

CEIE 410/510: GIS in Engineering, Fall 2009

Mohan Venigalla

ELEMENTARY SPATIAL ANALYSIS



Prelims

- Analysis - the heart of GIS
- Can be abused
 - Remember, Garbage In, Junk Out (GI JO)
 - You have to have a good idea about what type of analysis you want to do before you even start GIS software!
- Software/Hardware needs
 - Depend on analysis needs



© Mohan Venigalla, Fall 2009

Spatial Analysis

Analysis Needs

- Increasing order of complexity ↓
- What is the ultimate product?
 - Just a pretty map?
 - A pretty map showing analytical results?
 - A GIS database with your analysis results?
 - As a component of large study?
 - e.g. *A major investment study for an infrastructure project*
 - For regulatory business
 - (e.g. Fairfax County GIS operations)
 - Research?
 - A marketable product?
 - Data only
 - Data and analytical tools



© Mohan Venigalla, Fall 2009

Spatial Analysis

Ultimate Use

- GIS is not *unlike* a programming language:
The two steps to apply
 - you learn the skill
 - apply the skill to your domain
- Endless possibilities for GIS in Engineering
 - Again, analysis is the key!
 - transportation engineering
 - environmental engineering
 - utilities (water and electric)
 - water resources etc. etc.



© Mohan Venigalla, Fall 2009

Spatial Analysis

Complexity of Analytical Tasks

- Most simple
 - no new-data acquisition
 - no data manipulation
 - locate and identify objects
 - simple queries, to
 - complex queries
- Tedious but straight forward
 - a lot of data acquisition and manipulation
 - little analysis
- Most complex
 - some or a lot of data acquisition
 - extensive amount of data manipulation



© Mohan Venigalla, Fall 2009

Spatial Analysis

Entity Characteristics

- Truly spatial
 - physical location
 - we can search by $x,y!$
- Quasi spatial
 - attributes related to the location
- Other attributes
 - limitless (this is exactly where GIS distances itself from CAC)



© Mohan Venigalla, Fall 2009

Spatial Analysis

Important Considerations

- For the RDBMS -
 - separately define each group or category of the data
 - tabulate them
- Establish “relationships” among the entities of:
 - like-kind (categorical)
 - like-value (interval or ratio)



© Mohan Venigalla, Fall 2009

Spatial Analysis

Point Attributes

- Locate by x,y
- Locate by nominal data
 - e.g. name of the city
- Locate by any one or combination of attributes in the database!
 - Take the example - Realtor.com: You can search for house by:
 - Nominal data: city name, zip code etc. (any DBMS can do this)
 - Ordinal data: price range, no of bedrooms. (again, any DBMS can do this)
 - Other search criteria: certain distance within a location, say, Tyson's Corner! (Can any DBMS can do this? No! GIS + DBMS to the rescue!)

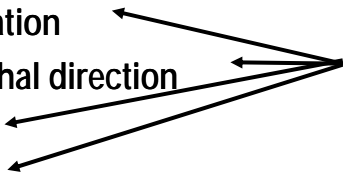


© Mohan Venigalla, Fall 2009

Spatial Analysis

Line Attributes

➤ Can locate any line object by:

- its location
 - azimuthal direction
 - shape
 - length
 - any combination query of *other* attribute values (*extraneous to truly spatial data*)
- No additional attribute data are needed
- 

➤ Other attributes

- can be limitless



© Mohan Venigalla, Fall 2009

Spatial Analysis

Area Attributes

➤ Search criteria:

- category
- class
- magnitude

➤ Basic measures

- shape and size

➤ Other measures of shape

- contiguity
- homogeneity



© Mohan Venigalla, Fall 2009

Spatial Analysis

Shape

- Euclidian shape - measured as a deviation from a known & predefined geometry
 - e.g. Earth is an ellipsoid (though three-dimensional)
- Fractal geometry - emerging interest
- One measure of polygon shape
 - polygon elongation ratio:
 - ratio of long axis to short axis



© Mohan Venigalla, Fall 2009

Spatial Analysis

Shape - 2

- Contiguity of an area/polygon
 - measure of wholeness or amount of perforation of a polygon
 - easily measurable for raster, difficult for vector
- Homogeneity of an area/polygon
 - measure of how much area of a given portion of a map is directly in contact with polygon features sharing the same attributes
 - attributes for homogeneity: min/max, average etc.
 - e.g. show all states with the same avg SAT scores!



© Mohan Venigalla, Fall 2009

Spatial Analysis

Higher Level Objects

➤ Points

- Centroids of area/polygons. Measured as:
 - geographical centroid
 - weighted mean center
 - center of gravity
- Measuring centroids - vector
 - separate polygon in to trapezoids
 - obtain individual trapezoid centroids
 - weight them to get the polygon centroid



© Mohan Venigalla, Fall 2009

Spatial Analysis

Higher Level Objects

- Networks - A full subject by itself
- Networks - a system of interconnected linear objects
 - A network of roads
 - Power grid
 - Telecommunications network
- Fully connected network
 - you should be able to go from anywhere to any where in the network!
 - Imagine not being able to:
 - go from New York to San Antonio
 - make a long distance call from Upland, CA to Richmond, VA



© Mohan Venigalla, Fall 2009

Spatial Analysis