GEO 309 – Intro to GIS

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Topics

- Discussion – Wood and Krygier
- GIS Data Models
  - Tabular, vector, and raster data
  - Scale and resolution of data
  - Concept of layering data
  - Common file formats
- Demo

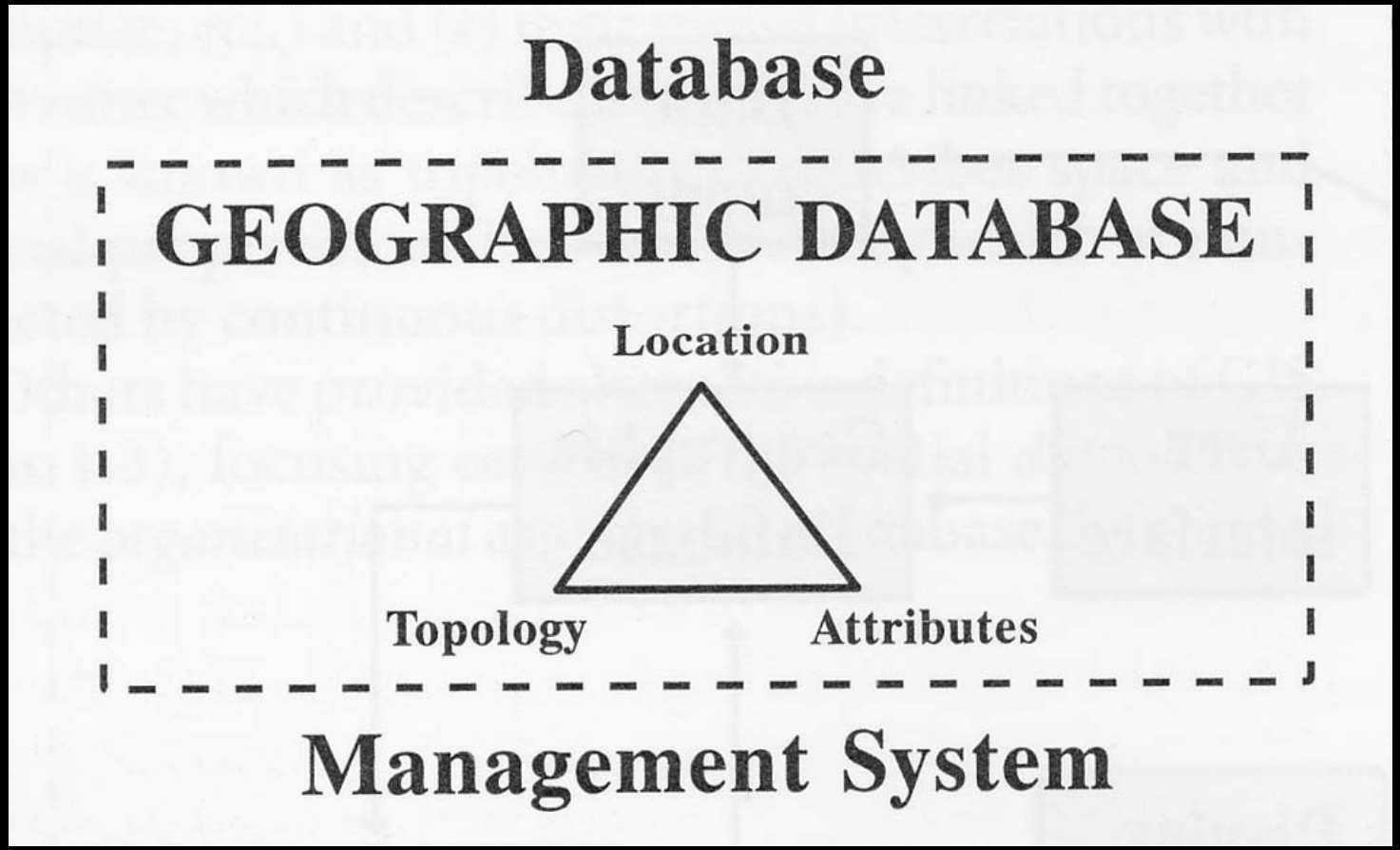
Discussion – Wood and Krygier

- Critical Cartography
  - Wood, D. and J. Krygier. 2009. Critical Cartography. In, International Encyclopaedia of Human Geography, pp. 340 – 344. Amsterdam, The Netherlands: Elsevier.

Tabular Data

- Spatial Indicator
  - Location information (e.g., lat, lon, z-axis)
  - Geometry information (WKT)
  - Unique ID (e.g., trigraph, digraph, Census ID)
- Attribute data
  - Quantitative
    - Area in Km, Income, Population Count, etc.
  - Qualitative
    - Name, Color, Emotions, etc.
- Topology
  - Relationship between points, lines, polygons

Tabular Data



Tabular Data

- US Census
  - Representation and Taxes
  - Decennial Census Data
    - 10 years (Population and Housing)
  - American Community Survey (ACS)
    - 1, 3, 5 year estimates (Population and Housing)
  - Economic Census Data
    - 5 years (American business and Economy)
  - TIGER Shapefiles
  - American FactFinder

Map Features

MAP FEATURES-- maps are abstractions of the landscape formed by the unique pattern of...

POINTS-- Dimensionless (e.g. wells)

LINES-- Length (e.g. streams)

AREAS-- L x Width (e.g. lakes)

(SURFACES-- Continuous, e.g. elevation)

VOLUMES-- L x W x Depth (e.g. lakes)

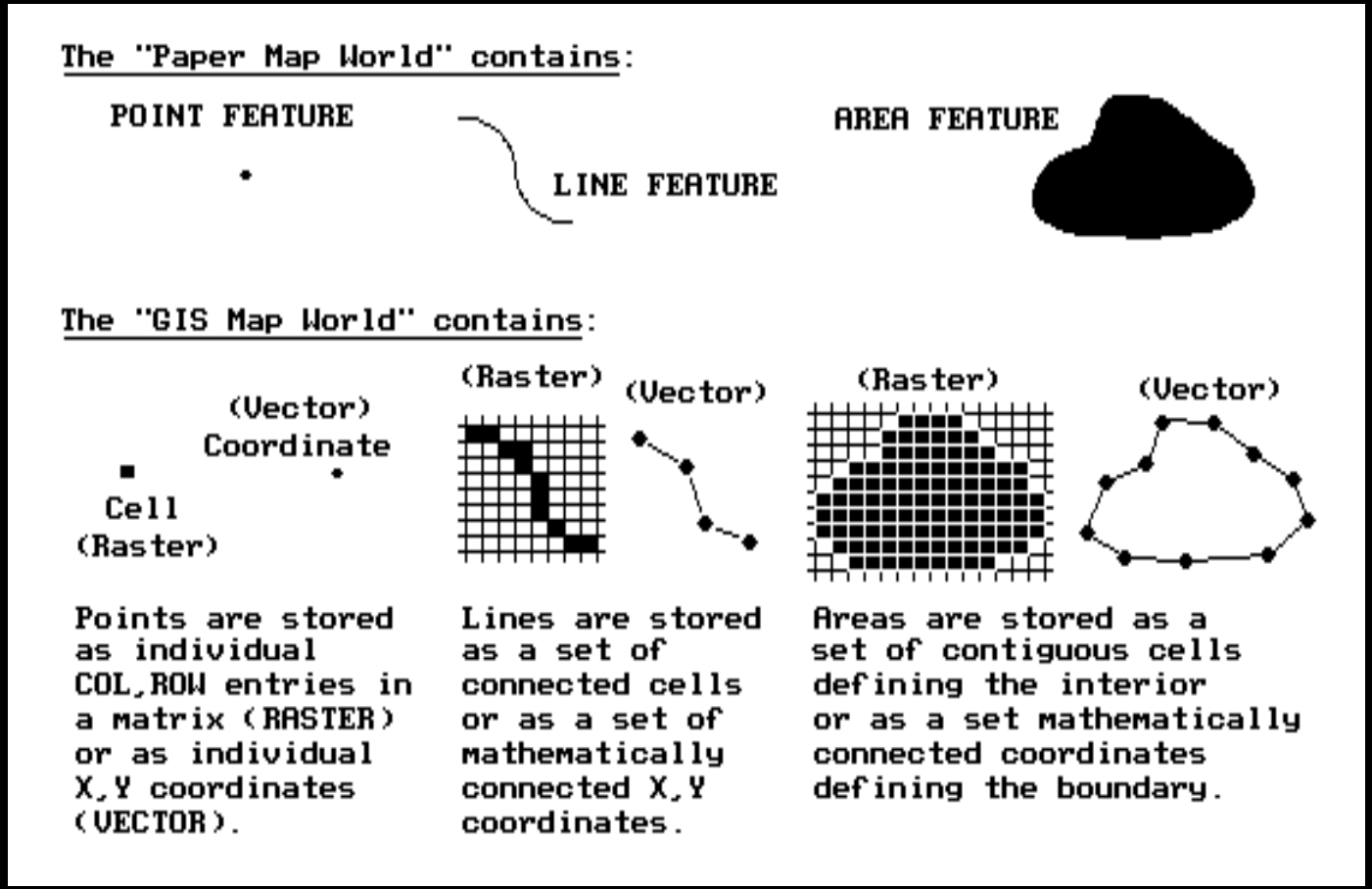
HYPER-VOLUMES-- L x W x D x Time
(e.g. reservoirs)

'FUZZY THEORY'-- uncertainity of feature's true shape

Traditionally, all maps are composed of three fundamental features-- Points, Lines and Areas (Polygons). The digital map provides additional dimensions of depth and time to extend these features to Surfaces, Volumes and Hyper-Volumes.

Berry

Map Features

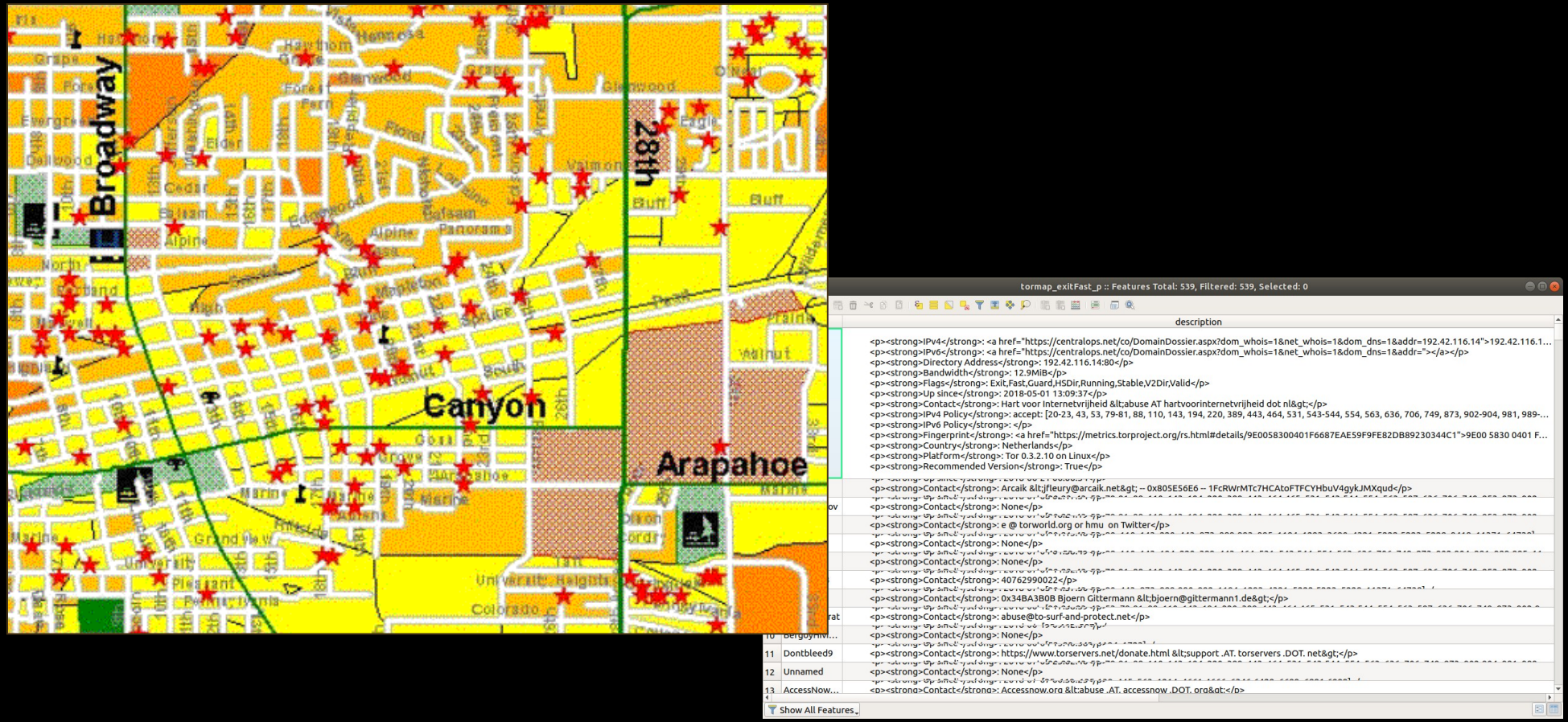


Berry

Vector Data

- Discrete location information
  - X, Y (longitude, latitude)
    - Points (single (X, Y))
    - Lines (Polylines as series of (X, Y))
    - Areas (Polygons or Multi-polygons)
      - Contiguous set of (X, Y)
    - Volumes (z-axis)
  - Digital maps can add dimension (with attributes)
    - Time

Vector Data



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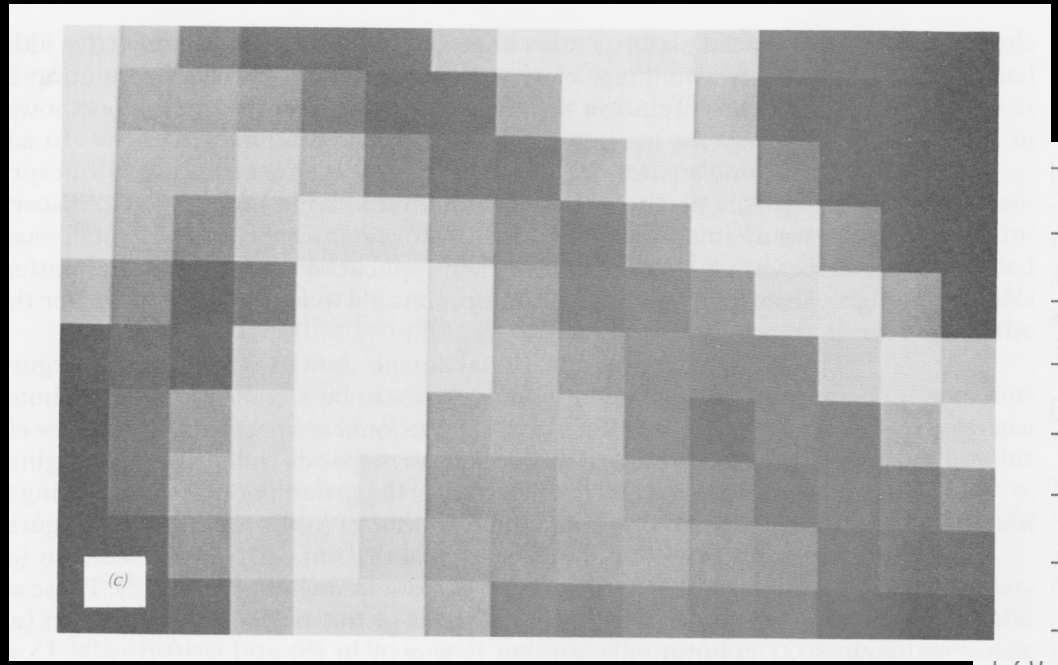
Raster Data

- Continuous location information
  - Columns and Rows
    - Each cell has a single value
    - Cells form a matrix
    - Matrix is georeferenced to digital map
  - Value of cell related to surrounding cells

Raster Data

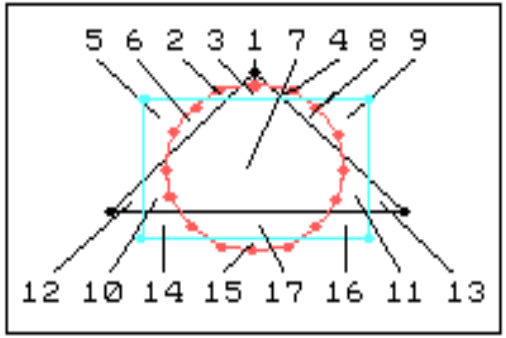


40	31	27	27	28	39	51	52	50	45	25	24	24	23
37	37	35	31	27	26	35	58	66	38	13	17	21	19
40	39	45	39	32	27	26	36	52	50	28	14	13	14
39	33	42	49	48	36	31	26	33	51	51	31	16	16
34	24	30	60	67	49	33	27	28	31	47	51	35	24
29	26	44	76	76	49	37	33	30	29	29	44	52	44
31	36	50	85	70	36	37	38	30	25	29	28	40	52
31	39	51	72	56	35	35	37	35	31	27	29	31	36
26	36	46	58	49	37	35	36	37	34	33	26	29	30
20	29	43	54	53	40	31	30	32	30	29	24	22	27

Lilles and Kiefer, 1994

Vector & Raster

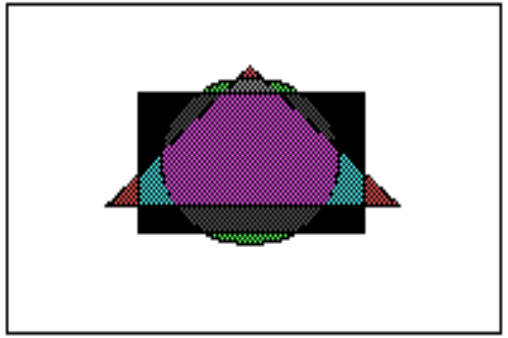
BASIC CONSIDERATIONS



'Boundaries'
VECTOR

Theoretically the same for both LINE and POINT features

... different for AREAL features



'Interiors'
RASTER

GIS

INVENTORY | ANALYSIS

AM-FM

- LINES REAL
- DATA CERTAIN
- DESCRIPTIVE
- MAPPING
- DATABASE MANAGEMENT

DSS

- LINES ARTIFICIAL
- DATA PROBALISTIC
- PRESCRIPTIVE
- STATISTICS
- MODELING

Generally, Vector is better suited for inventory-oriented applications; Raster for analysis-oriented applications.

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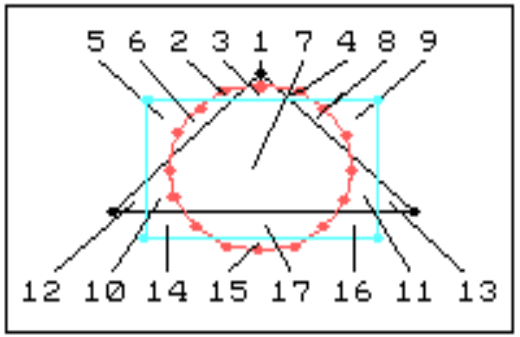
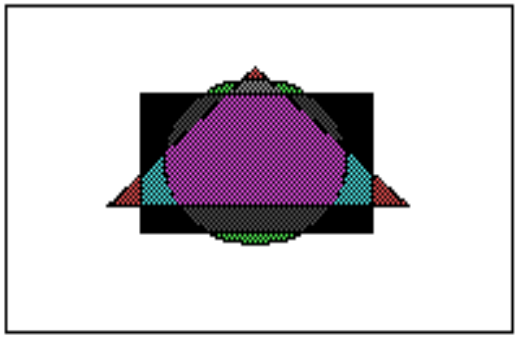
Vector & Raster

ADVANTAGES/DISADVANTAGES

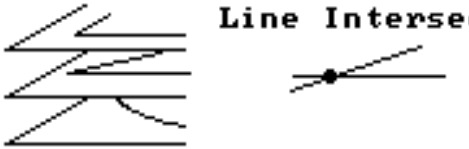


'Boundaries'

Most modern GIS systems have both VECTOR and RASTER capabilities.

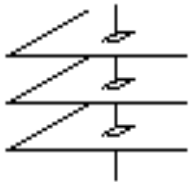


'Interiors'



Line Intersections

—1—2—4—
Stored Numbers



ADVANTAGES Inventory
- High Spatial Precision
- Low Initial Storage

DISADVANTAGES Analysis
- Compute Heavy
- Expodential Storage

DISADVANTAGES Inventory
- Low Spatial Precision
- High Initial Storage

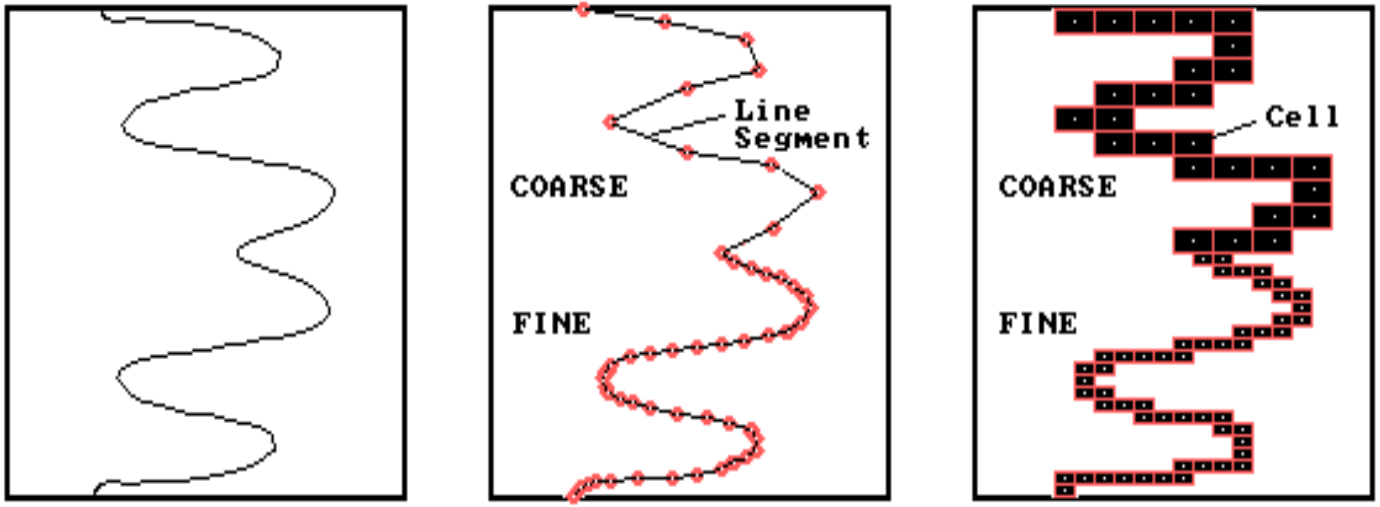
ADVANTAGES Analysis
- Compute Easy
- Constant Storage

Tabular, Vector, Raster Data

Questions?

Spatial Resolution

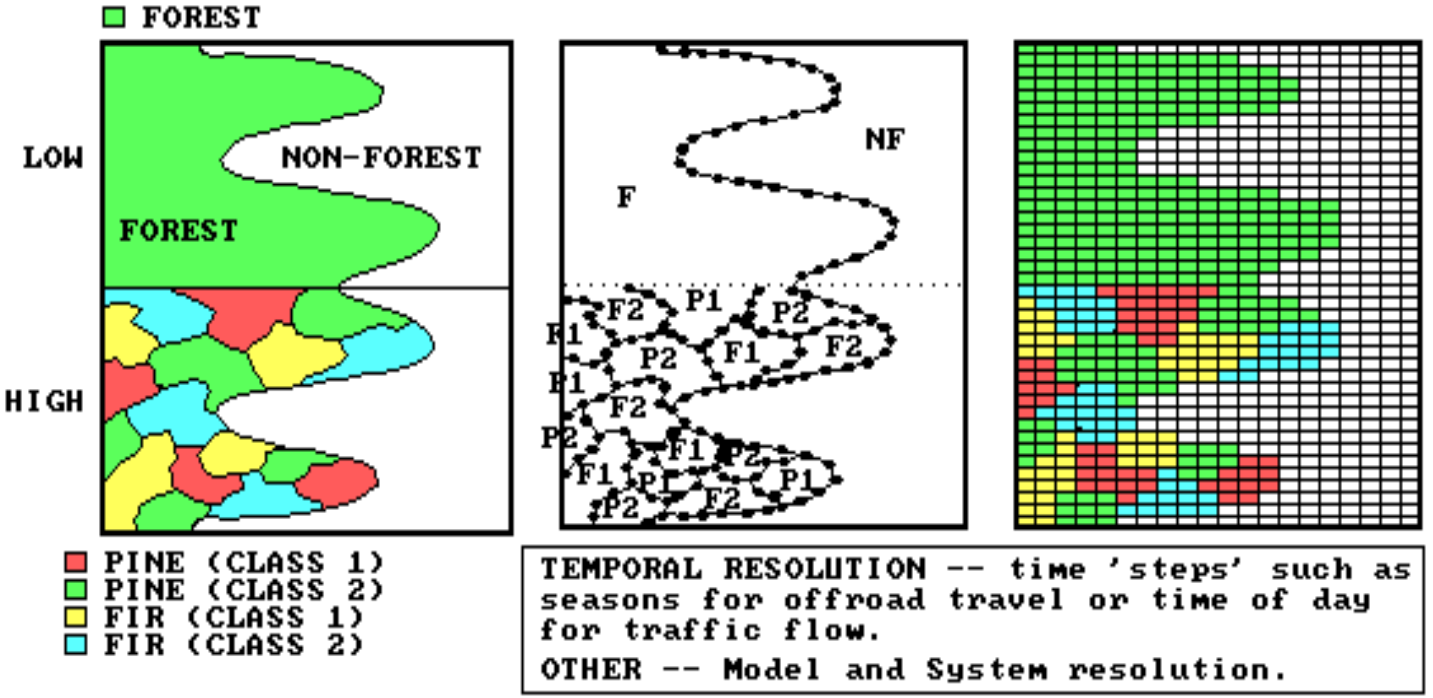
SPATIAL RESOLUTION -- 'resolution' means the ability to discern detail. Spatial resolution identifies the smallest addressable unit of space... in a vector system it is the 'line segment' and in a raster system it is the 'cell.'



...the smaller the line segment or the smaller the cell, the higher (finer) the spatial resolution.

Thematic/Temporal Resolution

THEMATIC RESOLUTION -- 'resolution' means the ability to discern detail. Thematic resolution identifies the smallest classification grouping of a map theme... for example a forest can be subdivided into species, age, stocking, etc.
... the more the subgroupings, the higher the thematic resolution.



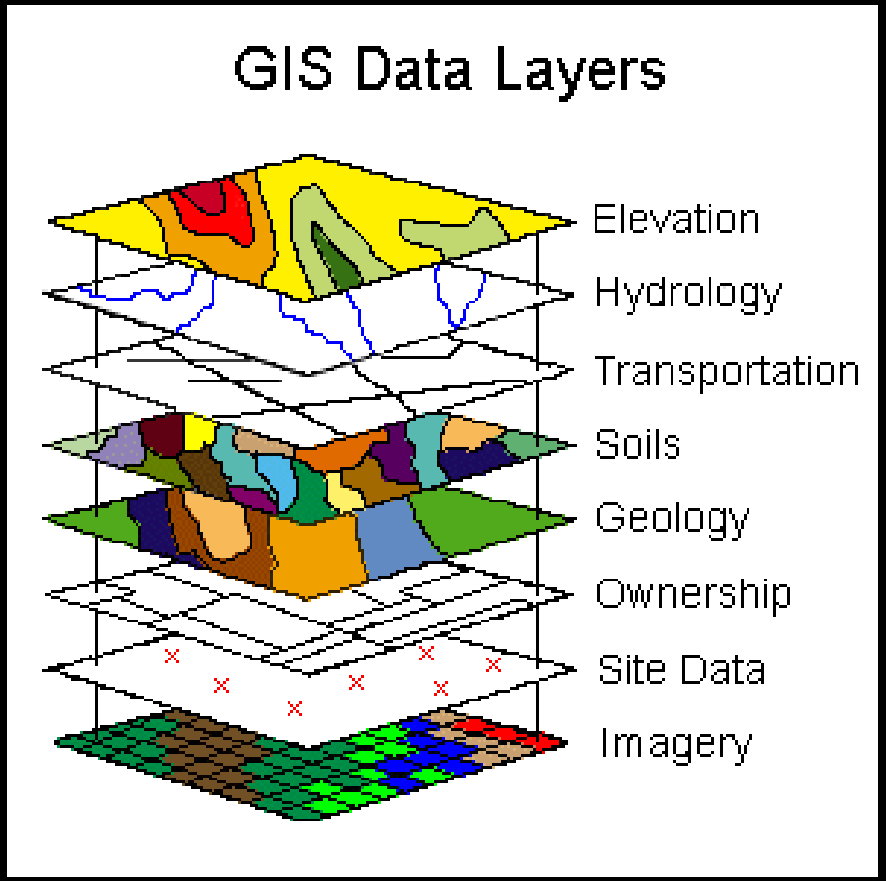
TEMPORAL RESOLUTION -- time 'steps' such as seasons for offroad travel or time of day for traffic flow.

OTHER -- Model and System resolution.

Spatial Resolution

Questions?

Data Layering



Are there issues with this arrangement?

Points
Lines
Polygons
Imagery

order?

Human
Physical
Other

Data Layering

- Data Organization
  - Scoped before mapping
    - User requirements (e.g., project definition)
    - Availability of data
  - Each layer has a theme
  - Layers overlaid based on analysis
    - Derived data layers

Data Layering

- Data Organization
  - Spatial indexing
    - Subset of input data
      - Query before and/or after input
    - Tiling
      - Packets of spatial data (vector & raster)
      - Quicker loading, faster distribution
    - Bigger the data set, more important indexing becomes

Data Layering

- Layer Ordering
  - User requirements (see project definition)
  - Theme
    - highest emphasis to lowest
  - Mapping medium
    - Visual variables
    - Visual hierarchy
    - Cognitive problematics
    - Number of layers

Data Layering

Questions?

Common File Formats

- Vector Formats
  - Shapefile
  - GeoJSON
  - KML/KMZ (Keyhole Markup Language)
  - CSV (Comma Separated Value)
  - Spatialite (SQLite spatial extension)
  - TIN (triangulated irregular network)
  - WKT (well-known text)

Common File Formats

- Raster Formats
  - GeoTIFF
  - NetCDF
  - JPEG2000
  - USGS
    - DRG (digital raster graphic)
    - DEM (digital elevation model) > now SDTS
  - RPF (raster product format – military)
  - MrSID (multiresolution seamless image database)

Common File Formats

- Additional File Formats
  - Aerial photography
    - Frame Camera, ISAT, scanned imagery
  - Satellite
    - Erdas (.img), Band Interleave (.bil), Band Sequential (.bsq)
    - LiDAR (light detection and ranging)
  - TIGER (US Census)
    - Topologically Integrated Geographic Encoding and Referencing
  - 3D
    - VRML

Common File Formats

Questions?