Watershed Sciences 4930 & 6920
GEOGRAPHIC INFORMATION SYSTEMS

WEEK FIVE – Lecture
VECTOR ANALYSES

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HOUSEKEEPING

• Forums
  - Nice job! Keep up the activity.
• Other Questions?

READING FOR TODAY

TODAY’S PLAN

I. Vector Analyses
   I. Some Basics
   II. Selection
   III. Classification
   IV. Proximity Functions & Buffering
   V. Vector Overlay

SPATIAL ANALYSIS:
A way of obtaining information

• Turns raw data into useful information
  - by adding greater informative content and value
• Reveals patterns, trends, and anomalies that might otherwise be missed
• Provides a check on human intuition
  - by helping in situations where the eye might deceive
• A.K.A. Spatial Operations or Spatial Functions
  - Hundreds exist
  - All involve manipulation or calculation of coordinate or attribute values
PROJ ECT REQUI SITE: SPATIAL ANALYSIS

- A method of analysis is spatial if the results depend on the locations of the objects/surface being analyzed
  - move the objects and the results change
- Method of investigation and interpretation
  - Basically, anything you do with data in space to answer a question is a form of analysis
  - Interpretation requires application of the right data for the task
  - how would one assess this?

SPATIAL ANALYSES CAN BE SEQUENTIAL

- The final analysis or output is arrived at after a series of spatial operations...

THREE TYPES OF OPERATIONS (VECTOR)

- Local
  - Use only data at one input location to determine value at corresponding same output location
- Neighborhood
  - Use data from both an input location plus nearby locations to determine output value
- Global
  - Use data values from entire input layer to determine each output value

1. LOCAL OPERATIONS

- Use only data at one input location to determine value at corresponding same output location

E.G. FIELD CALCULATOR – LOCAL OPERATION

- Powerful form of spatial analysis...
- You can come up with just about anything that combines existing attributes...

2. NEIGHBORHOOD OPERATIONS

- Use data from both an input location plus nearby locations to determine output value
FOR EXAMPLE... NEIGHBORHOOD OPS.

3. GLOBAL OPERATIONS

- Use data values from entire input layer to determine each output value

From Bolstad (2008), Chapter 9

E.G. FIELD CALCULATOR - GLOBAL OPPERATION

- How would this be different then a local operation?
- E.g. sort...

NUMBER OF INPUTS & OUTPUTS VARIES

- You can even have many inputs leading to many outputs...

From Bolstad (2008), Chapter 9

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VIEWS AND QUERIES

- GIS provides several different ways of viewing data:
  - maps, tables, catalog, charts

- A query is a statement or logical expression used to select elements from a larger set
  - Data Query: select records from a database
  - Spatial Query: select features by their location
- A Query is a form of **selection**
FOUR TYPES OF SELECTION

1. Scroll & Select
2. Set Algebra
   - Operations: less than <, greater than >, equal =, or not equal <>
3. Boolean Algebra
   - Conditions: OR, AND & NOT
4. Spatial Selection Operations
   - Adjacency & Containment

SELECT BY ATTRIBUTES (BOOLEAN & SET ALGEBRA)

- ArcGIS Example
  - For example: Select streams with code less than or equal to 4 but not equal to 0
  - SQL: "CODE" <= 4 AND "CODE" <> 0

DATA QUERY AND VIEWS

You've already done this (perhaps unknowingly…)

SELECT BY ATTRIBUTES

From Bolstad (2008), Chapter 9
SELECT BY ATTRIBUTES (BOOLEAN ALGEBRA)

- ArcGIS Example
  - For example: Select streams with code less than or equal to 4 but not equal to 0
    - SQL: "CODE" <= 4 AND "CODE" <> 0

- Class Example
  - Country, State (if U.S.), Hair Color, Sex, Reside On/Off campus, Degree Seeking, Height, Age
  - "HAIR COLOR" = 'brown'
  - "HAIR COLOR" = 'brown' AND age >= 21
  - We can also choose to select within selections:
    - Within the previous selection, select:
      - "STATE" <> 'Utah'

EXAMPLES OF BOOLEAN EXPRESSIONS

1. Scroll & Select
2. Set Algebra
   - Operations: less than <, greater than >, equal =, or not equal <>
3. Boolean Algebra
   - Conditions: OR, AND & NOT
4. Spatial Selection Operations
   - Adjacency & Containment

SPATIAL QUERIES (CONTAINMENT)

- Features fall inside of some geographic area
  - This feature requires special consideration. Will the query require the entire feature to fall within a given area?

SPATIAL QUERIES (SPATIAL SELECTION)

- Features are adjacent to one another
  - Polygon A is ADJACENT to polygon B.
SPATIAL QUERIES (SPATIAL SELECTION)

• Features lie within a specified distance of another feature

For example: No timber harvest within 10 meters of a stream channel

SELECT BY LOCATION

• With the Select By Location dialog box, you can select features based on their location relative to other features.
  • Referred to as a “Spatial Query”
  • Select by Location has several “Select From” features.
    • I want to:
      • Select features from
      • Add to the currently selected features in
      • Remove from the currently selected features in

SELECT BY LOCATION

• Further options:
  • Intersect
  • Are within a distance of
  • Completely contain
  • Are completely within
  • ...

For example: We want to select all communication towers that lie fall within 25 Km of a BLM Wilderness Study Area.

CHARTS AND GRAPHS

Extending Selection Analyses with Charts & Graphs
  • GIS Documents often require additional information to present your statement and clarify your position
  • Utilizing ArcGIS tools Charts and Graphs can be inserted into ArcMap documents
  • Graphs should be utilized carefully, don’t clutter your layout with unnecessary information
ARE YOU MISSING SOMETHING?

Extensions and ArcGIS

- New users often forget that there are many useful extensions that are not pre-loaded in ArcGIS
- These can be found (and activated) by right clicking on an empty space on your toolbar
- Depending on your license level, you may not have all ArcGIS extensions
- Many functions can also be found in ArcToolbox

BASIC DATA EXPLORATION

Using Geostatistical Analyst

- Statistical data exploration is required in many analysis - both basic and advanced
- Geostatistical Analyst allows a user to explore data (statistically) using basic statistical plots:

THE GEOSTATISTICAL WORKFLOW

DATA EXPLORATION EXAMPLES

DATA EXPLORATION EXAMPLES

NOT SURE, USE THE WIZARD
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CLASSIFICATION OF SPATIAL DATA

- Classification is a spatial data operation used in conjunction with previous selection operations
- A.K.A. reclassification or recoding
- This can either create a new data set or simply a different view of same data (e.g. display properties)

CLASSIFICATIONS BASED ON DISTRIBUTION OF DATA

A BINARY CLASSIFICATION

Classification of spatial data operation used in conjunction with previous selection operations
A.K.A. reclassification or recoding
This can either create a new data set or simply a different view of same data (e.g. display properties)

CLASSIFICATIONS BASED ON DISTRIBUTION OF DATA

- Natural breaks classification
- This can either create a new data set or simply a different view of same data (e.g. display properties)
HOW DO WE (PRIMARILY) CLASSIFY VECTOR DATA IN ARCGIS?

EQUAL INTERVAL

DEFINED INTERVAL

QUANTILE

NATURAL BREAKS

GEOMETRIC INTERVAL
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**PROXIMITY & BUFFER**

- Proximity functions modify existing features or create new features that depend on distances from that feature in some way.

**BUFFERS**

- Create a new object consisting of areas within a user-defined distance of an existing object (point, line, or polygon)
  - e.g., to determine areas impacted by a proposed highway
  - e.g., to determine the service area of a proposed hospital
- Feasible using either rasters or vectors

**STANDARD DEVIATION**

**SAME DATA... JUST DIFFERENT CLASSIFICATION**

**HISTOGRAMS! & OTHERS...**

**PROXIMITY & BUFFER**
**SPATIAL QUERIES (SPATIAL SELECTION)**

- YOU’VE SEEN THIS... Features lie within a specified distance of another feature
  
  For example: No timber harvest within 10 meters of a stream channel

**TYPES OF SIMPLE VECTOR BUFFERS....**

- 'Simple' refers to fixed distance...

**ALLOWS THEN SELECTION QUERIES OF:**

- Enclosed areas, inside buffer areas, outside buffer areas...

**FANCIER... VARIABLE DISTANCE BUFFER**

**BUFFER ISSUES TO CONSIDER**

- If you have many features to buffer, what happens if buffer zones overlap?
- If lines, are ends rounded or square?
- If polygons, outside or inside?
- If outside, do you want to include the original features?

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SIMPLY OVERLAYING DIFFERENT TYPES…

- Five possible combinations
- Sometimes just simple combination
- Output is always the simpler data type

SPECIAL CASES OF POLYGON OVERLAYS

VECTOR OVERLAYS IN ARC

- ArcToolbox → Analysis Tools → Extract|Overlay
- ArcToolbox → Coverage Tools → Analysis → Extract|Overlay
- Extract: SELECT, CLIP, SPLIT
- Overlay: ERASE, IDENTITY, INTERSECT, SYMMETRICAL DIFFERENCE, UNION, UPDATE

VECTOR OVERLAYS: DISCRETE OBJECTS

In this example, two polygons are overlaid to form 9 new polygons:

- Both input polygons (1) Polygon A only (4) Polygon B only (4)

Most overlay operations differ in two respects:

1. Which of these polygons are kept or discarded?
2. What happens to the attributes?

VECTOR OVERLAYS: DISCRETE OBJECTS

A CLIP operation would keep the features and attributes of A that fell within B
An INTERSECT would keep the overlapping areas and retain attributes from both
PROBLEMS WITH FIELD OVERLAYS

- In any two such layers there will almost certainly be boundaries that are common to both layers - e.g. following rivers, coastlines, county lines
- The two versions of such boundaries will not be coincident
- As a result large numbers of small sliver polygons will be created - these must somehow be removed - this is normally done using a user-defined tolerance
- Rasters do not have this problem

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THIS WEEK'S LAB

VECTOR ANALYSES

• Another Oil Spill!
• The city needs your GIS skills to help respond to the disaster