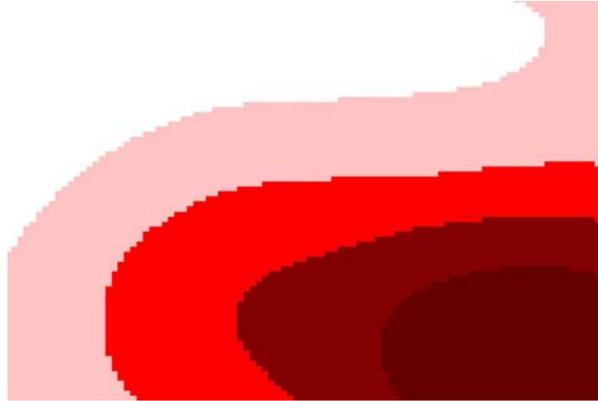


Beyond The Vector Data Model - Part Two



Introduction

- Spatial Analyst Extension (Spatial Analysis)
- What is your question?
- Selecting a method of analysis
- Map Algebra
- Who is the audience?

What is Spatial Analysis?

Approach* used to answer complex geographic questions by **evaluating** suitability, **predicting** and **interpreting** patterns.

Spatial modeling involves analytical procedures to abstract and **simplify complex systems**. We will use geographic data to describe, simulate, or predict real-world problems or systems.

There is more than one answer, and our role is to compare **alternative solutions**.

ArcView's Spatial Analyst (Functionality)

* Kindly refer to the Lecture Notes section

The software provides several tools to perform **spatial queries using grids**: overlay analysis, surface analysis like distance, proximity, density, slope, aspect, hillshade, viewshed, and contours.

What is your question?

(General) Where do robberies concentrate?

Know Your Data

Source	Philadelphia Police Department
Format	MS Access, Oracle
Size	Approximately 7 Million Records
Quality	Stringent Quality Assurance Procedures
Span	January 1, 1998 through December 31, 2001 (4 Years)
Detail	Street Address

Example used in class will rely on data subset of:

-Robberies (300 series)

-Dispatch date range of 1/1/98 to 3/31/98 and 1/1/99 to 3/31/99

Selecting a method of analysis

Criminal activity often analyzed with consideration to "hot spots" or "clusters"

Empirical studies typically rely on an **area-based unit of analysis** (census tract, block group, block, police precinct/district, etc.)

Area-based aggregation of crime incidents result in **aggregation bias**

Difficulties associated with **obtaining data** that represent individual crime incidents

Point-based methods, representing the finest level of aggregation, are **computationally intensive**

Introduction to the Density Function (Spatial Analyst)

Spatial Analyst can generate a grid theme from a point theme

Raster data model allows the user to create a smooth (continuous) surface with [peaks and valleys](#)

The [user defines the cell size](#), which influences the output

A [circular window](#) with a constant radius moves across the study area, centered on each grid cell

Incidents within the circular window are [weighted according to their distance](#) from the center of the window (incidents near the center have greater weight)

The [user defines the radius](#) of the circular window

Density function considers the number of crimes within the circular window AND their [spatial configuration](#) (density value of grid cell will vary)

- For more on [the formula that assigns individual grid cells a density value](#), see McLafferty, Sara, Doug Williamson, and Philip McGuire. "Identifying Crime Hot Spots Using Kernel Smoothing." In *Analyzing Crime Patterns: Frontiers of Practice*. Thousand Oaks: Sage Publications, 2000.

Using the Density Function (Spatial Analyst)

Activate a point or multipoint theme.

From the Analysis menu, choose [Calculate Density](#).

If the view's analysis properties haven't been set to a specific value, then you'll be prompted to set the extent and cell size for the output grid theme. Do so in the Output Grid Specification dialog and press OK.

In the Calculate Density dialog, choose a field from the [Population Field](#) dropdown list to identify the measured quantity to distribute through the output grid theme. A choice of <None> assigns a value of 1 to all points in the input point theme.

Specify a search radius in the [Search Radius](#) type-in box. The radius determines the distance to search for points from each cell in the output grid theme. The radius is reported in the distance units specified for the view. If the view's distance units are not set, then the search radius is reported in map units. By default, the radius value is initially set to the smaller distance of the width and height of the extent of the input point theme (or the extent of the selection) divided by 30.

Choose either [Simple](#) or [Kernel](#) in the Density Type dropdown list.

Choose the units that you want the density values to be presented in from the Area Units dropdown list. Press OK.

Calculate Density distributes the measured quantity of an input point theme throughout a landscape to produce a continuous surface.

The two types of density methods are:

Simple - Density is calculated for each cell by summing the value found in Population

Field for each point found in the Search Radius and dividing by the area of the circle in Area Units.

Kernel - Density is calculated the same way as with the Simple method except the value found in Population Field is distributed out from each point. The result is a smoother looking output.

The output density values will be the occurrences of the measured quantity per specified [Area Unit](#). If the map units of the view are not set, then the Area Units are set to Square Map Units and cannot be changed. If the map units of the view are set, Area Units can be Square Miles, Square Kilometers, Acres, Hectares, Square Yards, Square Inches, Square Meters, Square Centimeters, or Square Millimeters.

Calculate Density works off of the selected set of the active theme. If the active theme does not have a selected set, then all points in theme are used. For more information on selecting features, see [Selecting features on a view](#).

The output grid theme from Calculate Density is automatically named "Density from" followed by the name of the input theme. The grid data set associated with the output theme is written to the project's working directory, with the name "denst" followed by a unique number. Use Properties in the Theme menu to find out which data set is associated with which theme. Use Properties in the Project menu to change the project's working directory. The grid data set associated with the output theme is [temporary](#) and will be deleted when the theme is deleted.

EXAMPLE:

Active Theme = [Robberies 1/1/99 through 3/31/99 \(2,746 records\)](#)

Analysis Extent = [City boundary](#)

Cell Size = [50 feet](#)

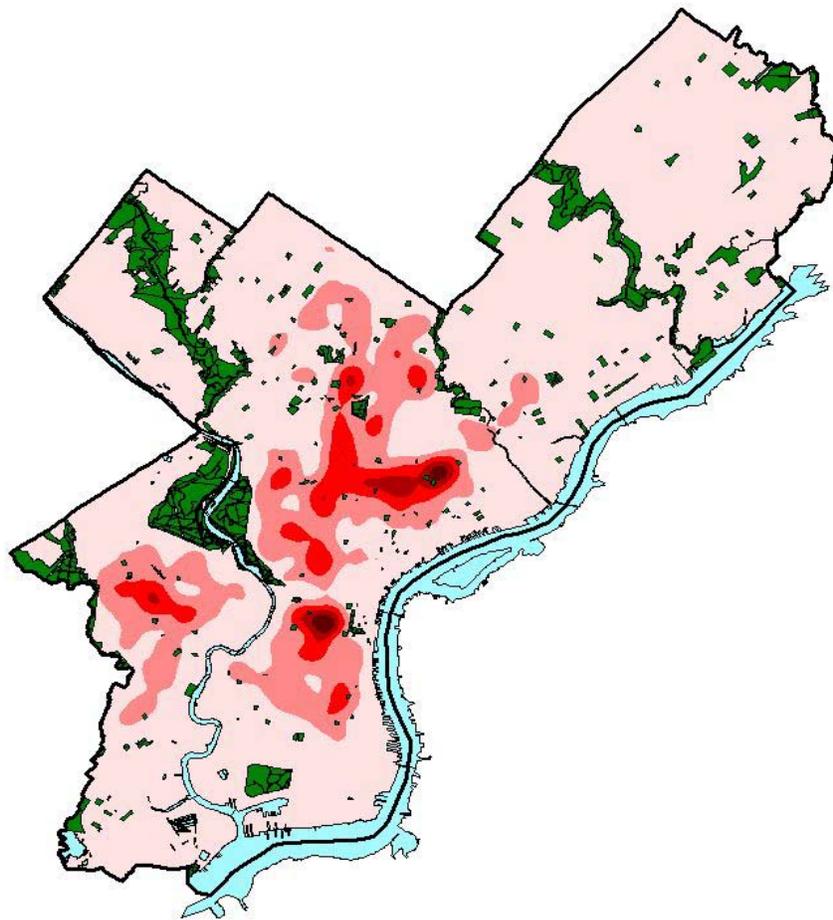
Population field = [<None>](#)

Search Radius = [1/2 mile](#)

Density Type = [Kernel](#)

Area Units = [Square Miles](#)

Output =



Zoom In (Frankford Special Services District)

This approach differs from traditional binning.

The output is aesthetically pleasing

Output not limited by social and political boundaries (census tracts, etc.)

Large radius (bandwidth) results in low density values and generalized findings (1/2 mile is large for this context)



How Should the User Define the Radius? (Bandwidth? Circular Window?)

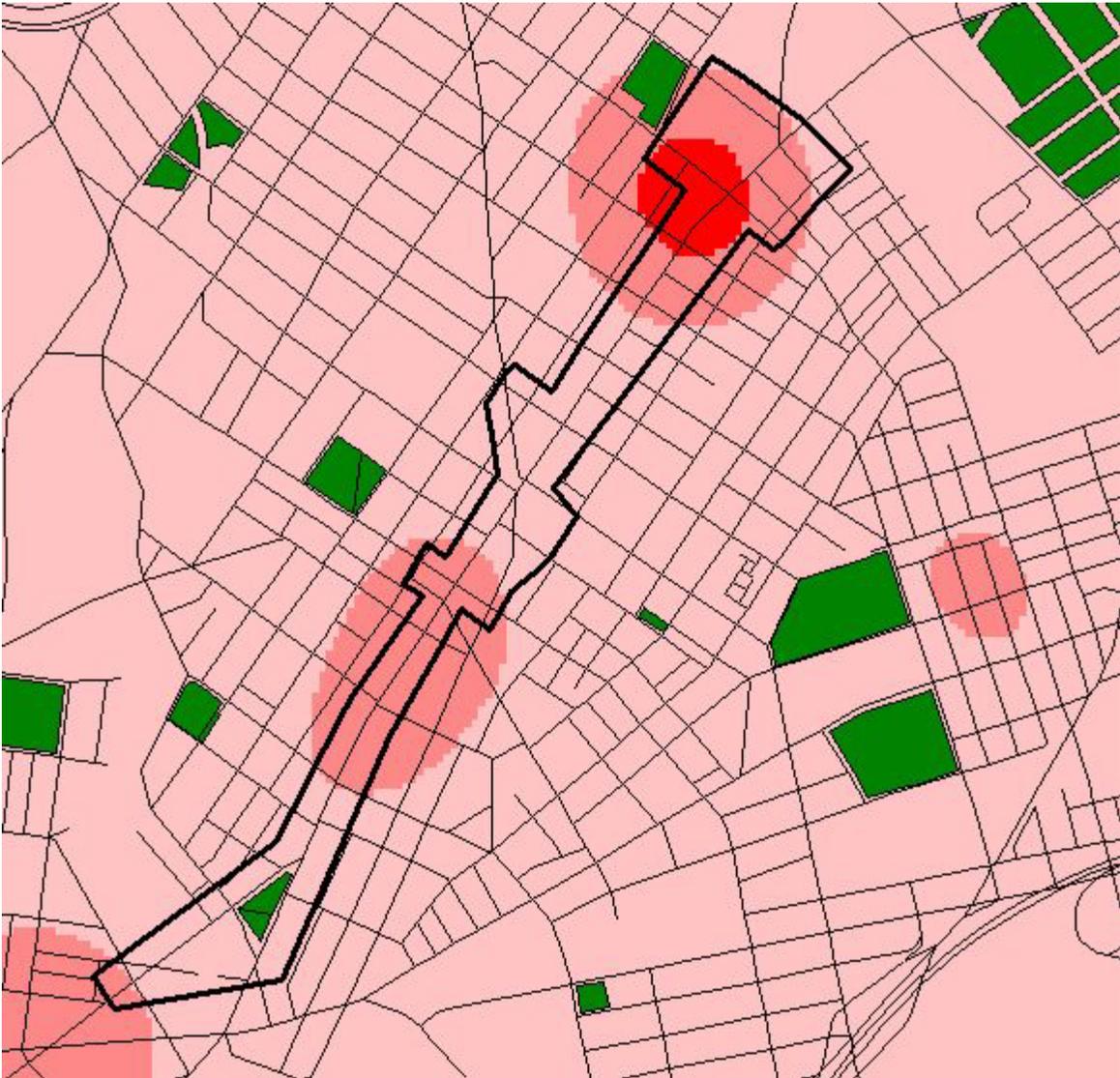
ArcView's default considers the width and length of the output grid, selects the smaller distance and divides by 30 (in this case, 1/2 mile)

This approach is arbitrary

User should carefully consider the question, data, and context

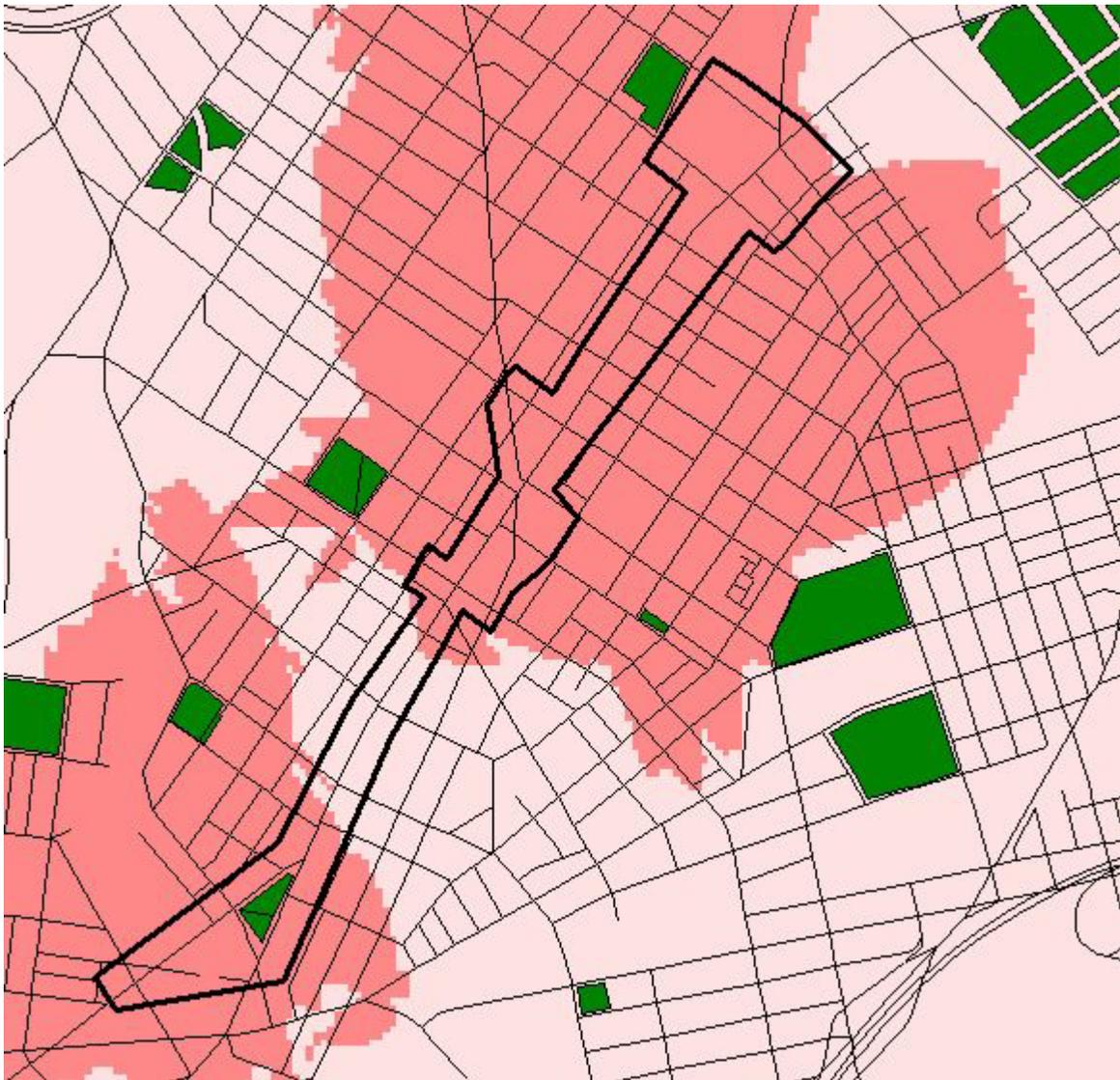
Smaller radius will demonstrate local variations

For example, the following map was generated using the same parameters defined above, except the radius = 1/4 mile



Simple or Kernel Method?

The first three images were produced using the kernel method
Here's the same analysis (Robbery theme, 1/4 mile radius) using the simple method
Edges are jagged



Map Algebra

One step beyond using overlays to conduct visual analysis

Map algebra is a **computational language** used to perform spatial analysis using raster (grid) data

Allows user to perform analysis on one or many grid themes (**thus creating new themes**)

Expressions are entered into the **Map Calculator** in the syntax of **Avenue** (native

programming language)

These operations are similar to spatial overlay, but returns numeric values

Pop90	Pop60	PChange
2 5	1 2	1 3
3 1	1 1	2 0

$$[\text{Pop90}] - [\text{Pop60}] = [\text{PChange}]$$

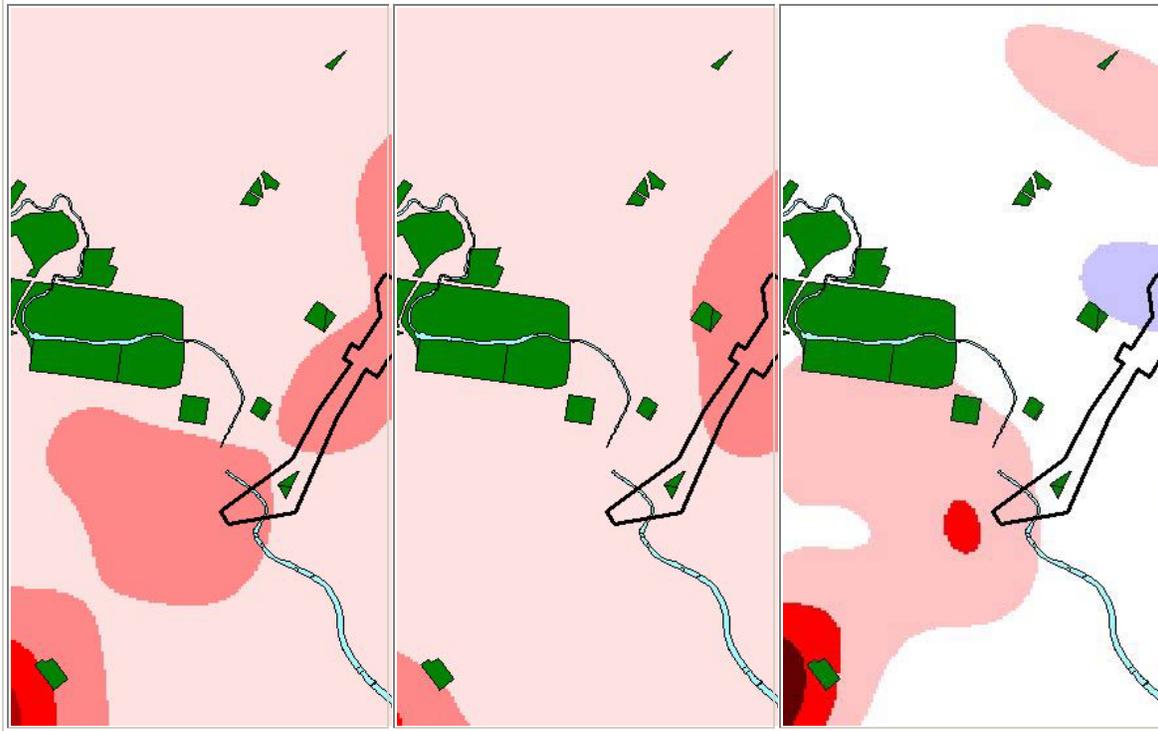
$$5 - 2 = 3$$

EXAMPLE

The first panel represents a density calculation for Robberies in 1999, and the second panel represents Robberies in 1998. Using Map Calculator, we can create a third image that represents the difference or change from one year to the next.

Blue = areas where crime (as measured by density) decreased

Red = areas where crime (as measured by density) increased



Querying Grids

Spatial Analyst lets you query grid themes using the [Map Query](#) dialog (User triggers a Map Query from the menu or button)

Select areas spatially by defining a [Boolean query](#) based on the values of one or more grid themes

The output is a [new grid theme](#) with areas that match the query and areas that do not. Those that do match will be given a value of **1 (TRUE)**; areas that do not are given a value of **0 (FALSE)**.

Who is the audience?

The results we get depend on how we slice the data and the methods we employ. We can produce a variety of answers to one general question!