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 features 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 etc.

- Other name for a point are vertex, node
Lines

- A line is a one-dimensional object that has the property of length.
- Lines can be used to represent road, streams, faults, dikes, marker 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, etc.
- 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.”

<table>
<thead>
<tr>
<th>Polygon</th>
<th>Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>1,2</td>
</tr>
<tr>
<td>P2</td>
<td>2,3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>FromNode</th>
<th>ToNode</th>
<th>LeftPolygon</th>
<th>RightPolygon</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>a</td>
<td>b</td>
<td>0</td>
<td>P1</td>
</tr>
<tr>
<td>2</td>
<td>a</td>
<td>b</td>
<td>P1</td>
<td>P2</td>
</tr>
<tr>
<td>3</td>
<td>b</td>
<td>a</td>
<td>0</td>
<td>P2</td>
</tr>
</tbody>
</table>
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**

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</tr>
<tr>
<td>P2</td>
<td>2,3</td>
</tr>
</tbody>
</table>

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Topology

- Node
- Vertex
- Line
- Polygons

Points

<table>
<thead>
<tr>
<th>Point ID</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>32.7</td>
<td>45.6</td>
</tr>
<tr>
<td>R</td>
<td>76.3</td>
<td>19.5</td>
</tr>
<tr>
<td>S</td>
<td>22.7</td>
<td>15.8</td>
</tr>
<tr>
<td>etc...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lines

<table>
<thead>
<tr>
<th>Line ID</th>
<th>Begin node</th>
<th>End node</th>
<th>Left poly</th>
<th>Right poly</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>1</td>
<td>4</td>
<td>...</td>
<td>A</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>2</td>
<td>...</td>
<td>A</td>
</tr>
<tr>
<td>52</td>
<td>2</td>
<td>3</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>etc...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Polygons

<table>
<thead>
<tr>
<th>Polygon ID</th>
<th>Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>11,12,52,53,54</td>
</tr>
<tr>
<td>B</td>
<td>52,53,19, 15,14,13</td>
</tr>
</tbody>
</table>