Distance and density

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Last week

- Defined interpolation
- Described the important property of spatial data that allows for successful interpolation
- Described several interpolation methods and their assumptions
- Discussed sampling strategies and methodological ideas behind local and global interpolation
Objectives

• Learn how distance and density functions work
• Describe cost, direction, distance and density surfaces are calculated
• Introduce three cell statistics types
Distance functions

• Allow you to determine the nearest location of something or the least cost path to a particular destination

![Diagram of distance functions](image)
Density functions

• Allow you to see the highest and lowest concentration of features
Straight line distance functions

• Computes the straight line distance to a particular location

• The value of each cell generated equals the measured distance of a straight line from the cell’s closest source
Straight line distance functions

- Measures from center of cell to center of source cell
- If more than one source, each cell value is the straight line distance to the closest source
Cost weighted distance function

• Calculates the least-cost path to a particular location

• The value of each cell generated represents the accumulated cost of travel from the closest source

• Usually one part of a larger analysis
Straight line allocation and direction

Allocation

Direction
Cost surface

Cost surfaces represent some factor or combination of factors that affect travel across an area.

A particular area can have more than one cost surface; one for each factor.
Cost weighted distance surfaces

- Evaluates the neighbors of each cell, beginning with the source
- Multiplies the average cost between each pair by the distance between them
- Assigns each of the neighboring cells a cost weighted value
- The process moves to the cell with the lowest value, evaluates its neighbors with unknown values, and so on
Direction surfaces

- Instead of a compass direction, each cell value is given a code number that indicates the direction of the next least-cost cell.
Least cost path analysis

• Uses the cost weighted distance and direction surfaces for an area to determine a cost-effective route between a source and destination
• The eight neighbors of a cell are evaluated and the path moves to the cell with the smallest accumulated value
Least cost path analysis

- The process repeats itself until the source and destination are connected
- The completed path represents the smallest sum of cell values between the two points
Density

• Density surfaces are great for illustrating concentrations or patterns that otherwise might not be apparent

• Calculation of the quantity of something per unit area

• Makes calculations using discrete objects or events

• There are two methods for calculating density
  – Simple
  – Kernel
Simple density calculations

\[
\frac{7 \text{ observations}}{2.88 \text{ acres}} = 2.4 \text{ observations per acre}
\]

• The size of the search radius will affect the calculation results
• The larger the search radius, the smoother the surface
Kernel density calculations

- Uses a kernel function to fit a smoothly tapered surface to each point or polyline
- The larger the search radius, the smoother the surface
Using attributes to calculate density

• Sometimes points represent populations or the number of occurrences at a particular location

• Instead of calculating the density of the points, you can also calculate the density of the populations or events that those points represent.
Using attributes to calculate density

\[
\frac{686 \text{ people}}{3.14 \text{ square kilometers}} = 218.47 \text{ people per square kilometer}
\]
Cell by cell statistics

• You use statistics to
  – Describe your data
  – Add validity to your research
  – Make sound decisions

• Inferential vs. Descriptive statistics
Cell by cell statistics

• You can use statistics to create new raster datasets. The statistical functions are divided into 3 basic groups:
  – Cell
  – Neighborhood
  – Zonal
Cell statistics function

- Cell statistics allows you to compare two or more raster datasets on a cell-by-cell basis.
- You can use it to find trends or detect change.
Neighborhood statistics function

- Calculates values of cells based on a specified neighborhood around the processing cell
- The size and shape of neighborhood can be specified
Neighborhood statistics function

- A 3-cell X 3-cell rectangular neighborhood is the default
- Other shapes can be used
Zonal statistics function

• Considers the values of cells based on groups of like cells, or zones, in another dataset

• Any 2 or more cells with the same value belong to the same zone
Zonal statistics function

- Zonal statistics produces a table of statistics and a graph.
Types of descriptive statistics for cell, neighborhood and zonal

- **Majority**: determines the value that occurs most often.
- **Minority**: determines the value that occurs least often.
- **Maximum**: determines the highest value.
- **Minimum**: determines the lowest value.
- **Range**: computes the difference between the highest and lowest values.
- **Mean**: computes the total of the values divided by the number of observations.
- **Median**: computes the central value, where there are an equal number of values above and below it.
- **Standard Deviation**: computes the spread or dispersion of values from the mean.
- **Sum**: computes a total value by adding all of the values.
- **Variety**: determines the number of different values.
Summary

• Distance and density functions

• How to calculate surfaces?
  – Cost
  – Direction
  – Distance
  – Density

• Introduced three cell statistics types
  – Cell
  – Neighborhood
  – Zonal