

NS481/581 Introduction to Geographic Information Systems (GIS)

I. What is GIS?

- A. GIS - A digital (computer-based) information system that builds, manages, distributes, and analyzes spatial data
 - 1. spatial data = any information that is related to 3-D space
- B. GIS Development
 - 1. geography, cartography, computer science, mathematics
 - 2. Interdisciplinary science and tool
- C. Characteristics of a GIS
 - 1. software / computer driven
 - 2. a toolbox for analyzing spatial data
 - 3. involves unique spatial data linked to maps
 - 4. linkage of computer-based maps and database management system
 - 5. GIS uses map features to manage data
 - 6. GIS uses map features to query and retrieve data

II. Cartographic Components of GIS

- A. Map Features
 - 1. points (discrete positions in space)
 - 2. lines (linear connections between points, aka "arcs")
 - 3. polygons (areas enclosed by lines)
- B. Map Layers (aka "Themes" or "Coverages")
 - 1. layers = classes of cartographic information stacked on top of one another
 - 2. examples of layers or themes or coverages for any given map region
 - a. topography
 - b. bedrock geology
 - c. population density
 - d. roads
 - e. streams
 - f. vegetation
 - g. soils.... etc.
- C. Map Position Coordinates (based on Cartesian coordinate system)
 - 1. Longitude - Latitude (degrees)
 - 2. Eastings - Northings (meters or feet)

III. Digital Data Structures for Map Information

- A. X-Y-Z data (X,Y = position, Z = "attribute")
- B. Attributes of map features
 - 1. points, lines, polygons are assigned attributes
 - a. attribute examples
 - (1) elevation

- (2) bedrock type
- (3) vegetation type

C. Digitizing

- 1. Process of obtaining digital map coordinates, map element types, and attributes of elements
- 2. digitizing = method of obtaining map information in computer format

IV. GIS and Spatial Database Functions

A. Purpose: to use map feature to call and retrieve data about a given area or map object.

B. Database Query

- 1. Asking questions about attributes in a spatial database
- 2. Geographic searching is critical to GIS database queries

C. Examples of spatial database queries that can be accomplished with GIS

- 1. Find all homes in the city of Portland that have the following attributes: they are located within 50 ft of a fire hydrant, are painted red, are situated within 500 feet of an active fault zone, and have median household incomes of greater than \$50,000.00
- 2. Find all map areas that are associated with hillslope gradients greater than 25 degrees
- 3. What is the total land area on the map that is underlain by alluvial deposits of the Willamette River?

V. GIS Map Types

A. Dot Maps or Symbol Maps

- 1. e.g. locations of state capitols around the U.S.

B. Line Maps

- 1. e.g. road maps
- 2. stream network maps
- 3. topographic (contour) map

C. Area Maps

- 1. isohyet map (map showing areas of equal rainfall)
- 2. land use map (map showing areas of similar land use)

D. Volume Maps

- 1. 3-D models of the Earth's surface

VI. Examples of Advanced Analytical Techniques

A. Hydrologic modeling and prediction

B. Statistical analysis of spatial data

C. Network analysis (choosing paths of lowest cost or most efficient routes)

VII. Example GIS Applications

A. Using GIS to understand the spread of forest disease over time

B. Using GIS to estimate seismic hazards in western Oregon

C. Using GIS to map the distribution of endangered species

D. Using GIS to track the spread of AIDS globally over time