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#### Geographic Information Systems 1 Lecture 9: Spatial Data Analysis



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**Spatial Analysis** 

- answer questions, support decisions, and reveal patterns
  - all of the transformations, manipulations, and methods
  - Data ----> Information ---> Understanding

 "a set of methods whose results change when the locations of the objects being analyzed change"



# Which is Spatial Analysis?

 calculating the average income for a group of people?

 calculating the center of the Czech Republic population?



# **Types of Spatial Analysis**

- Queries and reasoning
- Measurements
  - Aspects of geographic data, length, area, etc.
- Transformations
  - New data, raster to vector, geometric rules
- Descriptive summaries
  - Essence of data in 1 or 2 parameters
- Optimization ideal locations, routes
- *Hypothesis testing* sample to entire pop.



# **GIS Analysis Model (flowchart)**

### Residential areas in flood zone BUT

#### need spatial analysis to pinpoint locations





# GIS Lanslide Susceptibility Model in ArcGIS Model Builder





# 2 Analysis Examples from ArcGIS

- Interpolation soil samples on a farm [transformation]
- Location Analysis coffee shops & customers [optimization]



# "a set of methods whose results change when the locations of the objects being analyzed change"

- Interpolation soil samples on a farm
- Location Analysis coffee shops & customers

#### Soil Samples of Farm Area w/ Interpolation

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#### Interpolate samples, then query to find pH > 7 Farmer needs to treat these areas w/ammonium sulfate

# **GIS Analysis Model**

### **Choose Interpolation Parameters**

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## **IDW Interpolation**

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#### Instead of hillshade, use raster calculator

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#### Result: areas that farmer should treat w/ammonium sulfate to lower the pH to 7 so that soil is balanced

🎇 Farm.mxd - ArcMap - Arcini
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# The Farm

- Size = ~5.35 acres (233,046 sq ft. or 21,650 sq m)
- Combined size of new treatment areas = ~0.145 acres (6,338 sq ft or 588 sq m)
- Ammonium sulfate @ \$50.00 per acre
   Treat whole field \$267.50

– Treat only where needed - \$7.25

• Crop yield and treatment maps over time



# "a set of methods whose results change when the locations of the objects being analyzed change"

• Interpolation - soil samples on a farm

• Location Analysis - coffee shops & customers

# Best location for new Beanery w/ location analysis ( distance & proxmity )

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# Marketing questions

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v Českých Budějovicích

University of South Bohemia

- Too close to existing shops?
- Similar characteristics to existing locations?
- Where are the competitors?
- Where are the customers?
- Where are the customers that are spending the most money?



#### Shops w/in 1 mile will compete for customers Potential shops > 1 mile away

# **GIS Analysis Model**





# Straight line distance function

Straight Line		? ×
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#### Result: yellow/orange = close to shops purple/blue = farther away

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#### **Density Function, Customer Spending**

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# Result: Dark blues are greatest density of customer spending

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# Find areas 1 mile from an existing shop that are also in a high spending density customer area



#### **Result: Best locations for a new Beanery**

w/ proximity to an interstate highway, zoning concerns, income levels, population density, age, etc.

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# Uncertainty in the <u>Conception</u>, <u>Measurement</u>, and <u>Representation</u> of Geographic Phenomena

- Previous examples assumed it didn't exist
- Conception of Geographic Phenomena
- Spatial Uncertainty objects do NOT have a discrete, well-defined extent
  - Wetlands or soil boundary?
  - Oil spill? pollutants or damage?
  - Attributes human interp. may differ



# **Uncertainty in Conception**

- Vagueness criteria to define an object not clear
  - What constitutes a wetland?
  - An oak woodland means how many oaks?
  - Seafloor ages/habitats
  - What does a grade of "A" really mean??



## **Uncertainty in Conception**



Ambiguity - y used for x when x is missing Direct indicators: salinity (x) or species (y) Indirect more ambiguous Wetlands (y) of species diversity (x)??



## **Uncertainty in Conception**



- Regionalization problems
- What combination of characteristics defines a zone?
- Weighting for composites?
- Size threshold for zone?
- Fuzzy vs. sharp



- Physical measurement error
- Mt. Everest is 8,850 +/- 5 m
- Dynamic earth makes stable measurements difficult
  - Seismic motion
  - Wobbling of Earth's axis
  - Wind and waves at sea!





- Digitizing error, e.g.,
- Undershoots
- Overshoots
- Gafs"





- Misalignment of data digitized from different maps
- *Rubbersheeting* is a corrective technique





- Different lineages of data
- Sample vs. population



# Uncertainty in Representation Raster Data Structure



mixels

Classification based on dominance, centrality?



# Uncertainty in Representation Vector Data Structure



Points in cornersZones based on onlyof polysa few points

#### **Uncertainty in Analysis: The Ecological Fallacy**



(A)Before it closed down, the footwear factory drew its labor from its local neighborhood and a jurisdiction to the west (B) The closure caused high unemployment, but not among the service sector workers of Chinatown (C) a spurious relationship between Chinese ethnicity and unemployment



# Uncertainty in Analysis Ecological Fallacy

an overall characteristic of a zone is also a characteristic of any location or individual within the zone

Factory w/no Chinese employees may have closed



# Modifiable Areal Unit Problem (MAUP)

- number, sizes, and shapes of zones affect the results of analysis
- Many ways to combine small zones into big ones
- No objective criteria for choosing one over another



Path of boundary changes where high pop. is



# Uncertainty of Geographic Phenomena

- Conception spatial, vagueness, ambiguity, regionalization
- Measurement field, digitizing, lineage
- Representation raster, vector
- Analysis ecological fallacy, MAUP



#### Thank you for your attention

