, but good at surfaces
- Grids are good only at very localized topology, and weak otherwise
- Grids are a natural for scanned or remotely sensed data
- Grids suffer from the mixed pixel problem
- Grids must often include redundant or missing data
- Grid compression techniques used in GIS are run-length encoding and quad trees



A raster data model used a grid

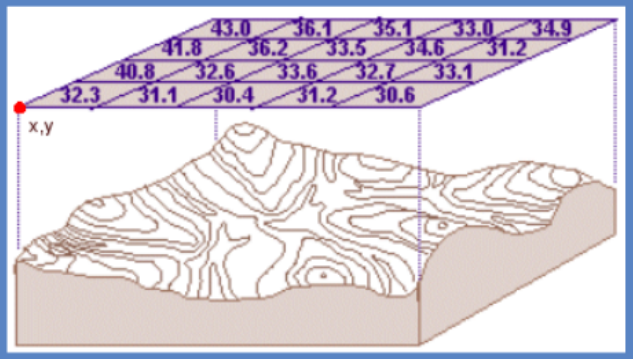
- One grid is one unit or holds one attribute
- Every cell has a value, even if it is "missing"
- A cell hold a number or an index value standing for an attribute
- A cell has a resolution, given as the cell size in ground units

Raster Features

- A point is represented as a value in a single cell, a linear feature as a series of connected cells that portray length, and an area feature as a group of connected cells portraying shape
- Because the raster data model is a regular grid, spatial relationships are implicit. Therefore, explicitly storing spatial relationships is not required as it is for the vector data model

Raster Data Model

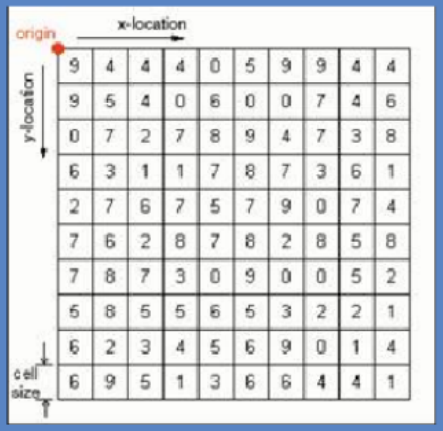
- The world is composed of cells/pixels arranged in a grid
- Each cell/pixel is assigned a numeric value
  - Integer – (no decimal)
  - Floating-point (decimal)
- The size of the cell/pixel determines the resolution



Every location given an object

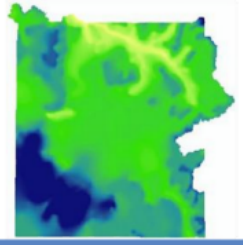
Raster Data Model

- Origin is set explicitly
- Cell size is always known
- Cell references (row/column locations) are known
- Cell values are referenced to row/column location
- Values represent numerical phenomena or index codes for non –numerical phenomena



Continuous data is everywhere—it can occur at every location on the earth.

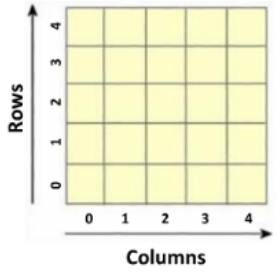
Examples are precipitation, ground cover, and terrain.



This raster dataset represents average annual precipitation in Yellowstone National Park. Different colors represent different precipitation values.

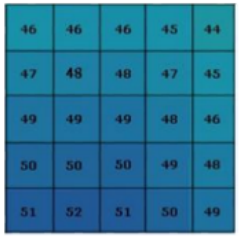
In a raster, the cells are arranged in rows and columns.

All cells in a raster are the same size.

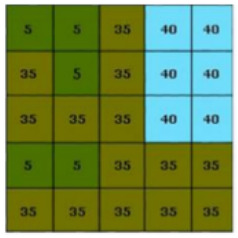


Each cell in a raster stores a value.

The value may be a measurement or a code.



Precipitation values (inches)



Ground cover types

5 = Lodgepole Pine
35 = Whitebark Pine
40 = Water

Characteristics of the raster data model

Rectangular grid of square cells

- Shape of discrete polygonal features generalized by cells

+ Continuous (surface) data represented easily

+ Simple data structure

Raster data are good at representing continues phenonena

eg..

- Wind speed
- Elevation, slope, aspect
- Chemical concentration
- Likelihood of existence of a certain species
- Electromagnetic reflectance (Photography or Satellite imagery)

Types of Raster Data

- Remotely Sensed Images
  - Satellite
    - Landsat (http://landsat.usgs.gov/)
    - AVHRR (http://edc.usgs.gov/products/satellite/avhrr.html)
    - SPOT (http://www.spot.com/)
  - Digital Elevation Models (DEMs)
    - U.S. Geologic Survey (USGS) DEMs
    - LIDAR (light detection and ranging)
    - Multibeam sonar (acoustics for capturing depth information)
  - Digital Orthophotos

A raster uses cells to store continuous data.

When you zoom in closely, you can see the cell structure.

After zooming in to a portion of the photo, the cells are visible.

- Grid of cells called pixels
- Two dimensional
- Each pixel has a discrete value, I.e. grey scale value

Feature Geometry

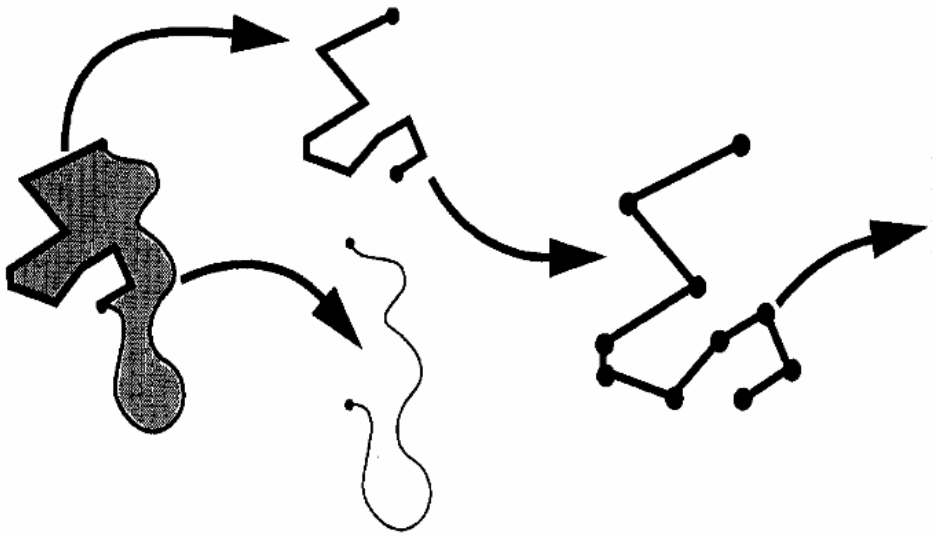
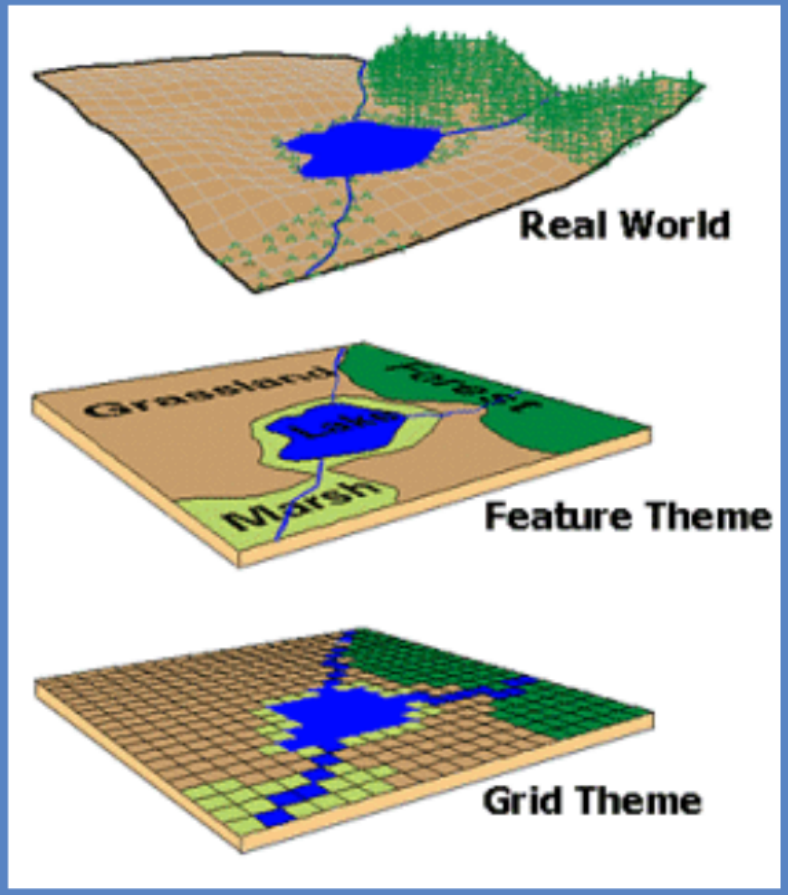


Figure 2.16 Geographic information has *dimension.* Areas are two-dimensional and consist of lines, which are one-dimensional and consist of points, which are zero- dimensional and consist of a coordinate pair.

Methods of representing geographic space

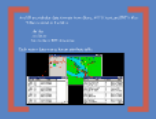


Vector

Raster

Attribute Data

Attribute represents the .....



GIS Database Concept....

www.colorado.edu/geography/gcraft/notes/datacon/datacon.html

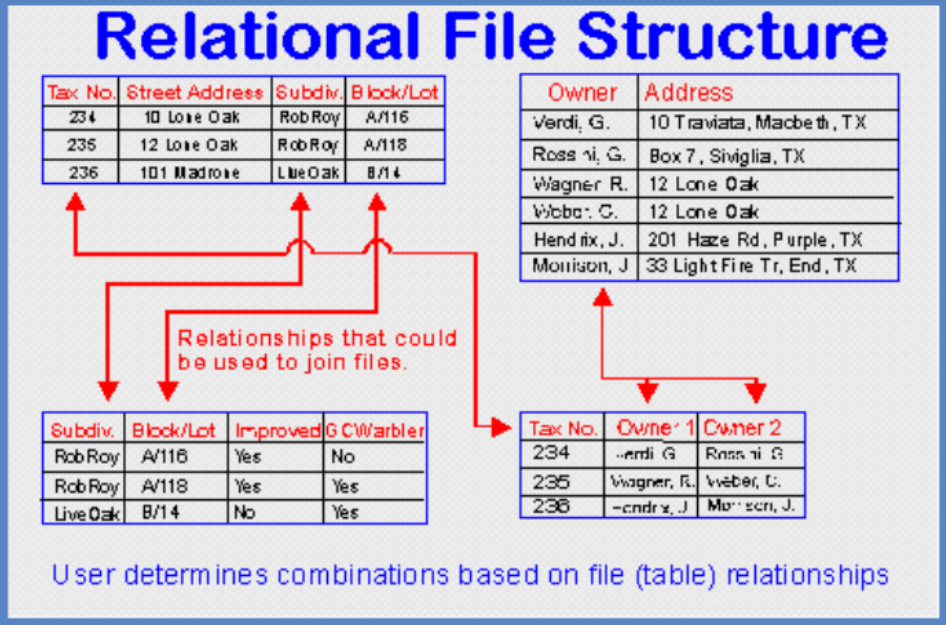
Read and make notes.....

3. Organizing Attribute Data
   a. Flat Files
   b. Hierarchical Files
   c. Relational files – Very Important

4. Representing Relationship
5. Topological Relationship – very Important

Relational files .....

- Connect different files or tables (relations) without using internal pointers or keys Instead a common link of data is used to join or associate records
- A "matrices of tables" is used to store the information
- The tables have a common link they may be combined by the user to form new inquires and data output

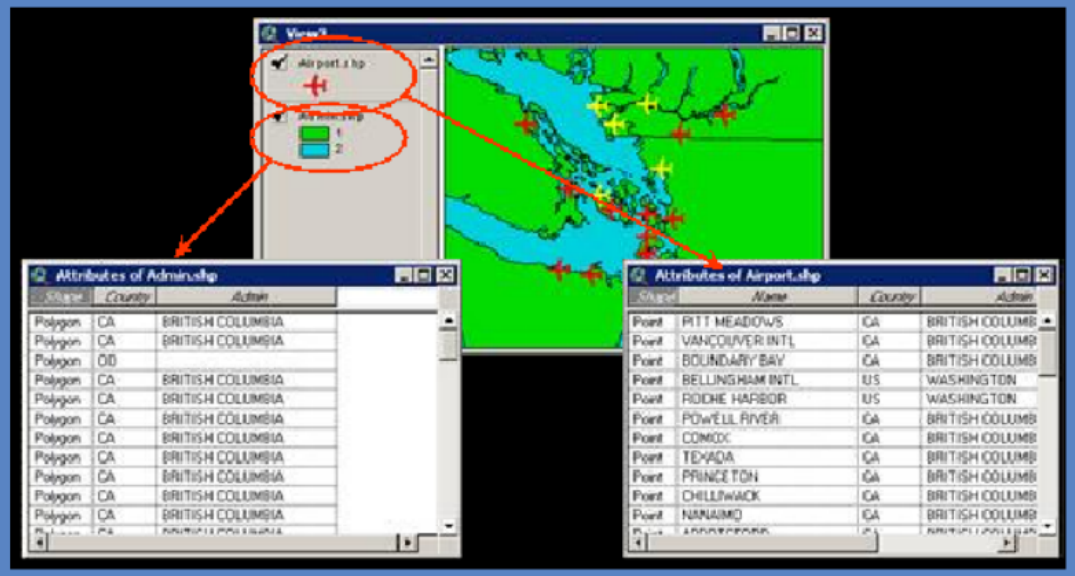


ArcGIS uses tabular data formats from dbase, ASC11 text, and INFO files

Tables are stored on the disk as

.dbf files
.txt files or
binary files in INFO directories

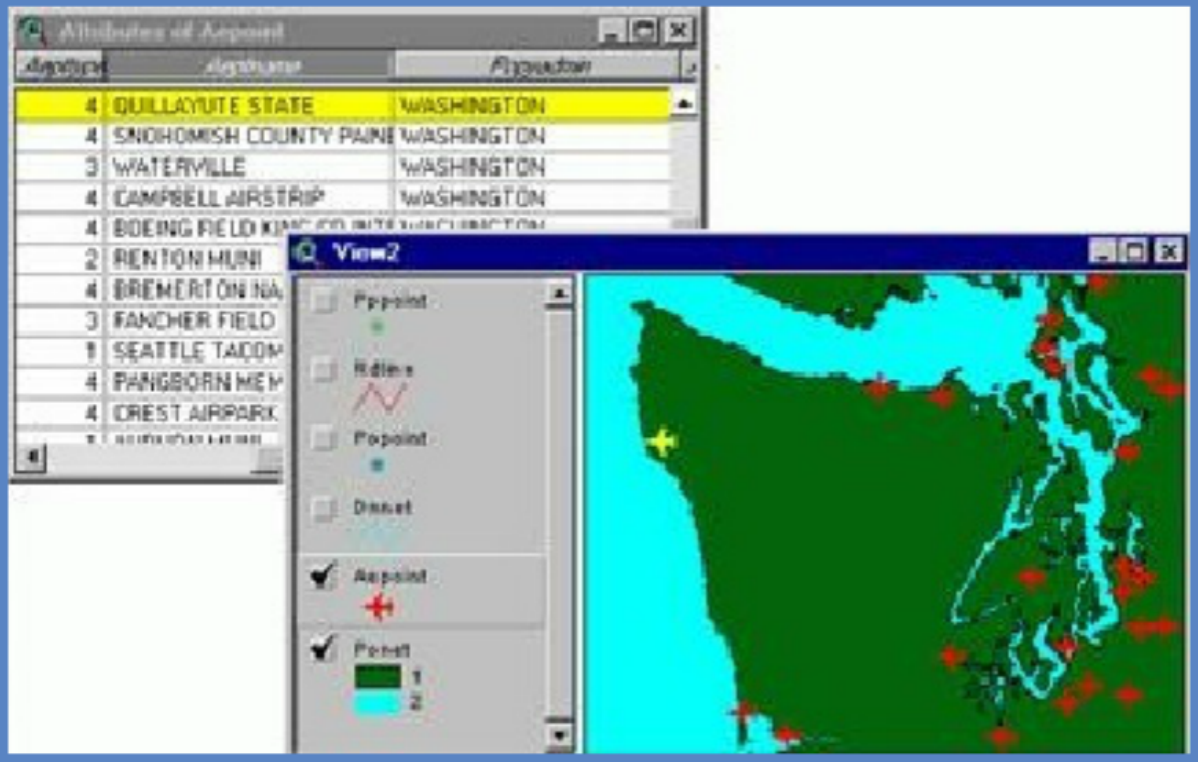
Each vector data source has an attribute table



Relationship between map and tabular data….

One to one between feature and records

When selection is made, both the record and the feature are selected



Raster and Vector Data Model Comparison

Raster Data Structures/Models

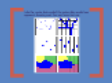
Advantages

- Simple data structure
- Location specific manipulation of attribute data is easy
- Many kinds of spatial analysis and filtering may be used
- Mathematical modeling is easy because all spatial entities have a simple, regular shape
- The technology is cheap
- Many forms of data are available

Raster Data Structures/Models

Disadvantages

- Large data volumes
- Using large grid cells to reduce data volumes reduce spatial resolution, loss of inbetweation & inability to recognize phenomenologically defined structures
- Crude raster maps are indigent though graphic elegance is becoming less of a problem
- Coordinate transformations are difficult & time consuming unless special algorithms & hardware are used and even then may result in loss of information or distortion of grid cell shape



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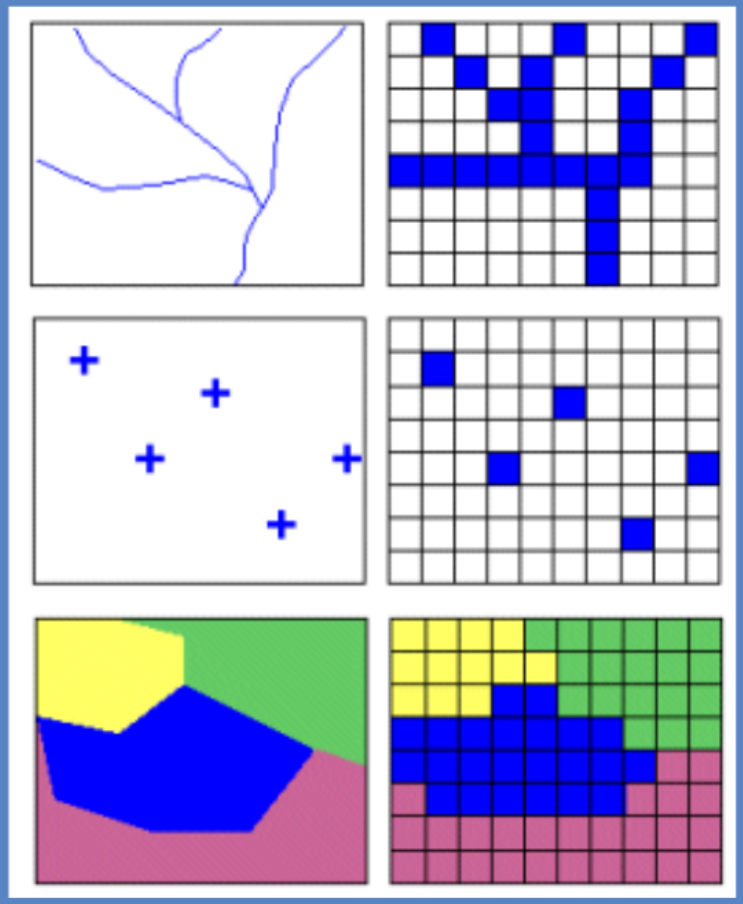
Vector Advantages

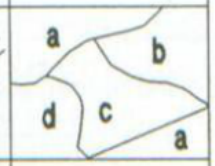
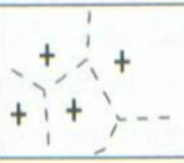
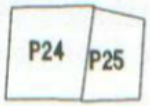
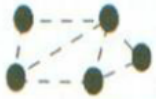
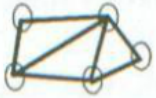
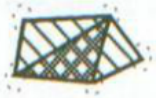
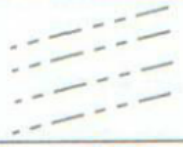
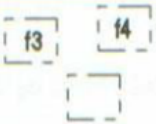
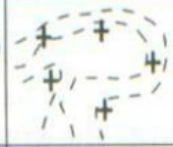
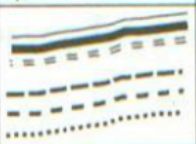
- Requires less disk storage space
- Topological relationships are readily maintained
- Graphical output more closely resembles hand-drawn maps
- Preferred for network analysis

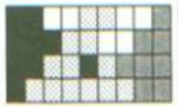
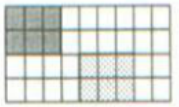
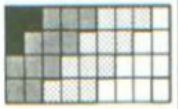
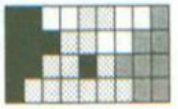
Vector Disadvantages

- More complex data structure
- Not as compatible with remotely sensed data
- Software and hardware are often more expensive
- Some spatial analysis procedures may be more difficult
- Overlaying multiple vetor maps is often consuming

Like the vector data model, the raster data model can represent discrete point, line and area features.



VECTOR	Points	Lines	Areas
Feature data			
Areal units			
Networks			
Sampling records			
Surface data			
Label/ text			
Symbols			
Relations	attributes and pointers	attributes and pointers	

RASTER	Points	Lines	Areas
Feature data			
Areal units		-	
Networks	-	-	-
Sampling records		-	
Surface data		-	
Label/ text	-	-	-
Symbols			
Relations	attributes and relations	attributes and relations	

Thank You