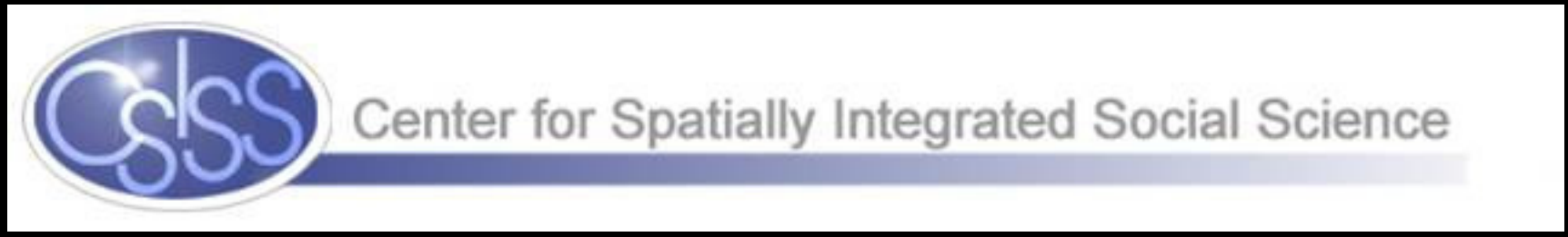

Spatial Analysis
Data Models

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Outline

- Data Model Concepts
- GIS Data Model
- Topology

Data Model Concepts

GIS Data Model

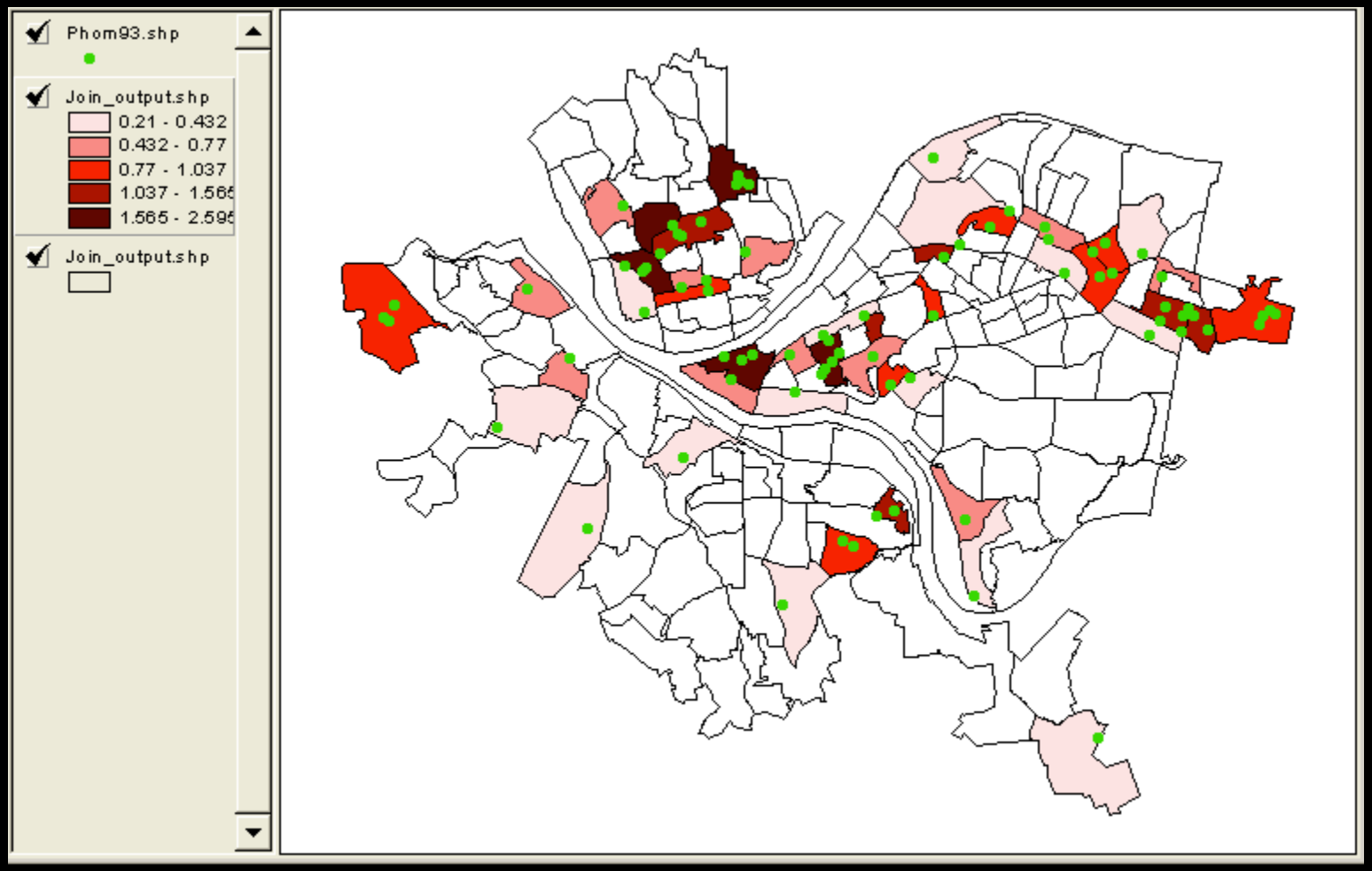
- Discretization of Geographical Reality Necessitated by the Nature of Computing Devices (Goodchild)
  - raster (grid) vs. vector (polygon)
  - field view (regions, segments) vs. object view (objects in a plane)
- Data Model Implies Spatial Sampling and Spatial Errors

Some Definitions

- Data Model
  - set of constructs for describing and representing selected aspects of the real world in a computer (Longley et al)
- Data Modeling
  - origins in software engineering, databases
  - process to move from problem description to problem solution
  - increasing level of specificity
    - conceptual = field vs object
    - logical = raster vs vector
    - physical (digital) = specific data structures (files)

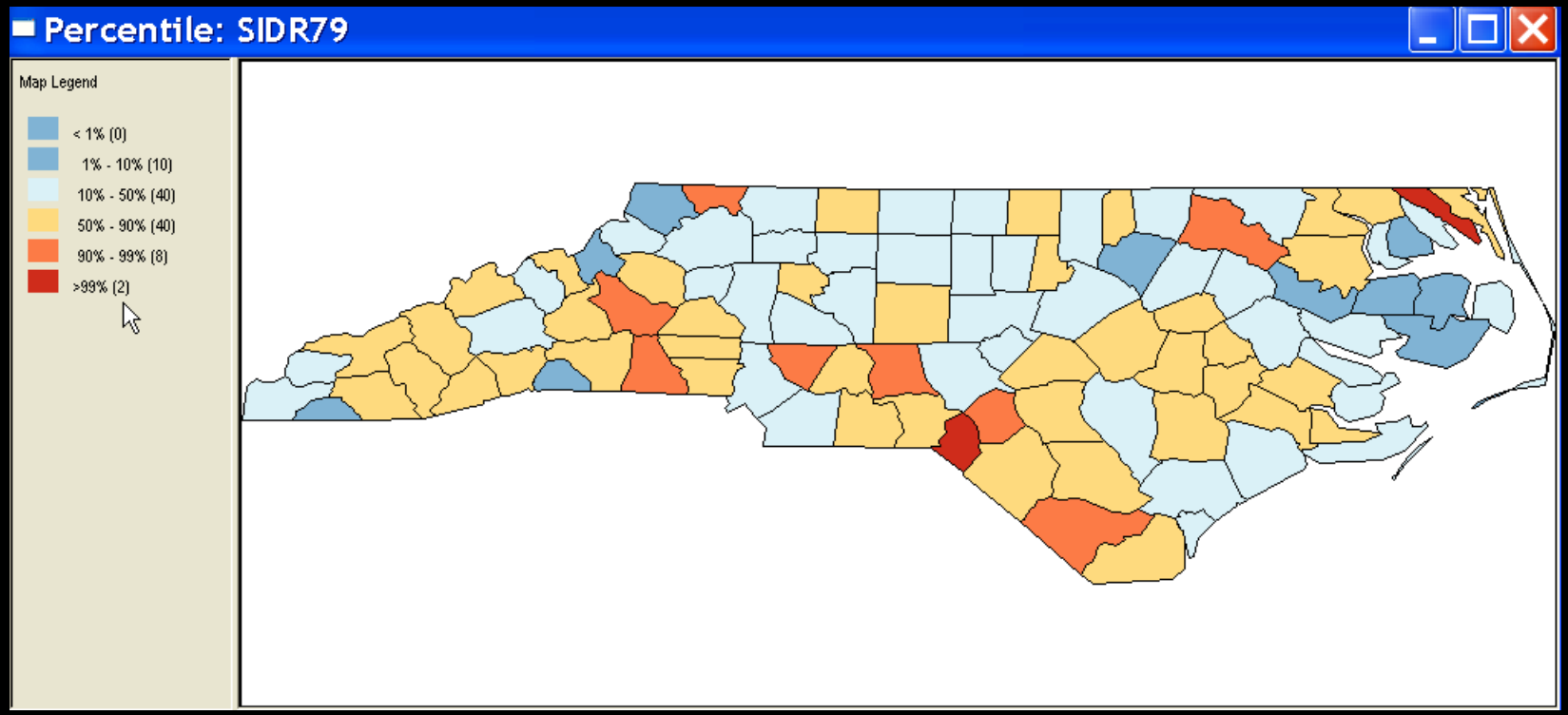
Spatial Objects

- Definition
  - collections of discrete objects with spatial reference
- Visualization
  - discrete entities
- Implementation
  - vector model (point, line, polygon)



Pittsburgh 93 Homicides as Tract Rate

Counties as Objects

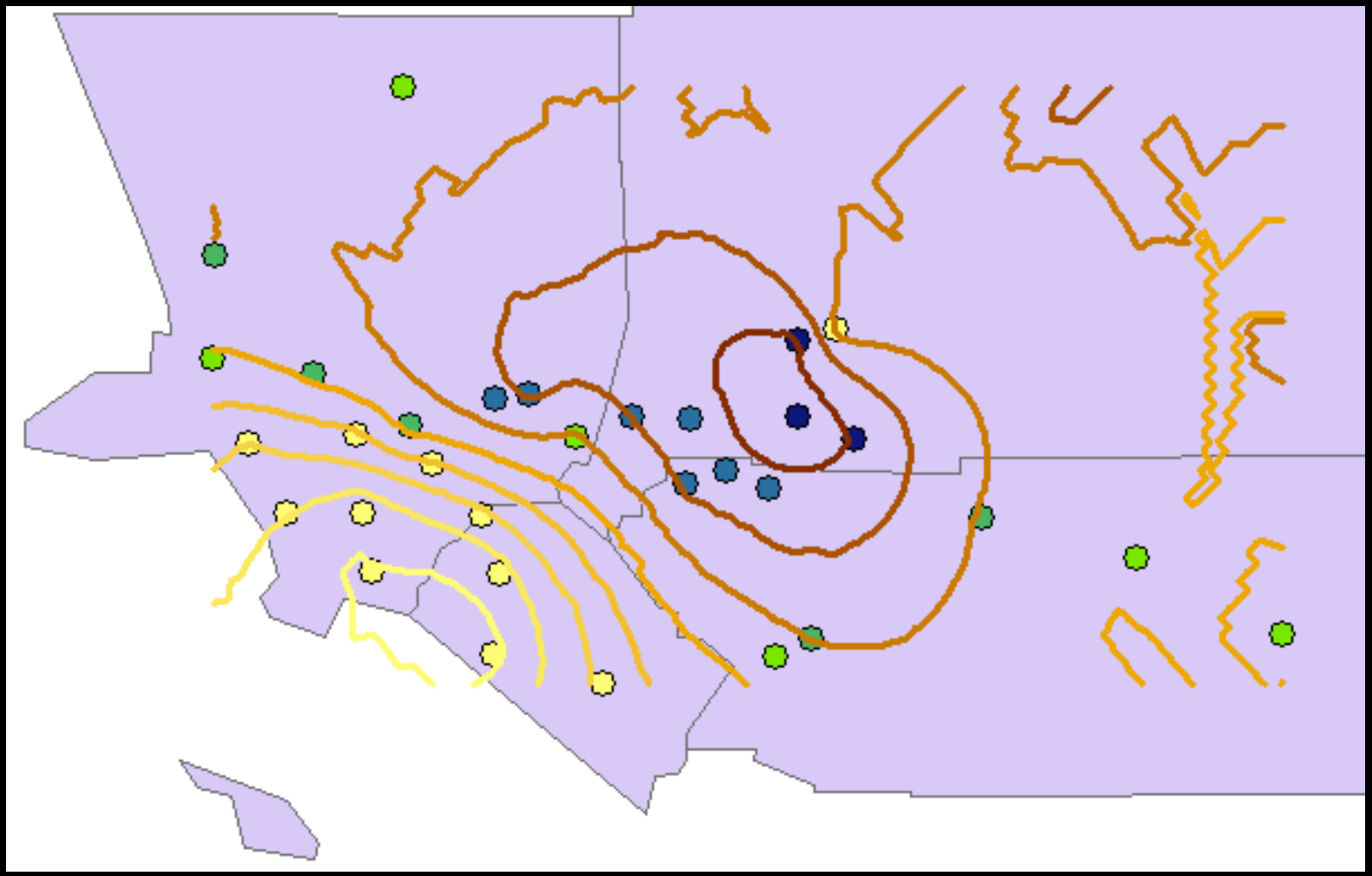


Spatial Objects - Data Analysis

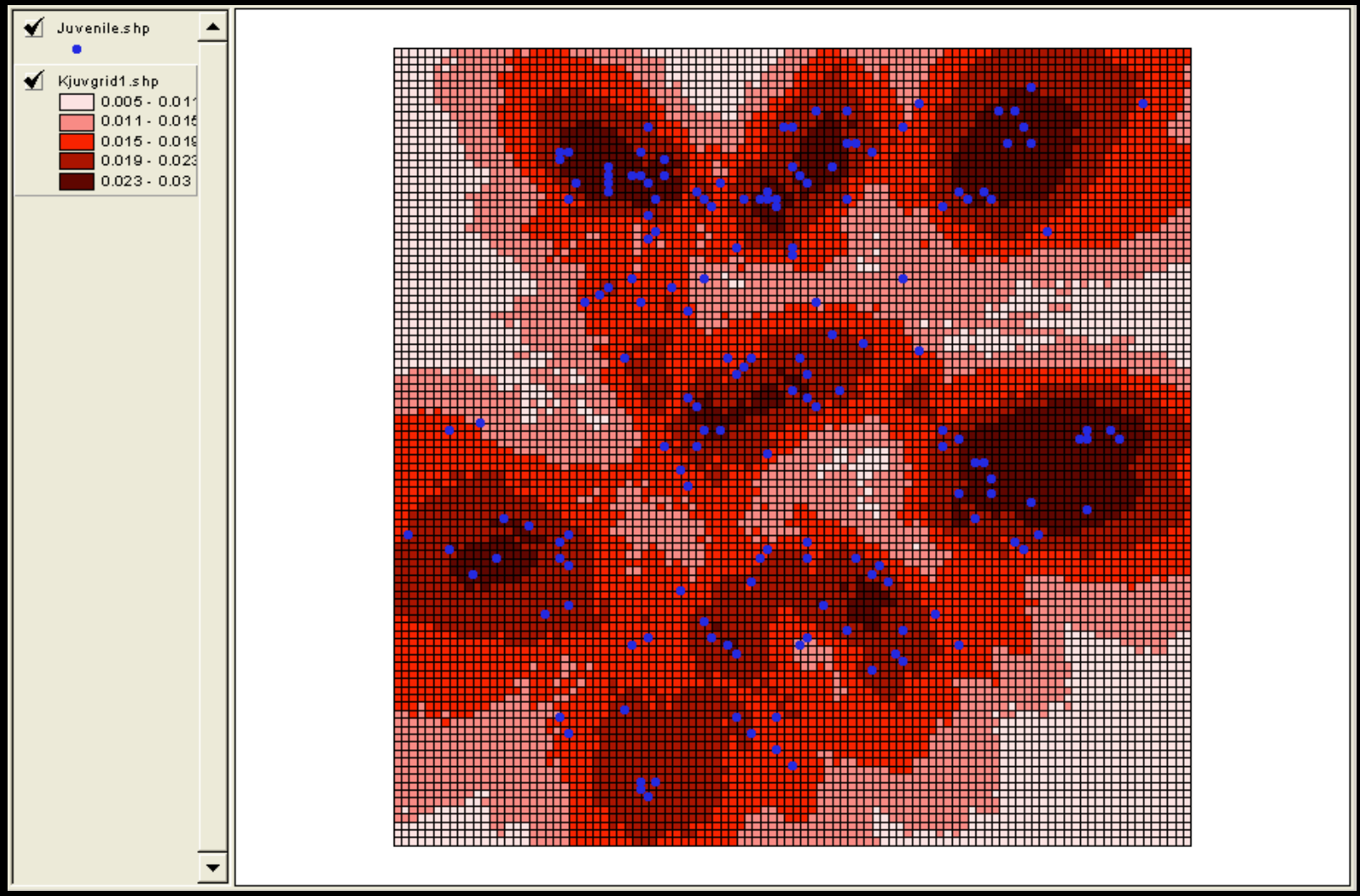
- Lattice Data Analysis
  - discrete spatial objects: points, areas
  - no sample, but superpopulation
  - spatial autocorrelation
- Points as Objects
  - discrete entities labeled as points
    - county centroids
  - NO interpolation
- Areas as Objects
  - discrete contiguous entities exhaust space
    - county boundary files

Spatial Fields

- Definition
  - collections of spatial distributions
  - spatial field function
    - mathematical function from a spatial framework (grid) to an attribute domain (i.e., domain of variables)
    - one value for each location or continuous function
- Visualization
  - surfaces, isolines (function is the field)
- Implementation
  - raster model (grids, tesselations)



Air Quality (Ozone) in Los Angeles Basin
Contours from Spherical Variogram Interpolation



Triangular Kernel Density Surface

Cardiff Juvenile Offender Locations

Spatial Fields - Data Analysis

- Geostatistical Analysis
  - models for continuous surfaces
  - geostatistics
- Points as Sample Points
  - data at point locations used to model the whole surface
- Focus on Spatial Interpolation
  - getting data for locations without observations

GIS Data Model

Evolution of GIS Data Models

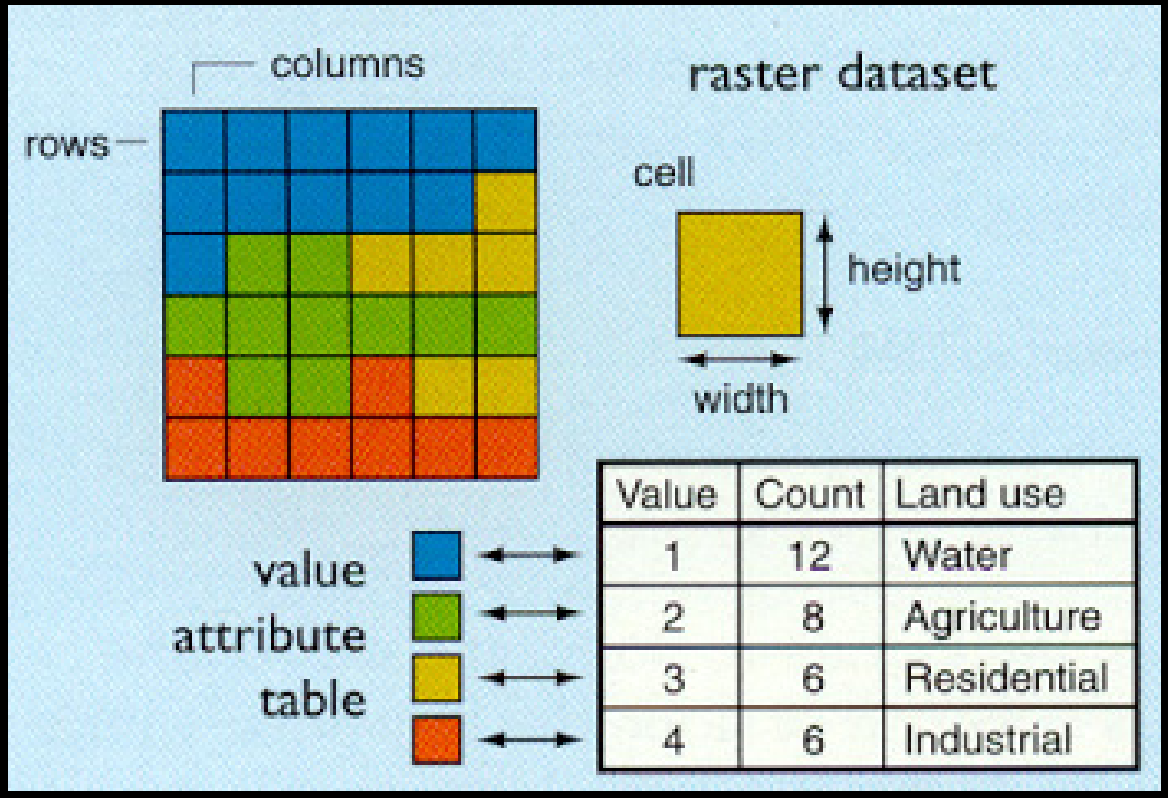
- CAD/Image
  - pre-GIS
- Georelational (Coverage)
  - raster data model
  - vector data model
- Object Data Model
  - geodatabase

CAD/Image Data Model

- Geometry Only
  - CAD: points, lines, polygons
  - Image: pixels
- No Attributes
- No Topology
- Optimized for drawing/representation
  - image compression (GIF, JPEG)

Raster Data Model

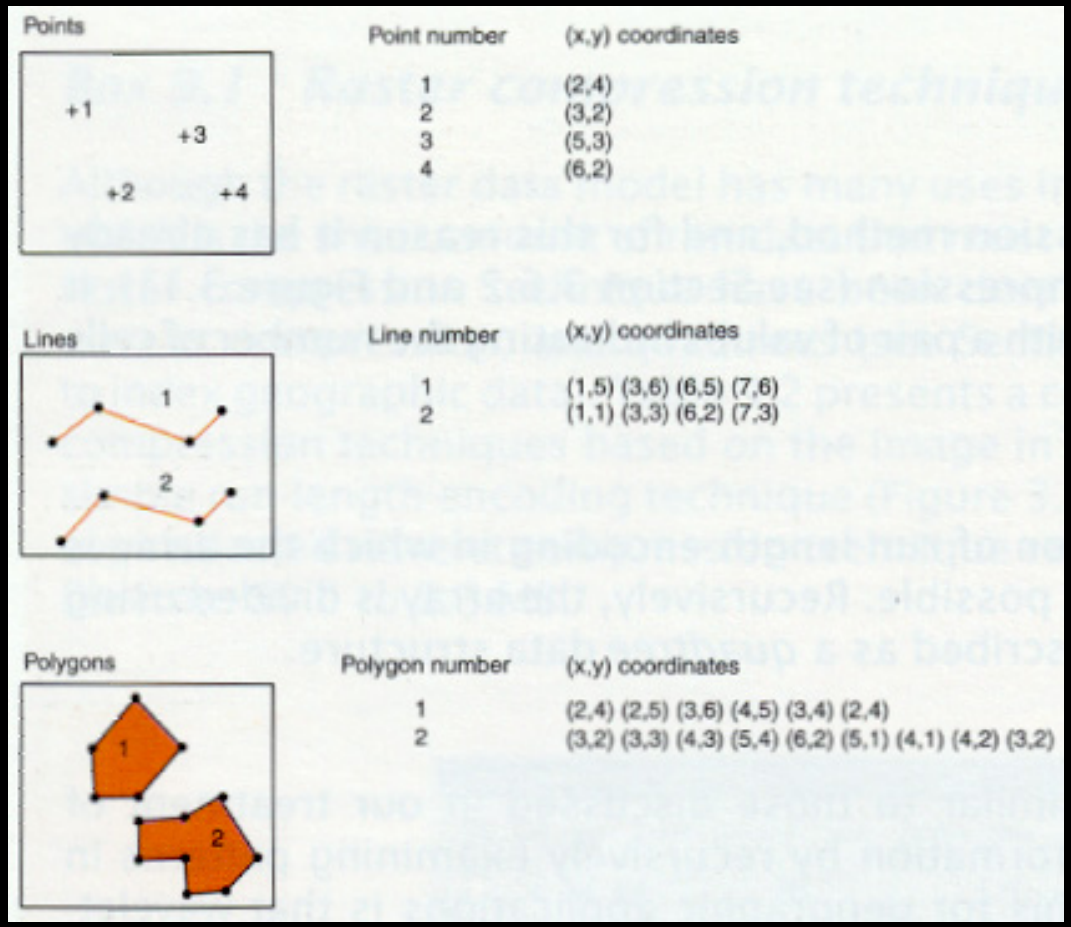
- Raster cells associated with attributes



Value	Count	Land use
1	12	Water
2	8	Agriculture
3	6	Residential
4	6	Industrial

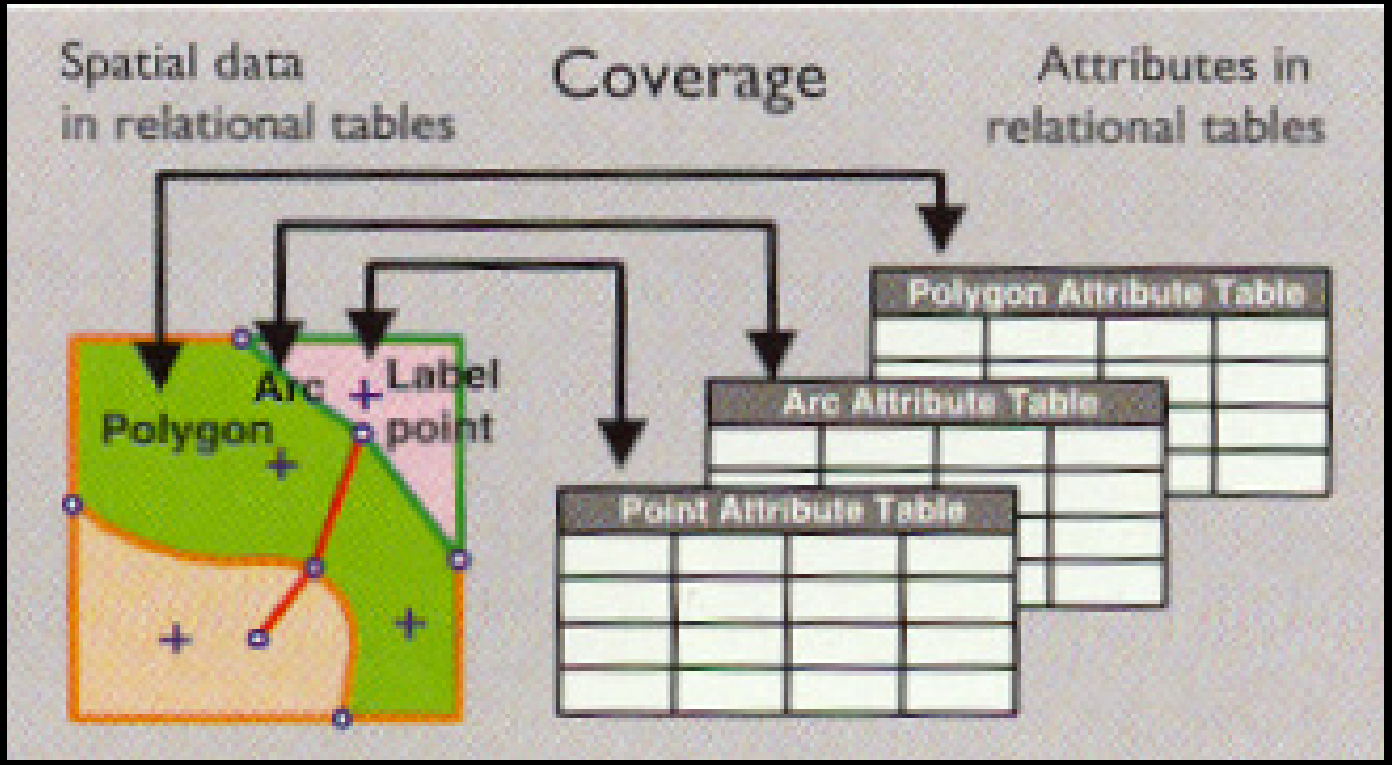
Source: Zeller (1999)

Vector Data Model



features, their coordinates and arrangement (topology)

Georelational Data Model



Source: Zeller (1999)

Object Data Model

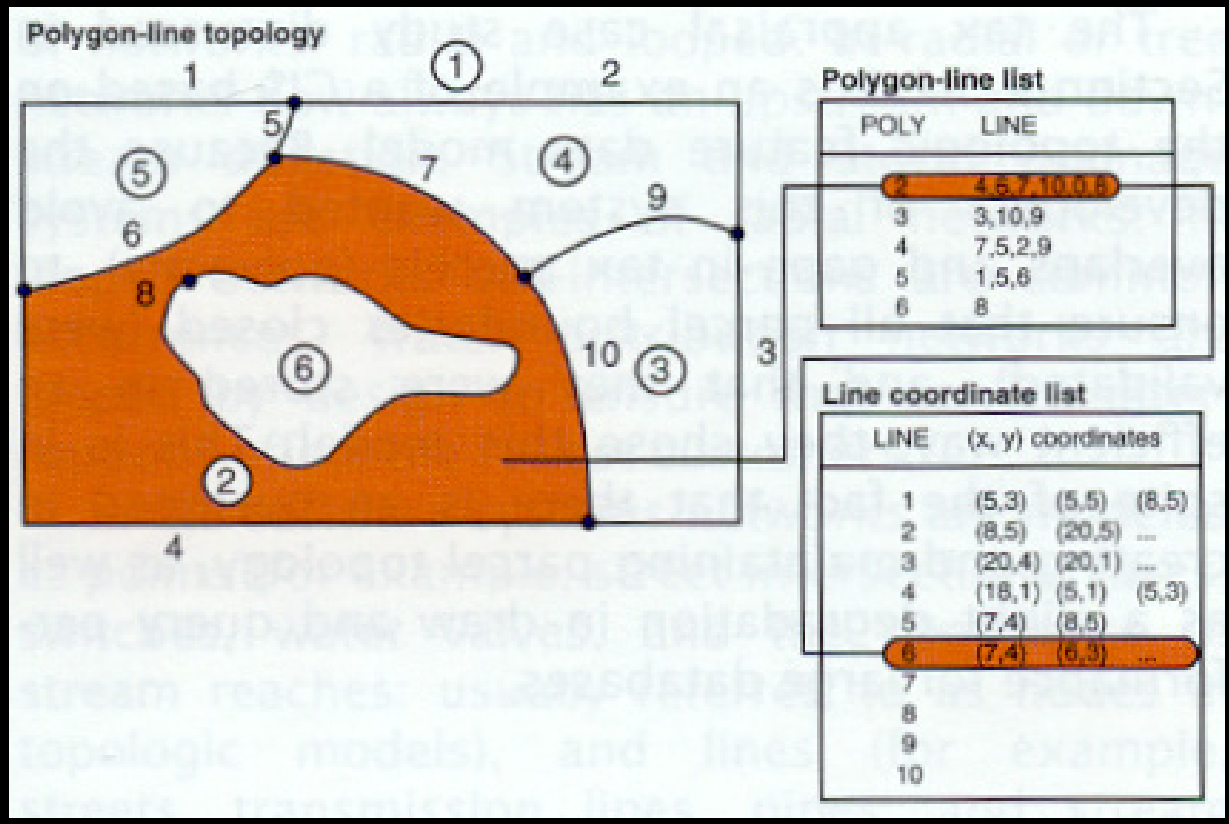
- Limitations of Georelational Model
  - too geometry-centric
  - separation state from behavior
- Geographic Objects
  - geometry
    - point, line, polygon
  - properties
    - where, area
  - methods
    - create, draw, merge

Topology

Topology in Spatial Data Bases

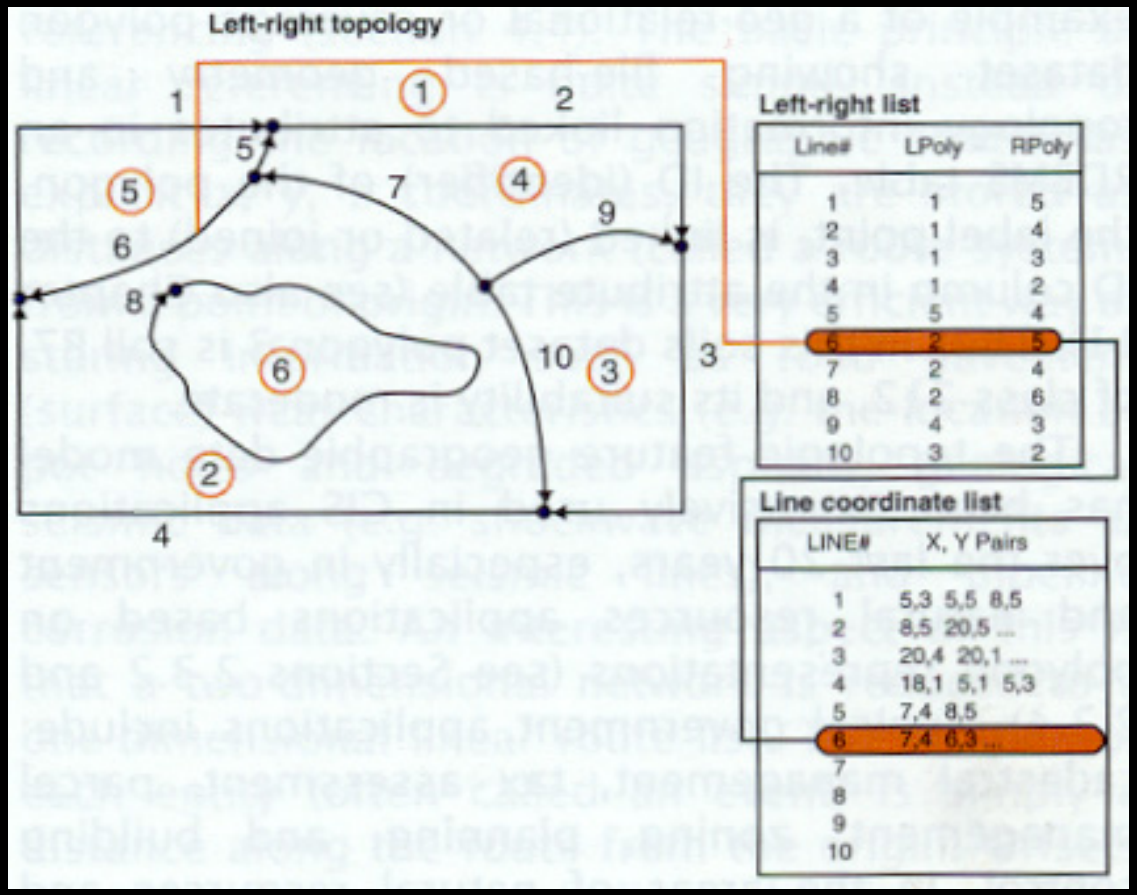
- Map Features
  - points: ID; x, y coordinates
  - lines = arcs: arc ID, from point ID, to point ID
  - polygons: polygon ID, arc IDs
- Topology
  - connectivity: arc-node
  - area definition: polygon-arc
  - contiguity: left-right

Area Definition



Source: Longley et al (2001)

Contiguity



Source: Longley et al (2001)

Topology in Spatial Data Analysis

- Spatial Weights
  - express "neighbor" relation
    - contiguity
  - requires topology
- Topology in Practice
  - ArcInfo: built-in (clean and build)
  - ArcView: no topology
  - ArcGIS: topology on the fly (8.3)