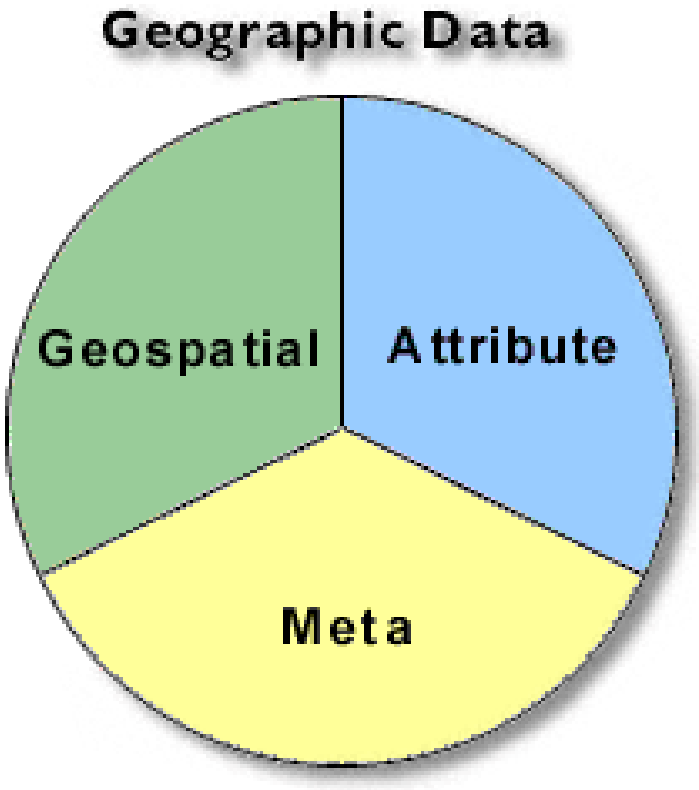
Spatial data models (types)

Lecture 2, 8/31/2006

Geographic Data



- Geospatial data tells you where it is and attribute data tells you what it is. Metadata describes both geospatial and attribute data.

Today, we focus on the geospatial data. Attribute data is stored in a attribute data (or database in this chapter 2 of the book) will be covered later.

Characteristics of spatial data

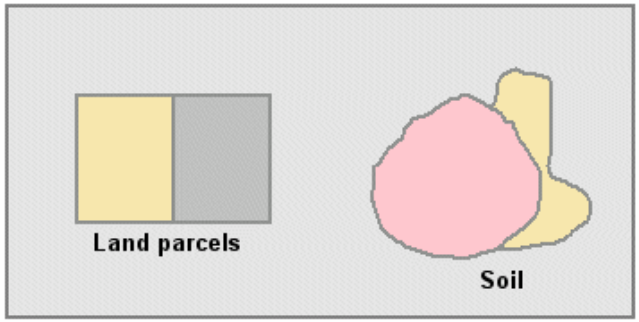
- “mappable” characteristics:
  - Location (coordinate system, will be lectured later)
  - Size is calculated by the amount (length, area, perimeter) of the data
  - Shape is defined as shape (point, line, area) of the feature
- Discrete or continuous
- Spatial relationships

Discrete and continuous

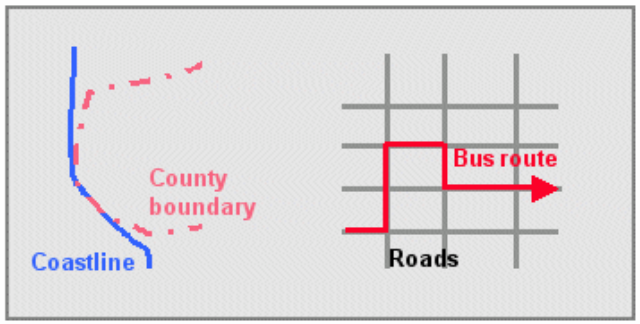
- Discrete data are distinct features that have definite boundaries and identities
  - A district, houses, towns, agricultural fields, rivers, highways, …
- Continuous data has no define borders or distinctive values, instead, a transition from one value to another
  - Temperature, precipitation, elevation, ...

Spatial relationship

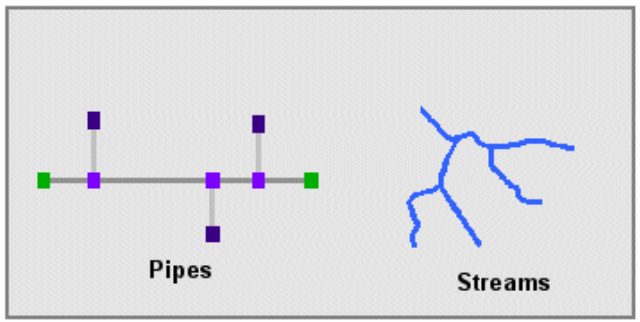
- Distance
  - From one feature to another (straight line or along roads)
- Density
  - The number of items per unit area
- Pattern
  - Consistent arrangement of features
- Proximity (or topology in GIS, more in Chapter 4)
  - Closeness
    - Adjacency
      - Share a common boundary
    - Contiguity (containment or coincidence)
      - One feature completely contained within another feature
    - Connectivity
      - Feature connect or touch,
        - Road network, road and stream



Adjacency allows you to identify which land owners or soil types share a common boundary with each other.



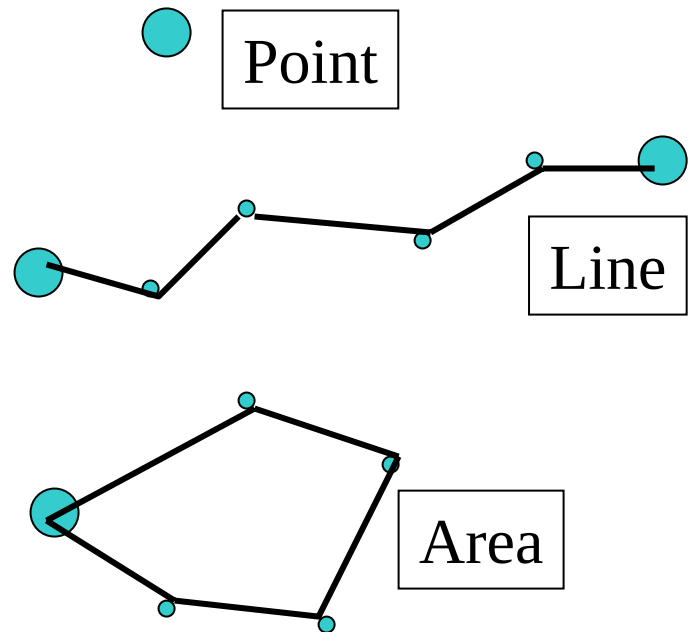
With coincidence, one boundary can lie on top of another. You can identify the bus routes on top of roads.



Connectivity allows you to follow a path from the water treatment plant to a house or the flow of water through streams.

GIS: a simplified view of the real world

- GIS is a computer representation of some aspects of the real world
- It is impossible to represent all feature of the real world, but a simplified view of the world, or models of the world as
  - Points
  - Lines (polyline)
  - Areas (polygon)
- For example,
  - Points: post offices in San Antonio
  - Lines: river in San Antonio
  - Areas: city of San Antonio



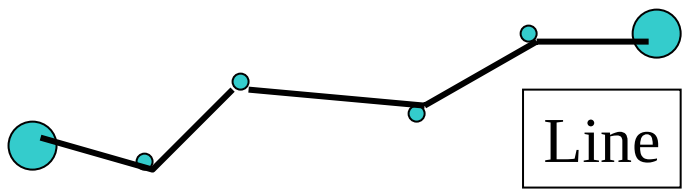
Points

- A point is a 0 dimensional object and has only the property of location (x,y)
- Points can be used to Model features such as a well, building, power, pole, sample location ect.
- Other name for a point are vertex, node

Point

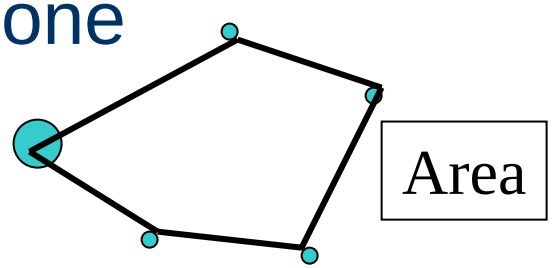
Lines

- A line is a one-dimensional object that has the property of length
- Lines can be used to represent road, streams, faults, dikes, maker beds, boundary, contacts etc.
- Lines are also called an edge, link, chain, arc
- In an ArcInfo coverage an arc starts with a node, has zero or more vertices, and ends with a node



Areas (Polygons)

- A polygon is a two-dimensional object with properties of area and perimeter
- A polygon can represent a city, geologic formation, dike, lake, river, ect.
- Other name for polygons face, zone



GIS: a simplified view of the real world

Discrete features

- Points
- Lines
- Areas
- Networks
  - A series of interconnecting lines
    - Road network
    - River network
    - Sewage network

Continuous features

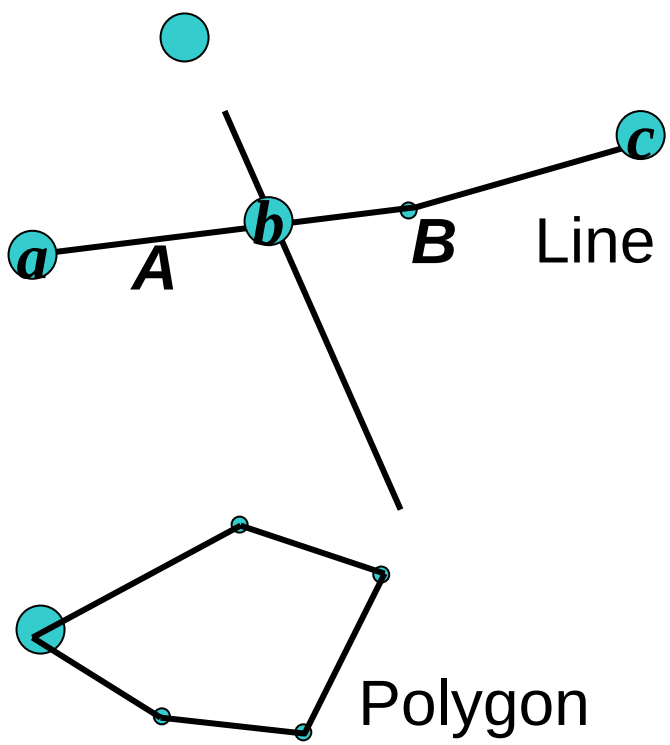
- Surfaces
  - Elevation surface
  - Temperature surface

Topology needed

- A collection of numeric data which clearly describes **adjacency**, **containment (coincidence)**, and **connectivity** between map features and which can be stored and manipulated by a computer.
- A set of rules on how objects relate to each other
- Major difference in file formats
- Higher level objects have special topology rules

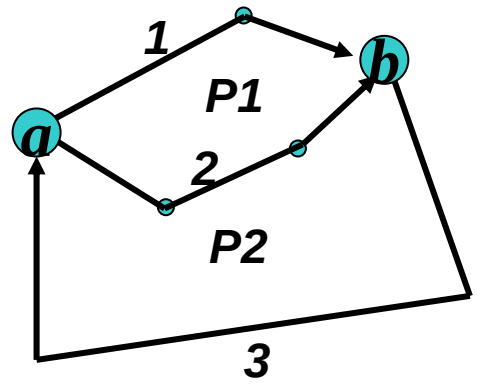
How Topology Works

- We previously discussed that lines represent linear features, or borders for area features. We also said that every line starts and ends with a node, and has intermittent shape points called vertices to define the shape of the line or border.
- So when you think about it, **lines don't really exist**. They simply represent a relationship between two nodes and zero or more vertices.
- When two lines cross, and form an intersection, they also have a node, since the intersection is the start of one line and the end of the other line.
- Topology describes the **connectivity** of the lines and nodes. So for our example on the right, lines **A** and **B** are connected by node ***b***. So line **A** goes from node ***a*** to node ***b***. Line **B** goes from node ***b*** to node ***c***.
- Now, we can create a whole string of lines and put them together into an area too. Now, just like a line, **polygons don't really exist**. They simply represent the relationship among lines, which in turn represent the relationship among points.



How Topology Works

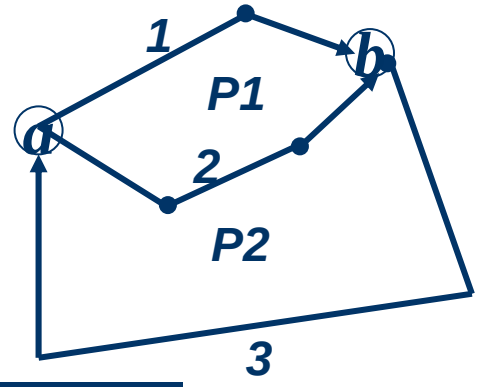
- Now we have described our **location** (with x,y coordinates), and our **connectivity**. What if we had two polygons ***P1*** and ***P2***, could we define the **adjacency**? Yes, here is how:
  - Line ***1*** goes from node ***a*** to node ***b***.
  - Line ***2*** goes from node **a** to node **b**.
  - Line ***3*** goes from node **b** to node **a**.
  - Polygon **P1** is to the left of line ***2,*** and to the right of line ***1***.
  - Polygon **P2** is to the right of line ***2***, and to the right of line ***3***.
- So, we can create a table that "clearly describes **location**, **adjacency**, **connectivity** and **containment**, or more specifically, a topology table.



Polygon	Lines
P1	**1,2**
P2	**2,3**

Line	FromNode	ToNode	LeftPolygon	RightPolygon
1	**a**	**b**	**0**	**P1**
2	**a**	**b**	**P1**	**P2**
3	**b**	**a**	**0**	**P2**

Traversing Topology

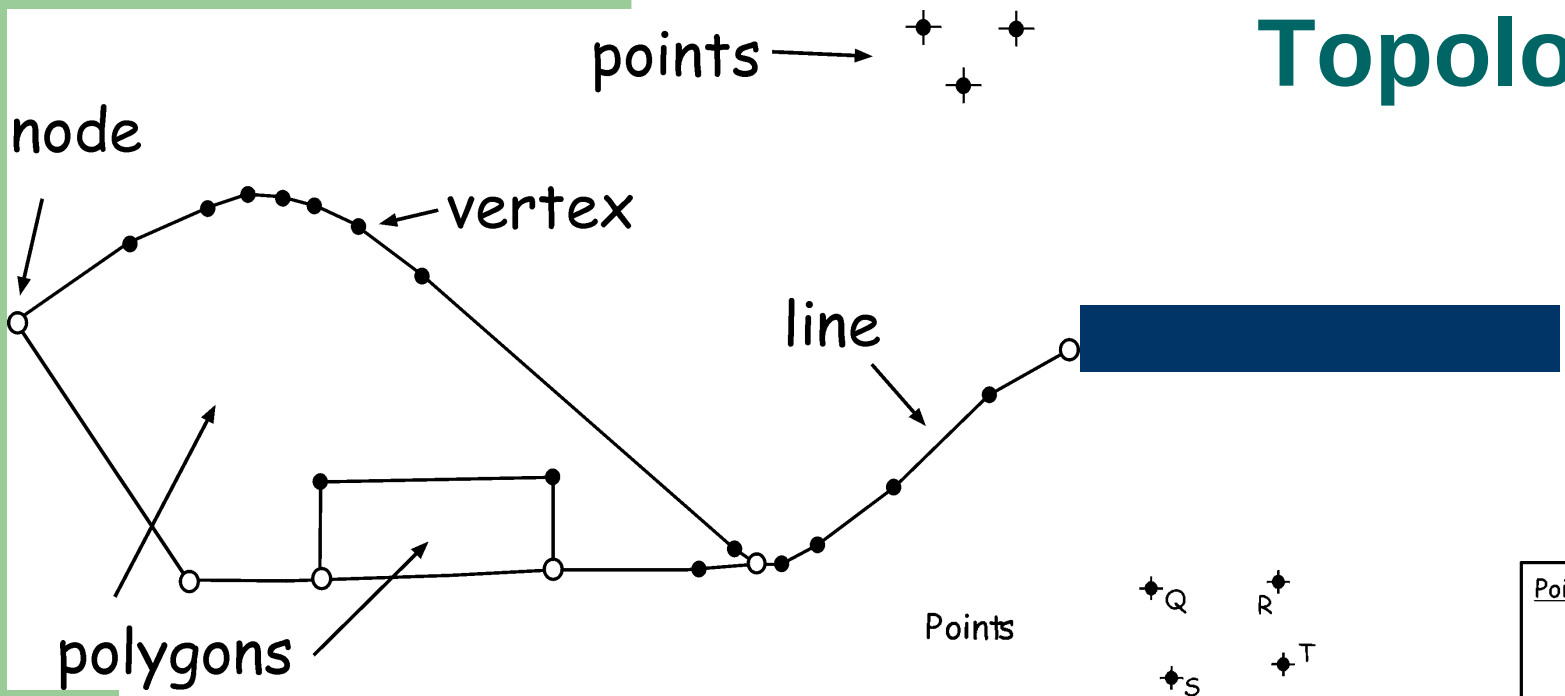


- Without looking at the picture, you can answer these questions from the table:
  - Where is node ***a***.
    - No problem. It has an x,y coordinate
  - What polygon is P1 next to, and where are they adjacent:
    - P1 is next to P2 because Line 2 has polygon P1 to the left and P2 to the right. This is **adjacency**.
  - How do I traverse from node ***b***, to node ***a***, and then back to node ***b***:
    - Easy! Take line **3** to node ***a***, and you have a choice to take either line **2** or **3** back to node **b**. This is **connectivity**.
  - What lines does polygon P1 fall inside of:
    - Easy! Polygon P1 is contained by lines 1 and 2. This is **containment**

Polygon	Lines
P1	**1,2**
P2	**2,3**

Line	FromNode	ToNode	LeftPolygon	RightPolygon
1	**a**	**b**	**0**	**P1**
2	**a**	**b**	**P1**	**P2**
3	**b**	**a**	**0**	**P2**

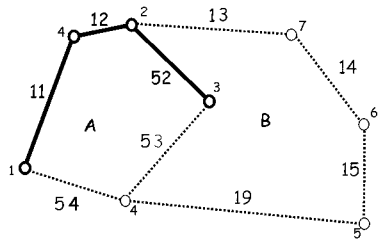
Topology



Points

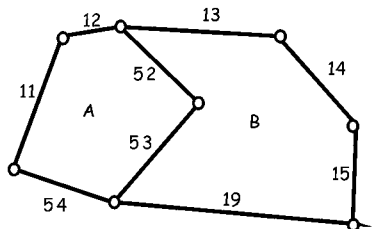
Point ID	X	Y
Q	32.7	45.6
R	76.3	19.5
S	22.7	15.8
etc...		

Lines



Line ID	Begin node	End node	Left poly	Right poly
11	1	4	...	A
12	4	2	...	A
52	2	3	B	A
etc ..				

Polygons



Polygon ID	Lines
A	11,12,52,53,54
B	52,53,19, 15,14,13