Representing Geography for GIS Data Processing

A Lecture for Undergraduate Students in Geography

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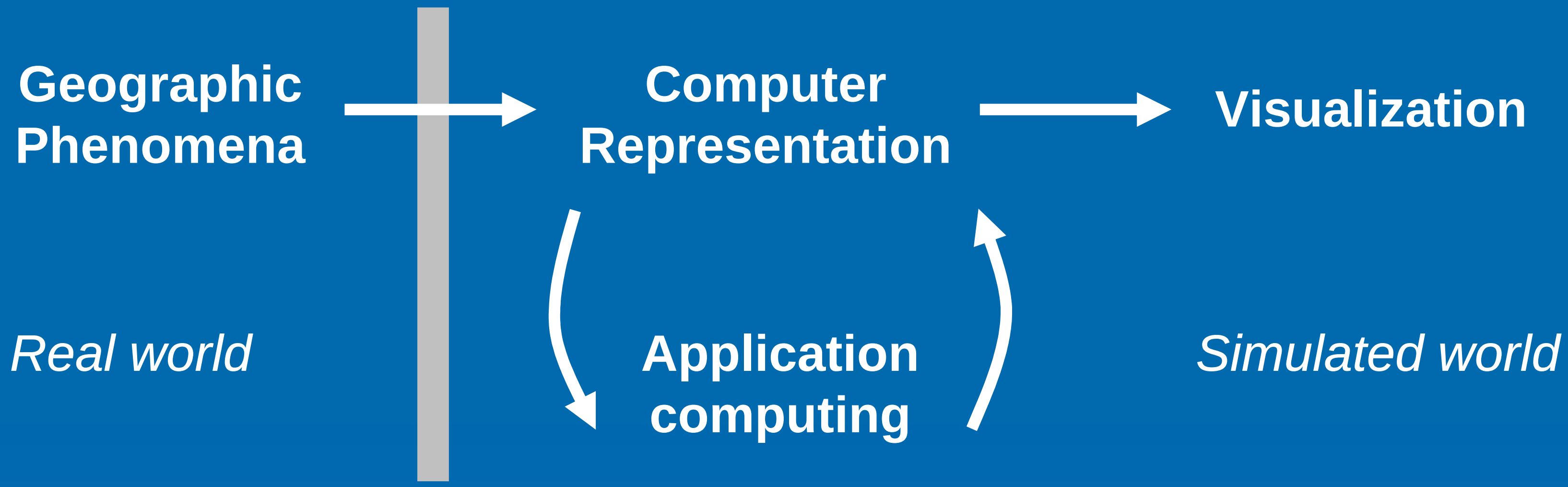
(**TA: Brandon M. Vista**)

Geographic Phenomena and GIS



Adopted from: ITC textbook, p. 37

Representing Geography

Satellite view of Mt. Fuji

Aerial view of Tokyo

Field vs. Object

- **Field – a field is a phenomenon that has a value everywhere in the geographic space; can be continuous or discrete**
- **Object – populates the study area, and are usually well distinguishable, discrete bounded entities; the space between them is potentially empty**

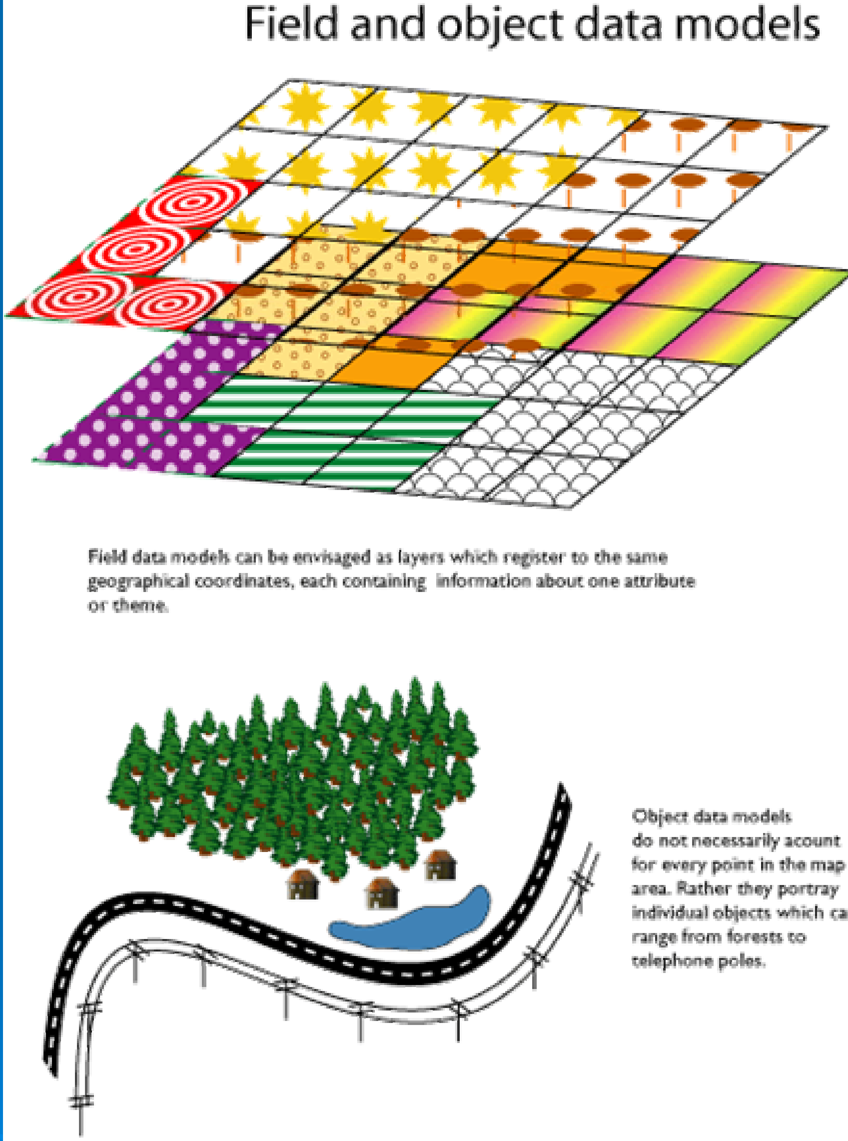


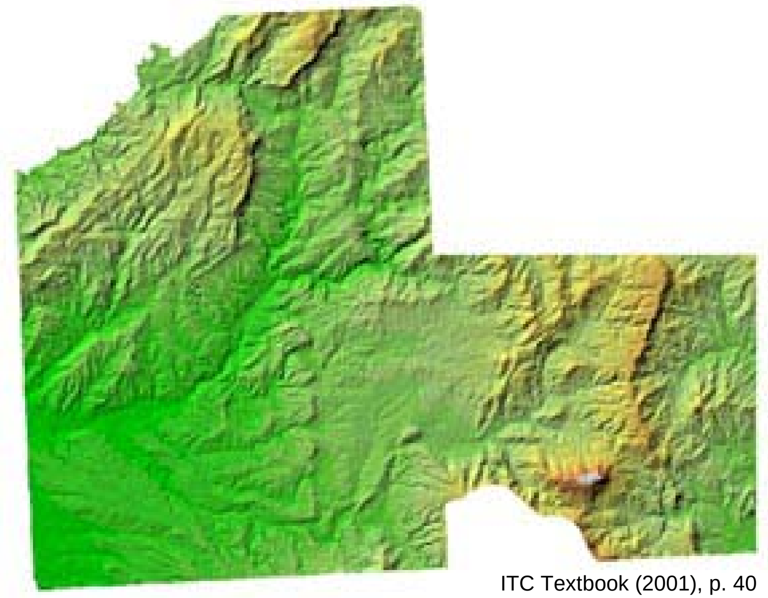
Figure 2.6. Conceptual differences between field and object data models.

Figure adapted from Schuurman, N. 1999 with permission.

http://www.sfu.ca/gis/bguide/icons/Fig2_6_fields_objects.gif

Continuous Field

- **Continuous field – all changes in the field values are gradual but can be differentiable because change (in the field value) per unit of distance anywhere can be measured**

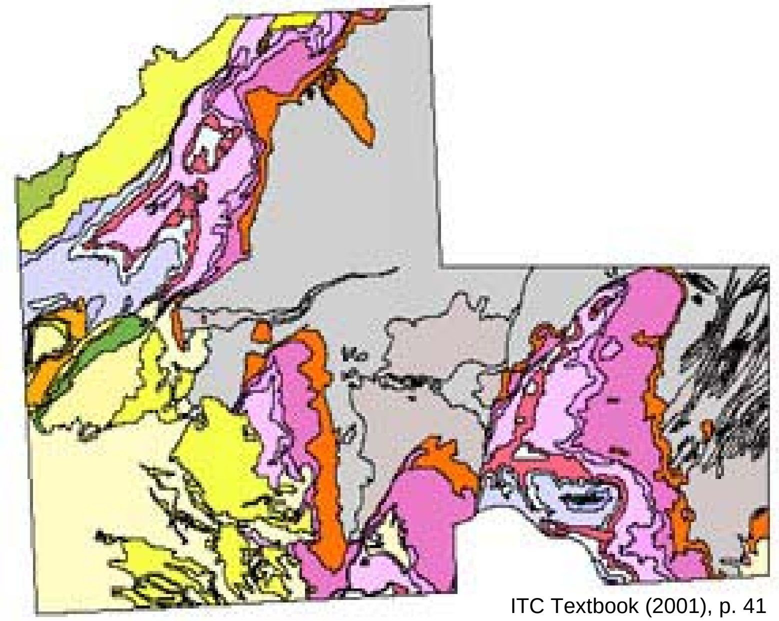


ITC Textbook (2001), p. 40

- **Examples:**
  - **Temperature**
  - **Barometric pressure**
  - **Elevation**
  - **Slope**
  - **Soil salinity**

Discrete Field

- Discrete field – cut the study area into mutually exclusive bounded parts, with all locations in one part having the same field value.

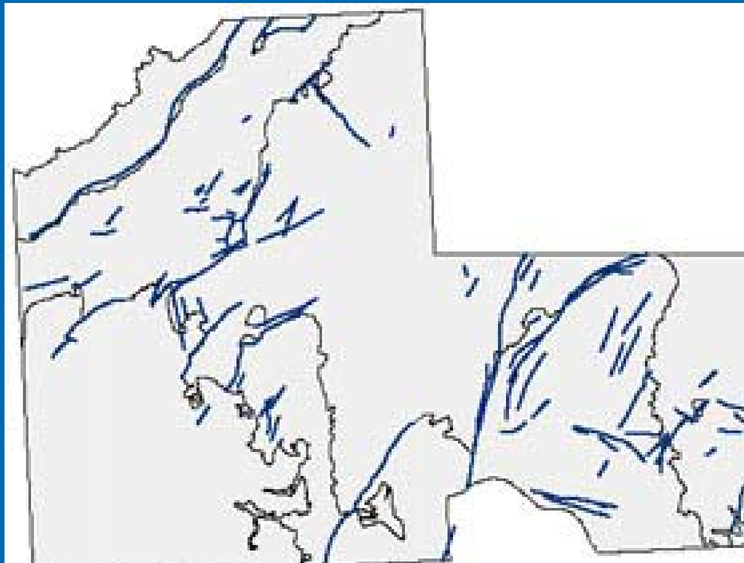


ITC Textbook (2001), p. 41

- Examples:
  - Land Classification
  - Land Use
  - Soil type
  - Countries` Territory

Object

- Not present everywhere in the study area
- Countable
- Their position in space is determined by a combination of the following:
  - Location (Where is it?)
  - Shape (What form is it?)
  - Size (How big is it?)
  - Orientation (What direction is it facing?)

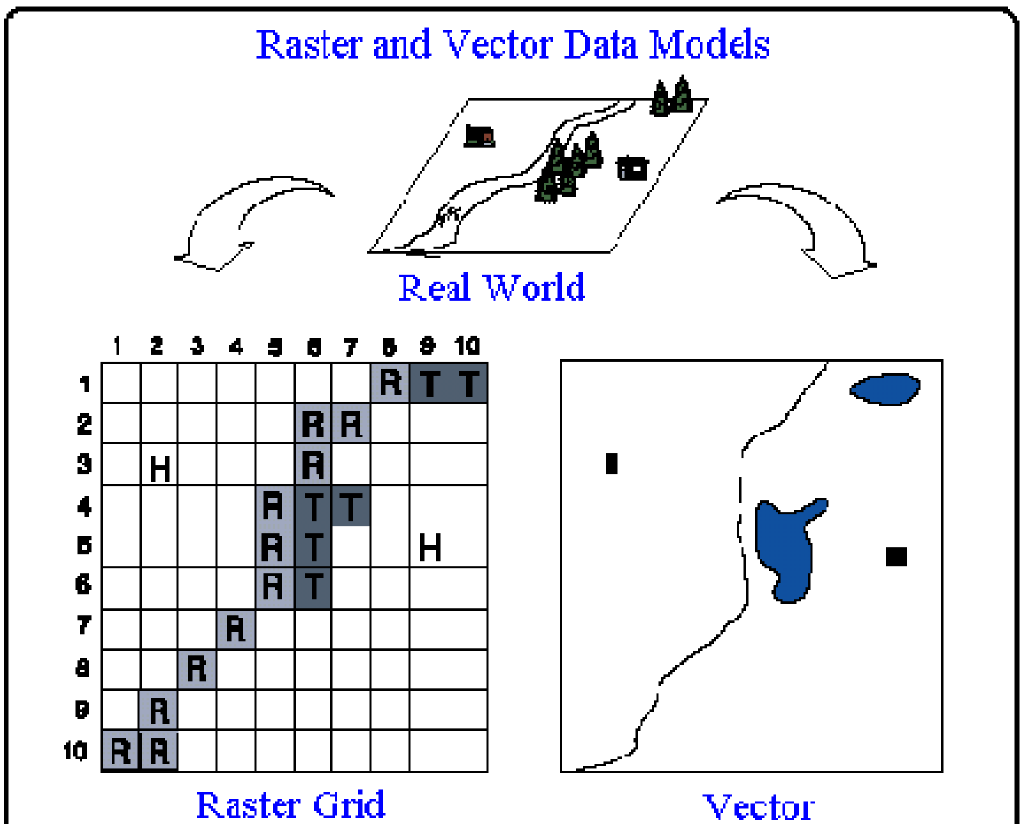


ITC Textbook (2001), p. 43

- Examples:
  - Houses
  - Streets
  - Fire hydrants
  - Trees
  - Vehicles
  - Earthquake faults

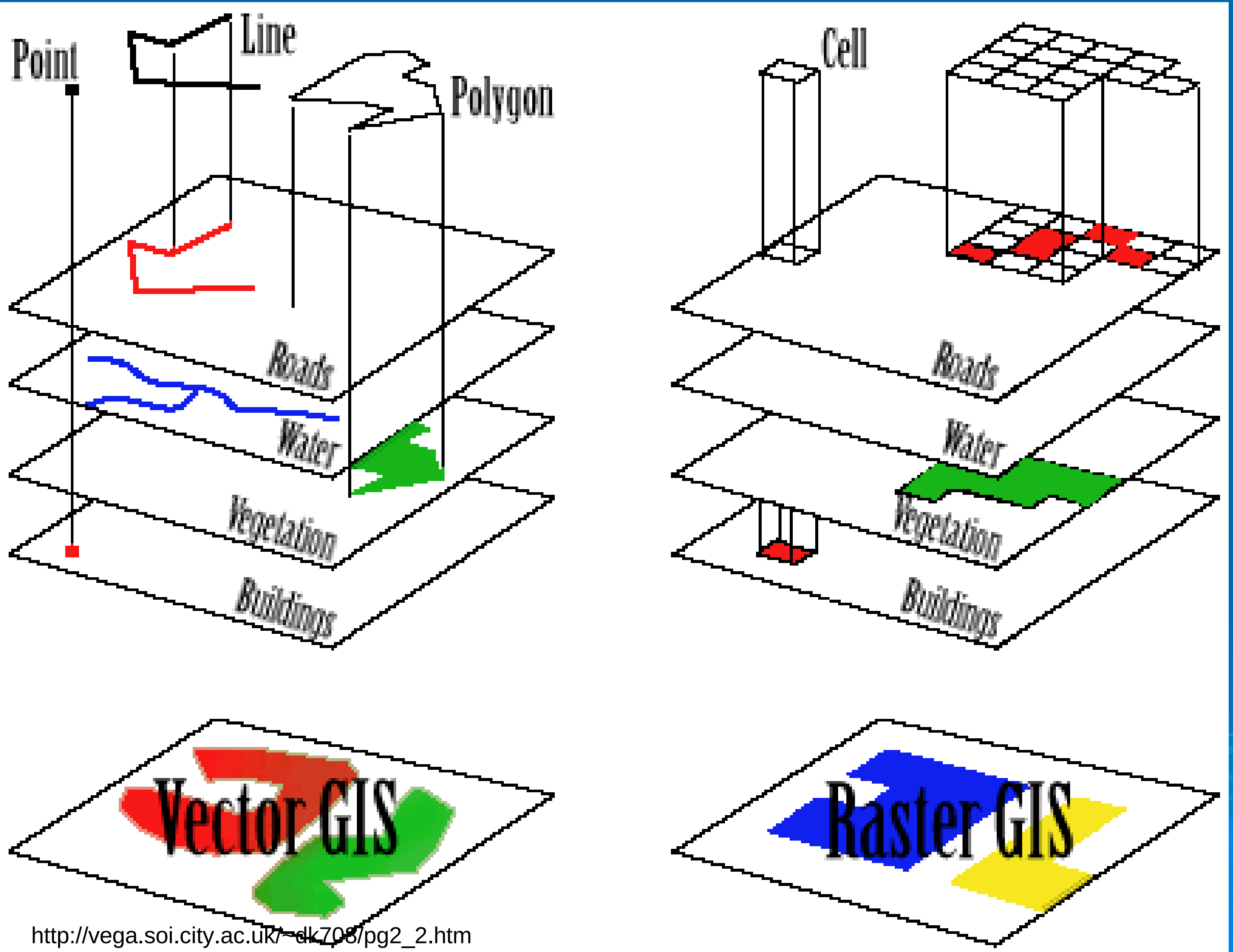
Computer Representation

- Tessellation approach for field phenomena
  - Raster data
- Vector approach for object phenomena
  - Vector data



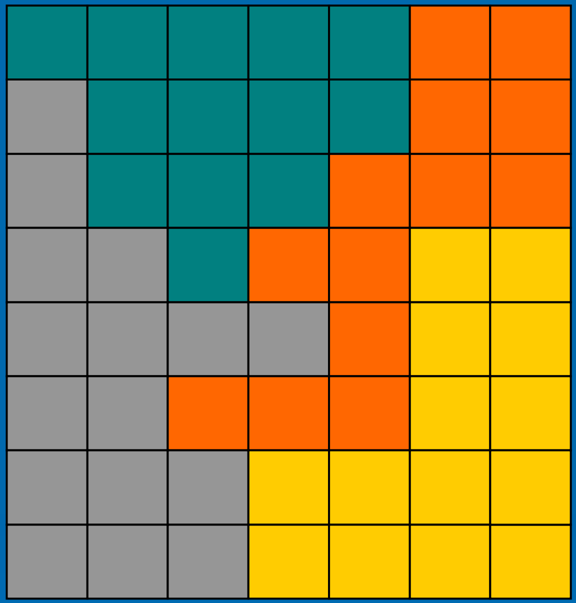
http://www.geog.ubc.ca/courses/geog376/notes/images/slide12.gif

Raster vs. Vector



http://vega.soi.city.ac.uk/~dk708/pg2_2.htm

(Tesselation) Raster Representation



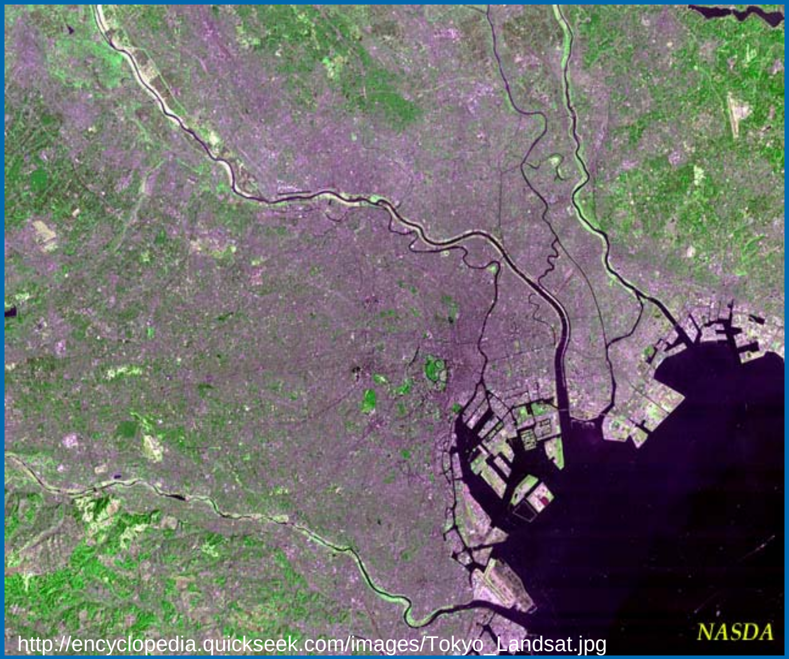
Source: Longley, et. al. 2005, p. 75

- Tesselation/tiling partitions space into mutually exclusive cells that together make up the complete coverage.
- Square cell is most commonly used
- Each cell is associated with thematic/attribute values.
- Square cell = grid, raster
- Represent discrete objects as collections of one or more cells.
- Represent fields by assigning values to cells
- More commonly used to represent fields than discrete objects.

Characteristics of Rasters

- **Pixel size**
  - The size of the cell or picture element defines the level of spatial detail
  - All variation within pixels is lost
  - The smaller the pixel size, the higher the resolution, therefore, the higher the level of spatial detail.
- **Assignment scheme**
  - The value of a cell may be an average over the cell, or a total within the cell, or the commonest value in the cell
  - It may also be the value found at the cell's central point

Raster Data

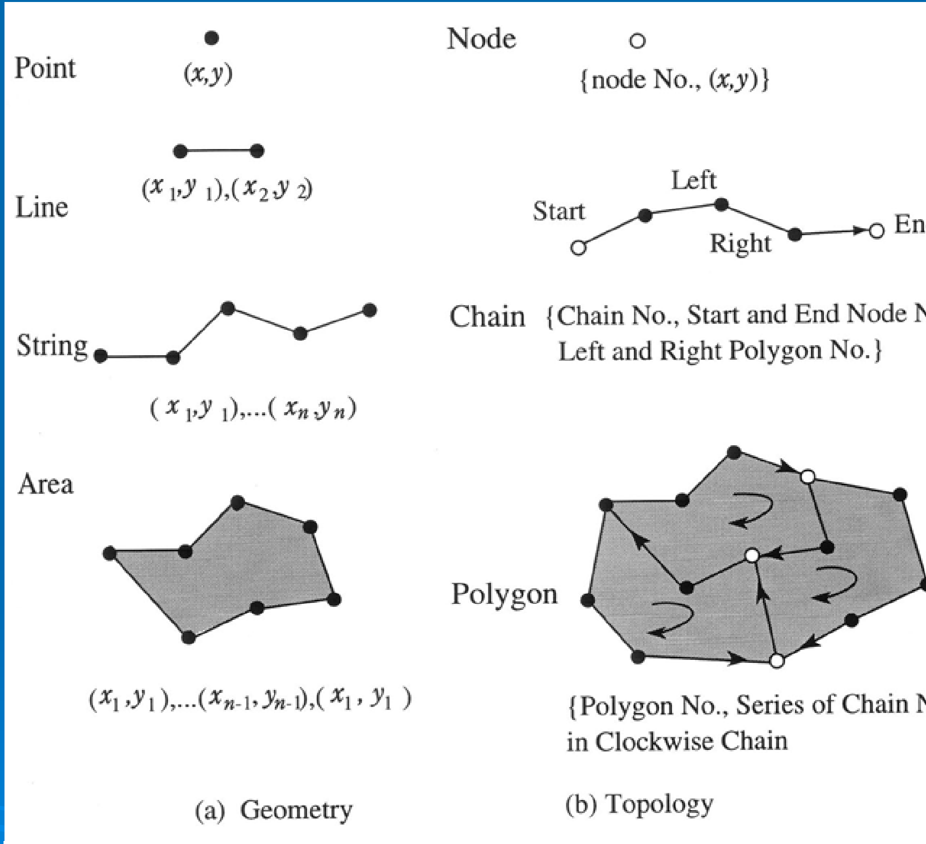


Landsat Satellite Image - Tokyo

Aerial Photograph - Tokyo

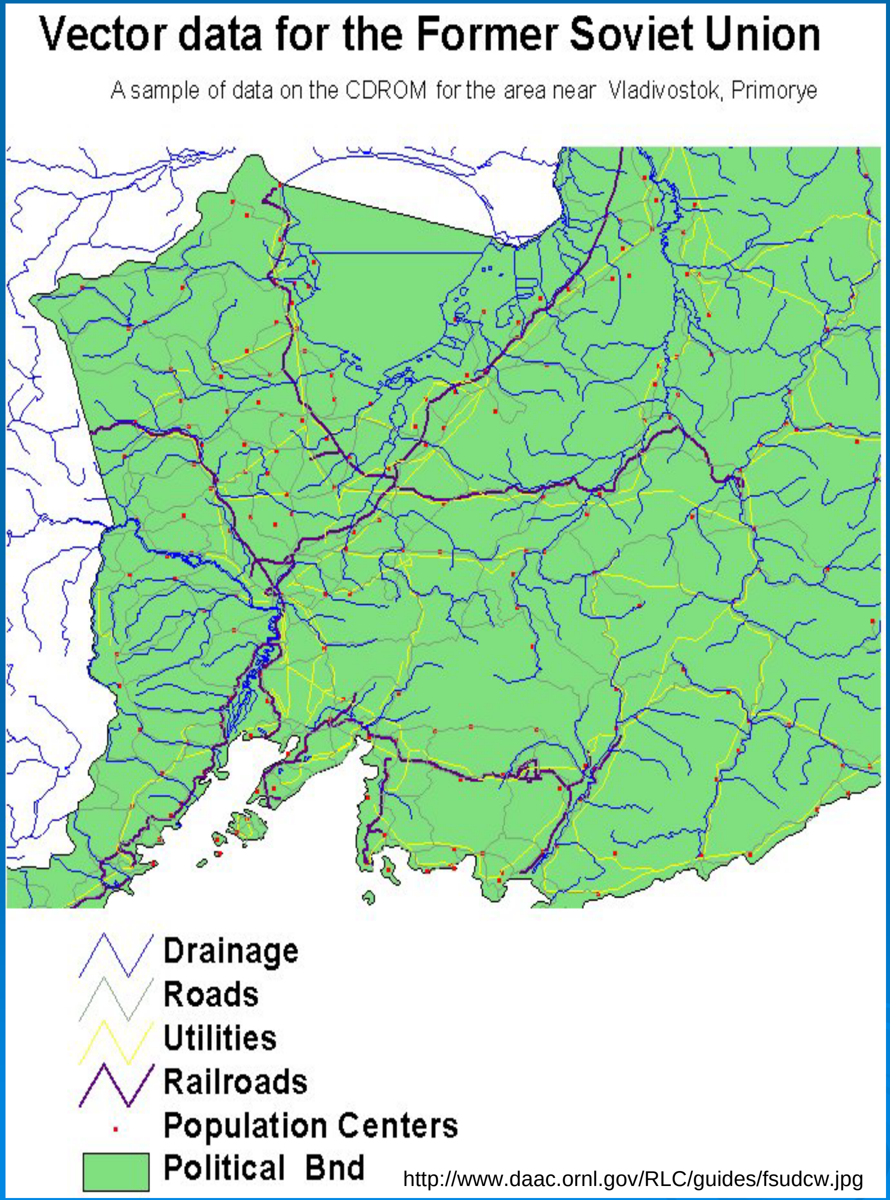
Vector Representation

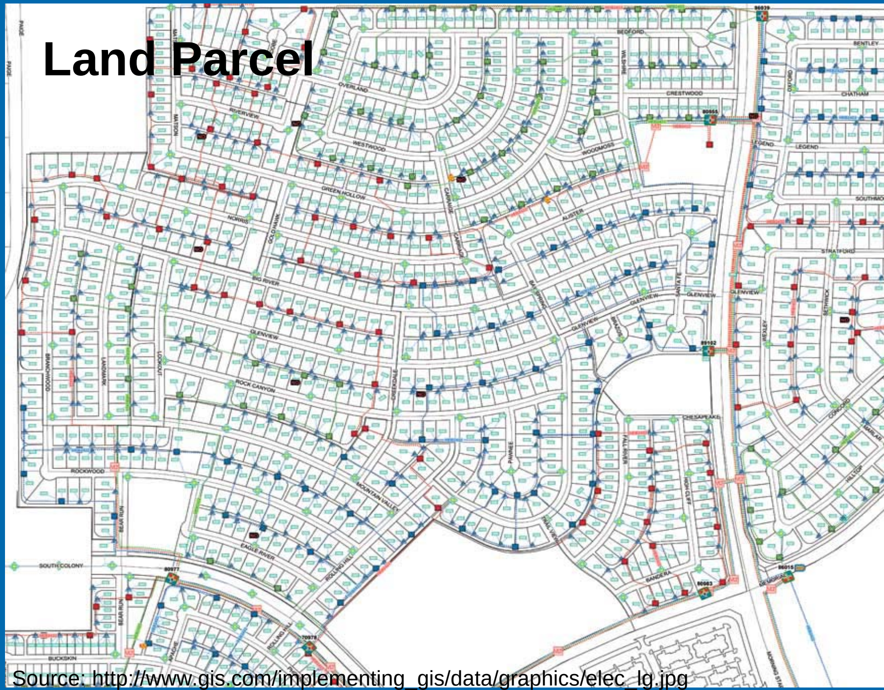
- Vector approach uses geometry to model objects
- Used to represent points, lines and areas
- All are represented using coordinates
- Areas are broken down into lines and nodes
- Lines are defined as two points
- A node is a point and a defining endpoint of an arc
- Points are defined as coordinate pairs (x, y)



Source: http://www.profc.udec.cl/~gabriel/tutoriales/giswb/vol1/cp2/2-2.gif

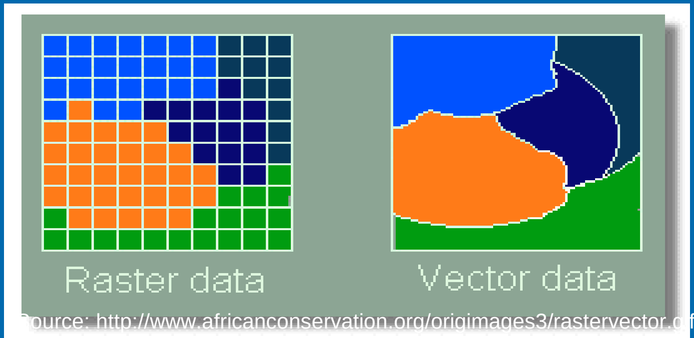
Vector Data


Vector data for the Former Soviet Union
A sample of data on the CDROM for the area near Vladivostok, Primorye
Drainage
Roads
Utilities
Railroads
Population Centers
Political Bnd
http://www.daac.ornl.gov/RLC/guides/fsudcw.jpg


Land Parcel
Source: http://www.gis.com/implementing_gis/data/graphics/elec_lg.jpg


Building Structures
http://grass.itc.it/grass61/screenshots/images/trento3d_colors.jpg

Raster vs. Vector

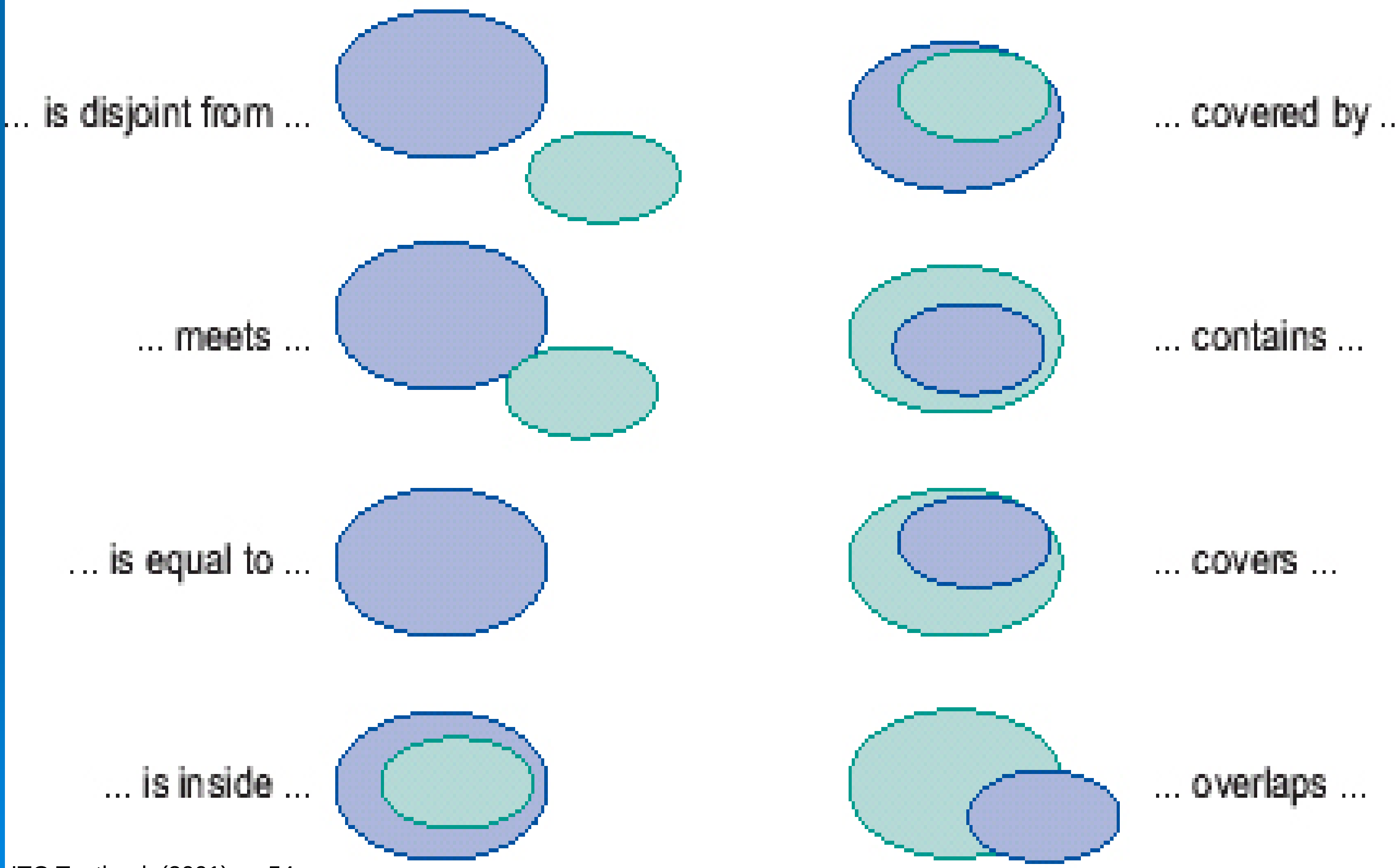


- Volume of data
  - Raster becomes more voluminous as cell size decreases
- Source of data
  - Remote sensing, elevation data come in raster form
  - Vector favored for administrative data
- Software
  - Some GIS better suited to raster, some to vector

Types of Attributes

Types	Examples
Nominal	Land cover class, Soil types,
Ordinal	Hierarchy of road type
Interval	Celsius temperature, contour interval
Ratio	Kelvin temperature, income, distance
Cyclic	Wind direction, slope aspect

Topological Relationship



ITC Textbook (2001), p. 54

Challenges in representation of geographic phenomena

- Accuracy of Representation
  - Representations can rarely be perfect
  - Details can be irrelevant, or too expensive and voluminous to record
  - It's important to know what is missing in a representation
  - Representations can leave us uncertain about the real world

Challenges in representation of geographic phenomena (2)

- Multiple attributes of geographic phenomena
  - Geographic information links a place, and often a time, with some attributes of that place (and time). The potential number of attributes is vast. These can be physical, social, economic, demographic, environmental, etc. The number of places and times is also vast. It is potentially infinite
- The more closely we look at the world, the more detail it reveals
  - Potentially *ad infinitum*
  - The geographic world is infinitely complex

References

- Longley, Paul et. al (2005). *Geographic Information Systems and Science.* 2nd ed. England: John Wiley & Sons, Ltd.
- de By, Royce A., et. al. (2001). *Principles of Geographic Information System: An Introductory Textbook.* Royce de By (ed). Netherlands: International Institute for Geoinformation Science and Earth Observation (ITC).