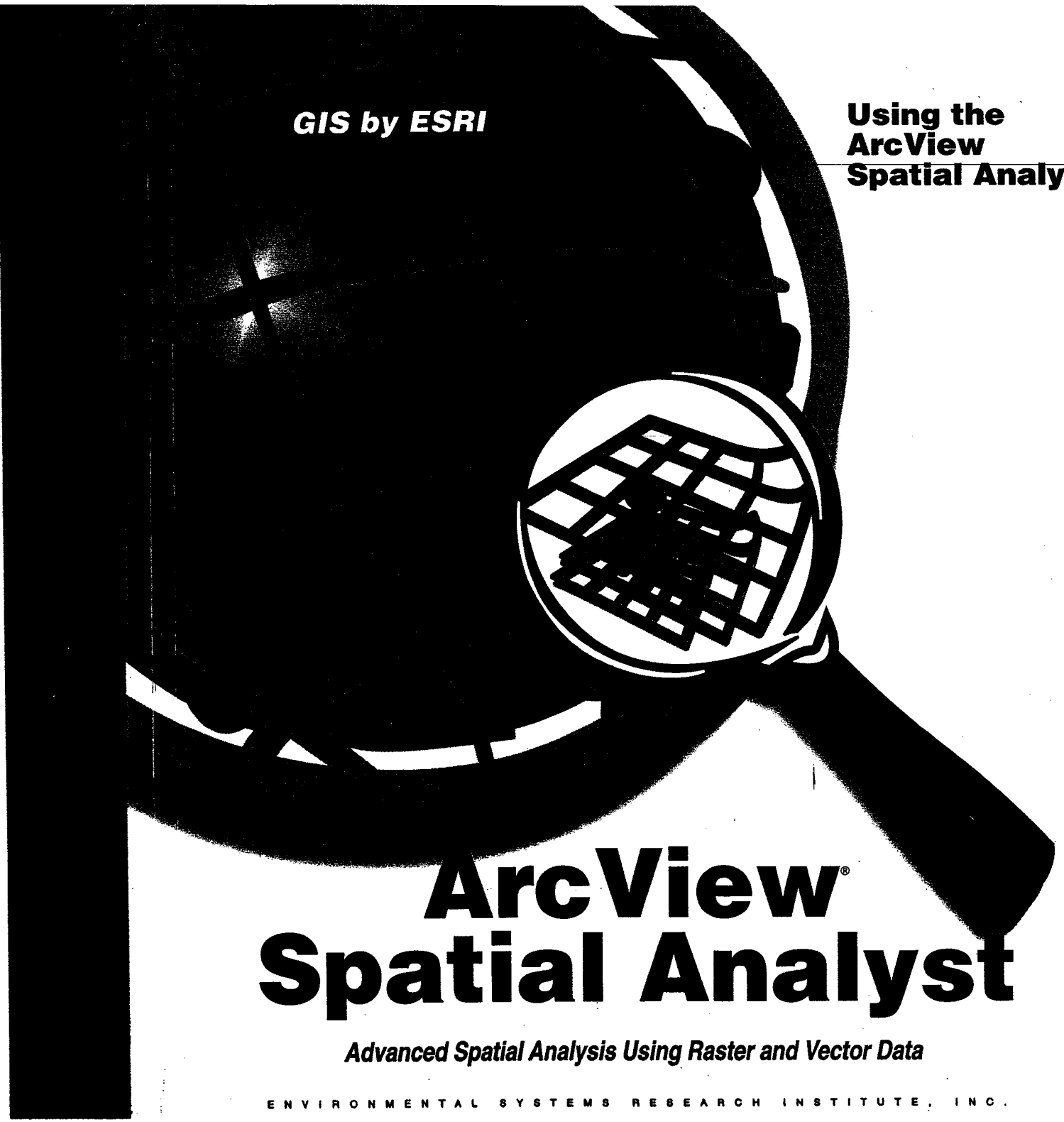
GIS by ESRI

Using the ArcView Spatial Analyst



ArcView® Spatial Analyst

Advanced Spatial Analysis Using Raster and Vector Data

ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE, INC.

CHAPTER 1

Introduction to the ArcView Spatial Analyst

This book will introduce you to some powerful new tools and concepts for solving spatial problems and guide you through your first few sessions with the ArcView® Spatial Analyst. From your previous experience with ArcView, you probably already have ideas about situations that the Spatial Analyst can address, such as finding the best location for a new facility or finding out where your best customers are. This book will help you better understand your problem as a set of spatial questions and show you how to answer them through a simple graphical interface.

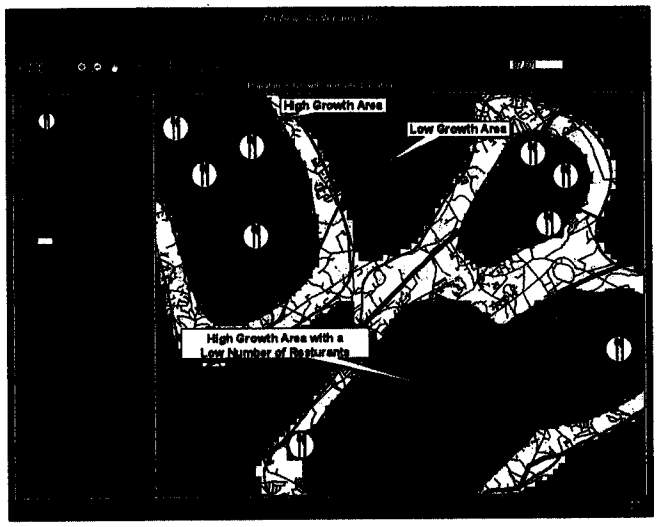
The Spatial Analyst is a rich set of tools for solving a wide range of problems such as:

- Find good retail locations by modeling population growth and demographic changes.
- Minimize environmental impact by modeling potential landscape and hydrologic changes due to development.
- Maximize agricultural profit by knowing the relationship between soil chemistry and crop yield.

What you can do with the Spatial Analyst

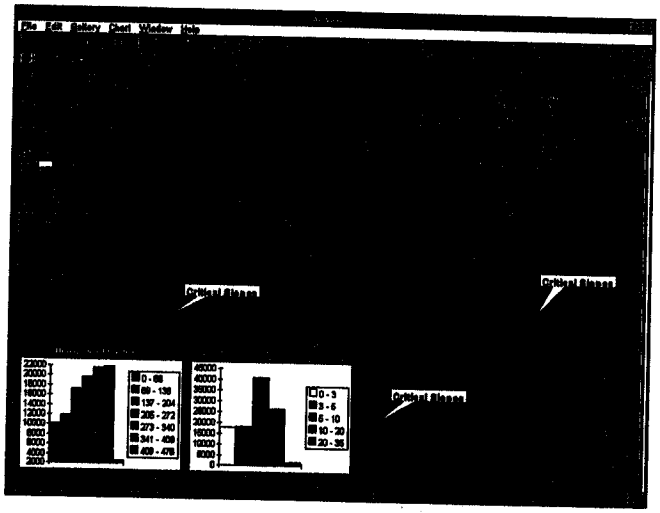
The ArcView Spatial Analyst helps you discover and better understand spatial relationships in your data, from viewing and querying your data to creating an integrated custom application. New types of analysis are possible using the Spatial Analyst because it can be used to model raster data, in addition to the vector data ArcView GIS already supports. Following are some sample problems that have been solved using the Spatial Analyst.

Suppose you want to find the best location for a new restaurant. You'll need to consider many variables such as economic growth potential and location of existing restaurants. An area with high growth and few existing restaurants is a good place to look for available real estate. The Spatial Analyst can help you derive these factors.

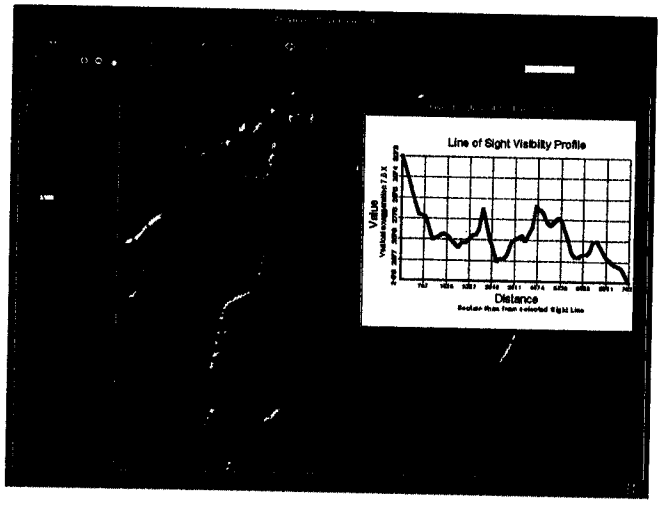


It can also answer questions such as "Where are the highest concentrations of a particular type of customer? How far away is the competition? Where is the available real estate that's close to a major road, zoned appropriately, and below a certain cost?"

Suppose a new housing development is proposed for your town. You want to know how the proposed land use plan can be modified to minimize the risk of landslides or flooding. The Spatial Analyst includes tools for generating surfaces and analyzing characteristics such as slope, or modeling drainage basins. There are also interactive tools for creating contours and histograms to help you explore your data.



Suppose you want to find a good location for a fire observation tower or a cellular communications tower. The Spatial Analyst includes tools to create maps and charts of locations that are visible or not from a specified location.



These tools can also be used for visual impact assessment. For example, if you clear cut a stand of forest, will it be visible from the road?

CHAPTER 2

Quick start tutorial

Before starting this tutorial, we assume you have already been through the ArcView Quick Start and know basic ArcView terminology and interface concepts. We also expect that you are familiar with the analysis capabilities of the standard ArcView product and are wondering what the Spatial Analyst can do for you.

In this chapter you will work through four step-by-step exercises. They begin with the basics such as how to display and manage grid themes, and progress to creating and exploring new data through application scenarios. Along the way, side notes give you more information about the concepts and techniques that you're using in the exercises. You'll be able to learn more about these topics in the other chapters of this book and in the ArcView on-line help.

In this chapter you'll perform these exercises with the Spatial Analyst:

- Exercise 1: Working with grid themes.
- Exercise 2: Finding the best place for a new bank.
- Exercise 3: Mapping population density within trade areas.
- Exercise 4: Creating and analyzing surface data.

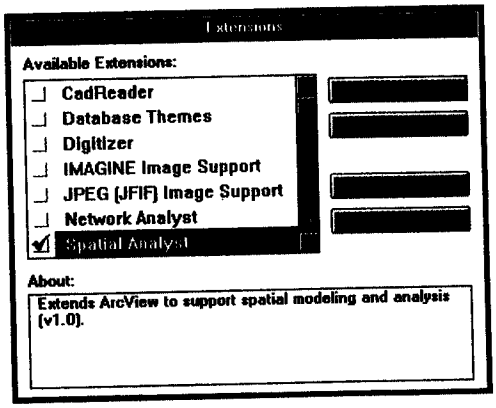
Exercise 1: Working with grid themes

In this exercise you'll display, query, and chart characteristics of grid themes, a new type of theme supported by ArcView Version 3.

In this exercise you'll learn:

- How to load ArcView extension products.
- How to view and explore new theme types supported by the Spatial Analyst.
- How to create new data layers.
- How to manage and save data for these new grid themes.
- How grid themes differ in display and table handling.

Start ArcView



Load the Spatial Analyst extension

1. From the File menu choose Extensions.
2. Click in the check box labeled Spatial Analyst, then press the OK button on the Extensions dialog to load the extension.

Open a new view

1. Choose Views at the left of the project window.
2. Click New to open a new view.

NOTE: ALL FILES ARE LOCATED IN THE V:\ESRI\AV_GIS30\AVTUTOR\SPATIAL FOLDER

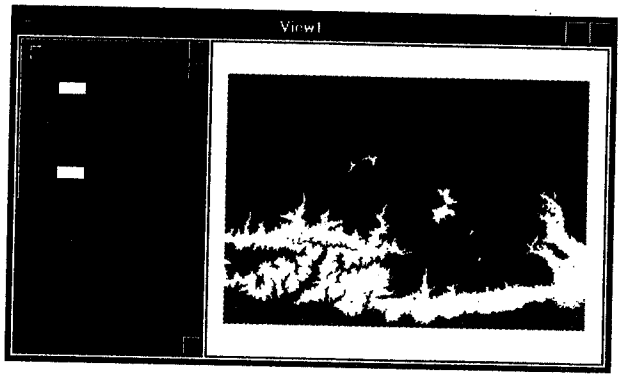
Add and draw a grid theme

1. Press the add theme button.
2. Navigate to the AVTUTOR directory. Double click on the spatial directory under the AVTUTOR directory.
3. Choose Grid Data Source as the Data Source Type.
4. Double click on elevgrd to add it as a theme.
5. Click on the check box in the legend to draw the theme.

Change the colors of the display

The colors of the display are easy to change, and specialized color ramps are provided for common data such as elevation.

1. Double click on Elevgrd in the legend to bring up the Legend Editor.
2. Click the Classify button.
3. Change the Number of classes to 7 and click OK.
4. Choose Elevation #2 as the Color Ramp.
5. Click Apply.
6. Close the Legend Editor.



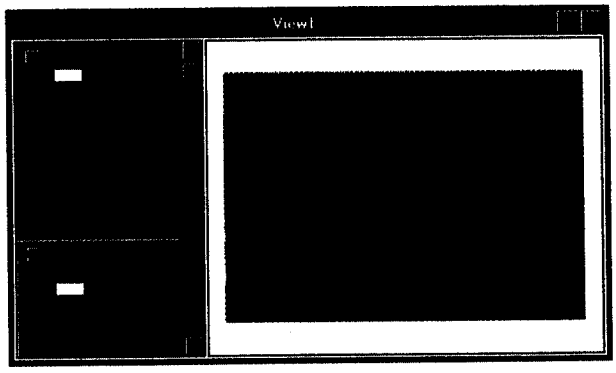
The legend has now been updated to reflect the new classes and color scheme. Take some time to become familiar with the legend editor. Double clicking on a symbol in the legend editor will bring up the symbol palette, which can be used to change the color of individual symbols or classes.

Each cell in a grid theme has a value, which puts it into one of the classes in the legend. Each cell is filled with the color of its class, solid fill only. Changing the fill pattern won't change the display. The grid theme will always display with solid fill.

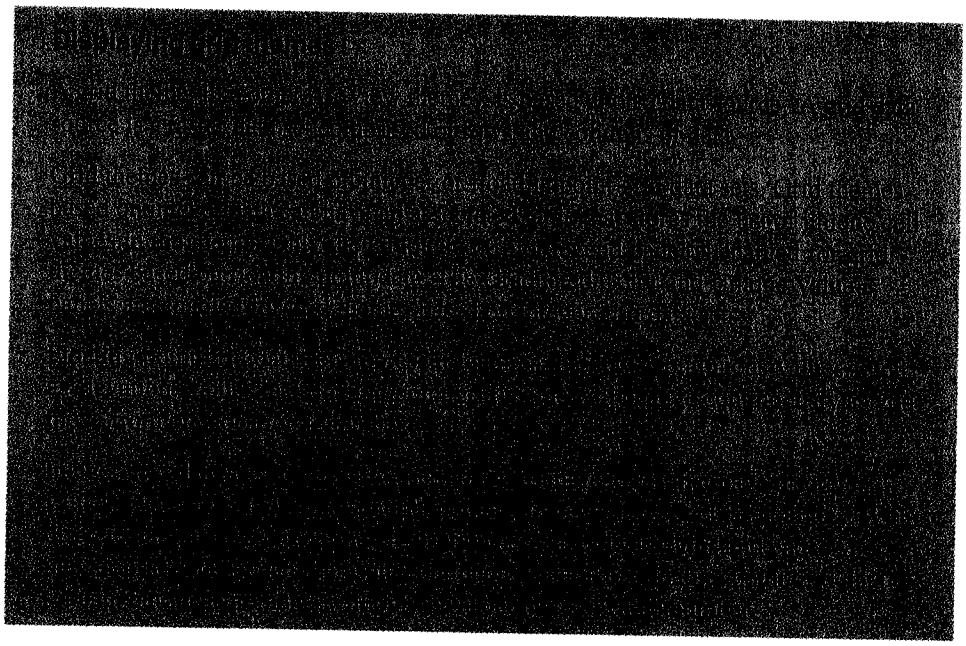
Giving the display depth

You can create composite displays of two themes; one theme, such as elevation, provides the color, and another theme, such as a hillshade, provides the brightness.

1. Add the grid data set hillshd to the view. (It's located in the spatial directory of the AVTUTOR data directory.) This is a grid of hillshade values for the elevation grid you are working with at the moment.
2. Double click on Elevgrd in the legend to bring up the Legend Editor, unless it's already present.
3. Press the Advanced button on the Legend Editor.
4. Choose Hillshd as the Brightness Theme.
5. Set the Minimum Cell Brightness to 20.
6. Set the Maximum Cell Brightness to 80.
7. Press OK on the Advanced Options dialog.
8. Press Apply on the Legend Editor.
9. Close the Legend Editor.



IN LAYOUT: LABEL & PRINT



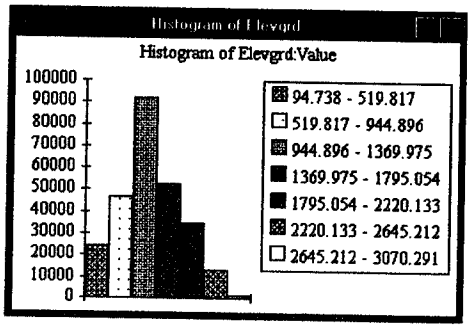
View the distribution data

1. Click on the Elevgrd theme to make it active.

Notice that the open table button does not become available when the Elevgrd theme is active. The Elevgrd theme is a floating point grid theme and does not have a table associated with it.

2. Click the histogram button to view a distribution of the values within the Elevgrd theme.

The x-axis displays the classes in the Elevgrd theme's legend, and the y-axis shows the number of cells, or COUNT, in the Elevgrd theme for each class.

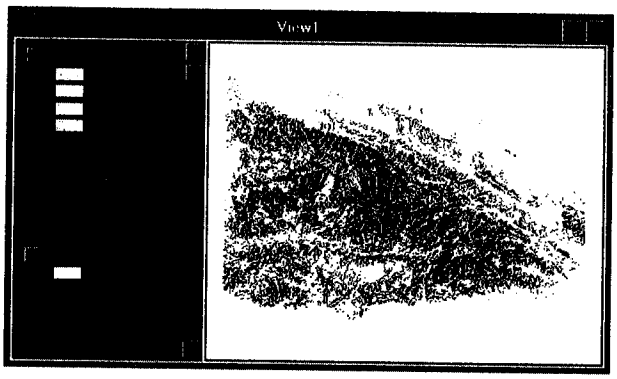


3. Close the Histogram of Elevgrd window.

Derive slope from the elevation theme

It is easy to perform analysis to create new grid themes. Suppose you want to map the steepness of slopes from an elevation theme.

1. Click on the Elevgrd theme to make it active.
2. From the Surface menu choose Derive Slope.
3. Click on the check box in the legend to draw the newly created grid theme.



This shows how easy it is to create new data layers from your existing data sources. The operations on the Analysis menu work on the active theme for the most part. You will not be prompted for an output name for the new data created. A name describing the action taken will be supplied by default. In this case it is "Slope of Elevgrd."

Rename the new grid theme

The name of any theme can be changed with the Theme Properties dialog.

1. Click on the Slope of Elevgrd theme to make it active.
2. From the Theme pulldown choose Properties.
3. Change the Theme Name to Slope.

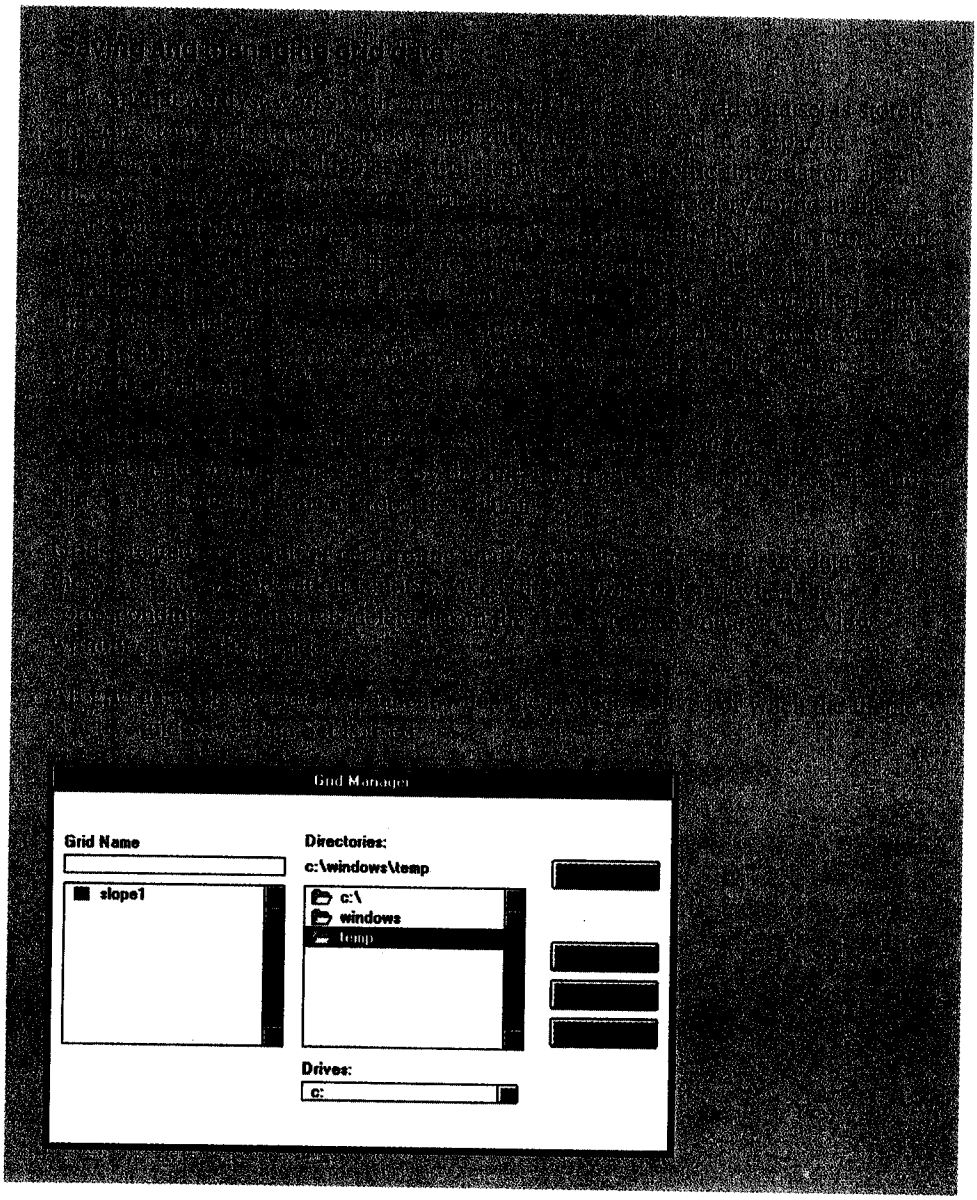
Notice some of the other properties that a grid theme has. You will notice that for this grid theme the Type is Float and Status is Temporary.

4. Click OK on the Theme Properties dialog to apply the changes.

Notice the change in the theme's name in the view's table of contents.

Save the analysis results

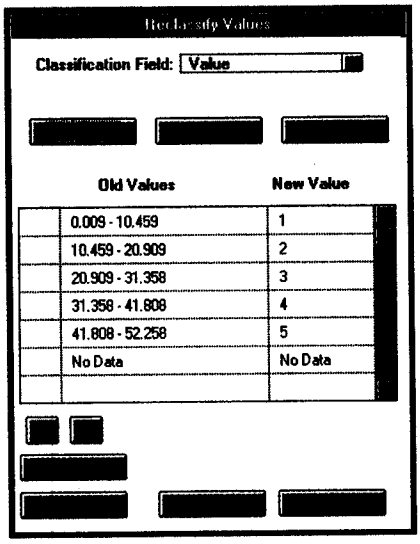
1. Click on the Slope theme to make it active.
2. From the Theme menu choose Save Data Set.
3. Specify a location and name for the data set and click OK.



Reclassify the slope theme

You can convert the floating point grid theme, Slope, into an integer grid theme by classifying its values into groups. You might do this to change the slope theme into a theme representing building suitability based on slope.

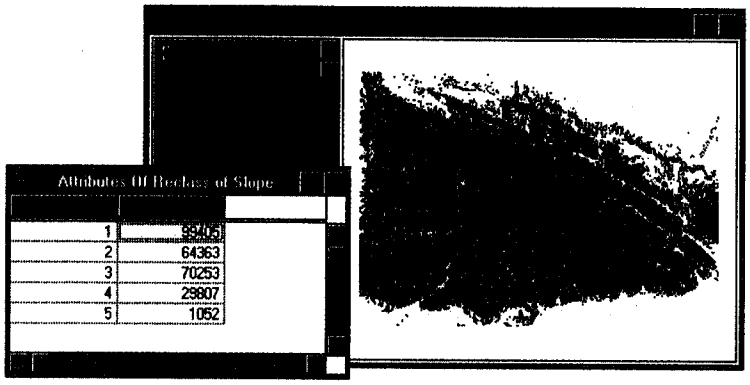
1. Click on the Slope theme to make it active.
2. From the Analysis menu choose Reclassify.
3. Click the Classify button on the Reclassify Values dialog.
4. Change Number of classes to 5 and then click OK .
5. Click OK on the Reclassify Values dialog, then draw the newly created grid theme.



Explore the table of slope attributes

You can make selections from a table that will highlight areas in the grid theme display.

1. Click on the Reclass of Slope theme to make it active.
2. Click on the open table button to view its attribute table.
3. Click on the select tool .
4. Select a row in the table by clicking the cursor in that row.



Notice that when you select one row in the table, multiple regions of the map are selected and highlighted. This is because there is one record in the table for all grid cells with that value, even if they are not physically connected.

Holding shift and clicking on a row in the table will add it to the selected set.

IN LAYOUT: LABEL & PRINT

Exercise 2: Finding the best place for a new bank

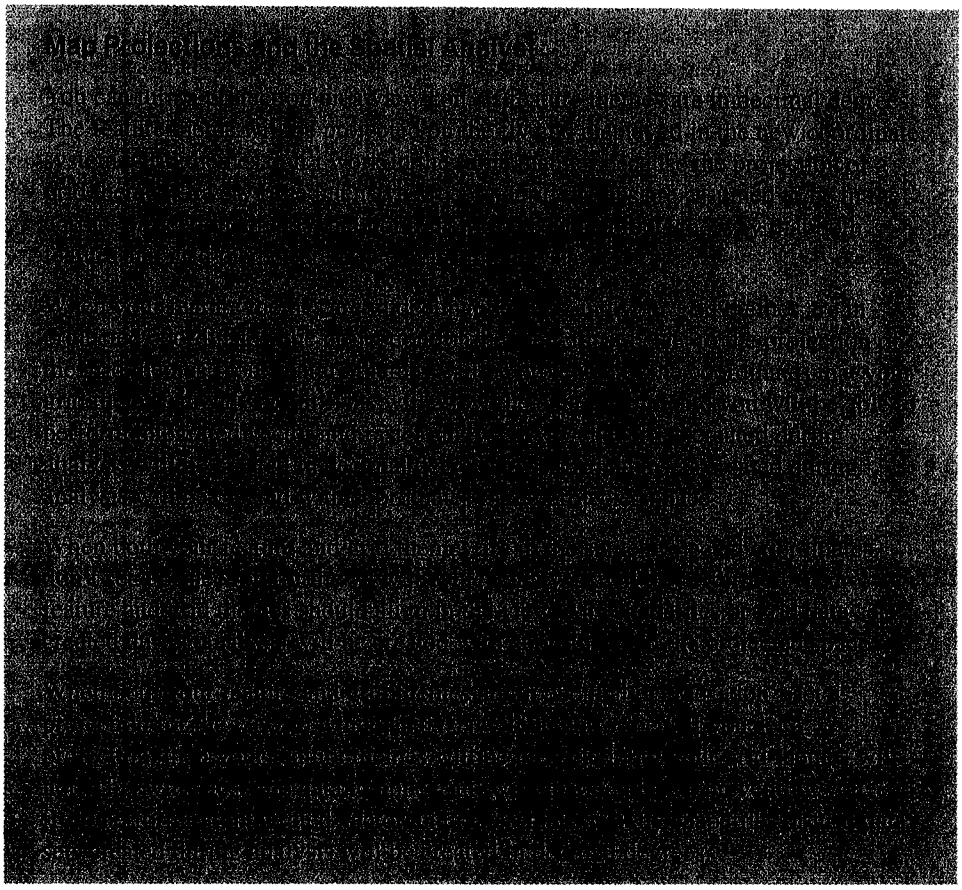
As district manager for a chain of banks, you want to find good locations for new banks. You're most interested in areas far from your existing banks and with many people living nearby. In this exercise you'll create a map of distance from banks and query the map for information on distance and population to find the best location for a new bank. The results will be converted to a shapefile and displayed with other data in a final presentation.

In this exercise you'll learn:

- How to query multiple data sets to create new data.
- How to convert grid themes to shapefiles.

Load data into new view

1. If necessary, start ArcView and load the Spatial Analyst extension.
2. Open a new view.
3. Set the projection of the view to State Plane - 1983, Georgia, West using the View Properties.
4. Add the grid data set popden, located in the spatial directory of the AVTUTOR data directory, to the view. The data set popden is a grid of population density.
5. Add the shapefile bank.shp, located in the spatial directory of the AVTUTOR data directory, to the view.



Query banks for high deposits

You don't want to compete with your best banks, so select them before making the distance map.

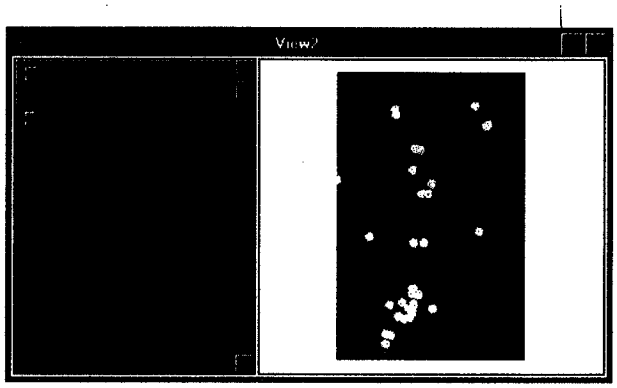
1. Click on the Bank.shp theme and display it.
2. Click the query builder button ■.
3. Double click on [Privat_dep] in the Fields list. This field represents the value of deposits made by private account holders.
4. Click on the greater than button ■.
5. Type 10000000 in the expression box.
6. Click the New Set button, then close the query builder.

Notice that the display is updated so that the selected banks are highlighted.

Create a map of distance from selected banks

1. Click on the Bank.shp theme to make it active.
2. From the Analysis menu choose Find Distance.
3. Select Same as Popden for both the Output Grid Extent and Output Grid Cell Size, then click OK.
4. Draw the newly created theme.

   You now have a continuous map of distance from all locations to banks with private investments greater than ten million dollars.
5. Move the Bank.shp theme up in the table of contents so it draws on top of the Distance to Bank.shp theme.



Notice that only the distance to the selected (yellow highlighted) banks was measured.

Overlaying maps and performing a query for satisfying a condition

Your goal is to find potential locations for new banks, such as neighborhoods with high population density that do not have banks nearby.

1. Turn off the display of all themes and turn on the display of the Popden theme.
2. From the Analysis pulldown choose Map Query.
3. Double click on [Popden] from the Layers list in the Map Query dialog.
4. Click the greater than button, then type 3000 in the expression box. This query will find areas where the population density is greater than 3000 people per square kilometer.
5. Click the AND button.
6. Double click on [Distance to Bank.shp] from the Layers list.
7. Click the greater than button, then type 500 in the expression box below. This query will instruct ArcView to find areas greater than 500 meters from an existing bank.
8. Click on the Evaluate button to evaluate the expression. Draw the newly created theme.

   The result is a map of locations that satisfy the expression. Now you can refine the area.
9. Return to the Map Query dialog, which should still be open. If you have closed the Map Query dialog, you can open it by clicking on the Map Query 1 theme to make it active and choosing the Edit Theme Expression operation on the Theme menu.
10. Edit the equation, changing the [Popden] cutoff value to 5000 by typing it in. This will select areas where the population density is greater than 5000 people per square kilometer.
11. Click on Evaluate again and notice the changes in the resulting display.
12. Close the Map Query dialog.

You have created a map showing areas more than 500 meters from existing banks with a population density of greater than 5000 people per square kilometer. These areas should have sufficient population to provide a good customer base for a new bank.

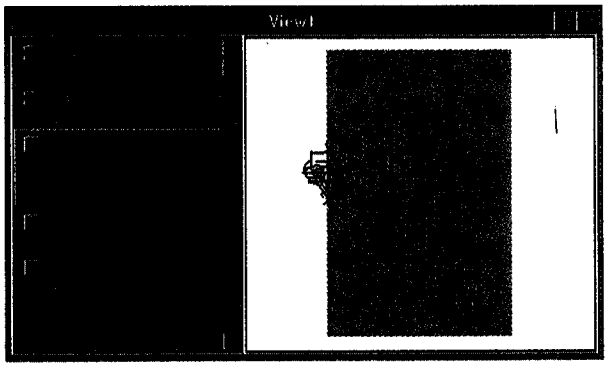
Convert results to a shapefile

1. Click on the Map Query 1 theme to make it active.
2. From the Theme menu choose Convert to Shapefile.

3. Specify a name and directory for the new shapefile, then click OK on the Convert Map Query 1 dialog.
4. Click Yes to add the shapefile as a theme to a view.

Display final results

1. Draw the new theme and bring up the Legend Editor for it by double clicking on its legend.
2. Choose Unique Value as the Legend Type and Gridcode as the Values Field.
3. Click on the Symbol next to the Value of 0, then click the delete button on the Legend Editor dialog.
4. Double click on the Symbol next to the Value of 1 to display the Fill Palette.
5. Select the middle fill pattern on the second row.
6. Click on the Color Palette button at the top of the dialog, then change the color of the foreground to a medium red and the color of the background to transparent. Close the Color Palette.
7. Click on the Label of 1 and change it to New Banks.
8. Click Apply on the Legend Editor dialog, then close it.
9. Turn off the display of the Map Query 1 theme.
10. Add the shapefile streets.shp to the view from the spatial directory of the AVTUTOR data directory and draw it. Then move it under the theme displaying areas for new banks in the view's table of contents.



You could continue by labeling the streets and adding other data layers, then putting the view into a layout with a title, scale, legend, and north arrow for your final presentation.

IN LAYOUT: LABEL & PRINT

Exercise 3: Mapping population density within trade areas

As a sales manager, you want to understand why some salespeople are overworked and others have too much free time. In this exercise you'll create a map of population density from census point data, then determine the number of people within the trade area for each salesperson.

In this exercise you'll learn:

- How to create a continuous map of population density from point measurements.
- How to summarize the values in one theme by the zones of another.
- How to create tables and charts of statistics describing two themes.

Load data into a new view

1. If necessary, start ArcView and load the Spatial Analyst extension.
2. Open a new view.
3. Set the projection of the view to State Plane - 1983, Georgia, West using the View Properties.
4. Add the shapefiles blkptsub.shp and trade.shp to the view from the spatial directory of the AVTUTOR data directory.

Create a population density map

1. Click on the Blkptsub.shp theme to make it active and draw it. This is a point theme of population at the block group level.
2. From the Analysis menu choose Calculate Density.
3. Accept the Output Grid Specification by clicking OK.
4. Choose Population in the Population Field, type in 350 as the Search Radius, and choose Kernel as the Density Type. Press OK. Draw the newly created theme.

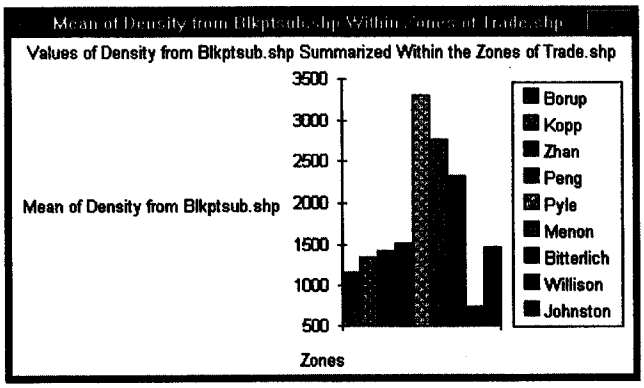
Chart the number of people within each trade area

You want to summarize the mean population density within each trade area to see if the sales territories need to be redefined.

1. Double click on the Trade.shp theme to bring up the Legend Editor. This is a polygon theme of trade areas for each of your sales managers.
2. Choose the Unique Value Legend Type and the Value Field of Salesmgr. Press Apply and close the Legend Editor.
3. Draw the Trade.shp theme and turn the display of Density from Blkptsub.shp off.

4. From the Analysis menu choose Summarize Zones.
5. Choose Salesmgr as the field defining zones.
6. Choose Density from Blkptsub.shp as the theme to summarize.
7. Choose Mean as the statistic to chart.

A table and chart are created. The table contains multiple statistics, such as min, max, and mean, for population density within each trade area. The chart will display the mean population density for each trade area. The chart window can be resized to allow you to see it better.



Using the table and chart you may decide to divide a trade area with a high mean population density in two or assign some of its area to an adjacent trade area with lower population density. After you create your new trade areas, you can check to see if each has an acceptable mean population density by running the same analysis with the new trade area map.

If you want an estimate of the total population for each trade area, you can multiply the area of each trade area by the mean population density for that trade area

PRINT THE CHARTS

Exercise 4: Creating and analyzing surface data

As a large corporate farmer, you want to understand the soil chemistry of your fields so you can more accurately apply the necessary amounts of chemicals. Using point measurements, you'll create a surface of potassium content for a field. From this surface you'll create contours that will show where you need to apply more potassium.

In this exercise you'll learn:

- How to turn point measurements into a continuous surface.
- How to create an alternate surface representation using lines.

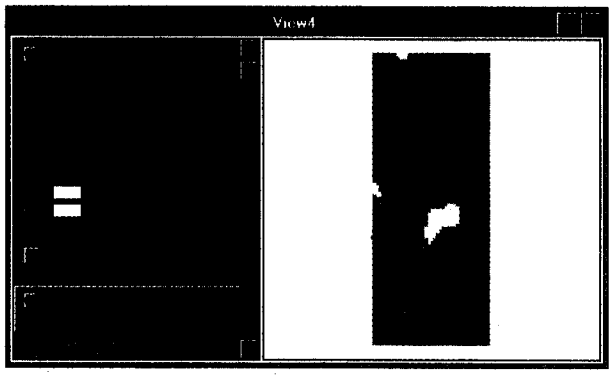
Load data into a new view

1. If necessary, start ArcView and load the Spatial Analyst extension.
2. Open a new view.
3. Add the shapefiles soilsamp.shp and thefarm.shp to the view from the spatial directory of the AVTUTOR data directory.
4. Draw the Soilsamp.shp theme.

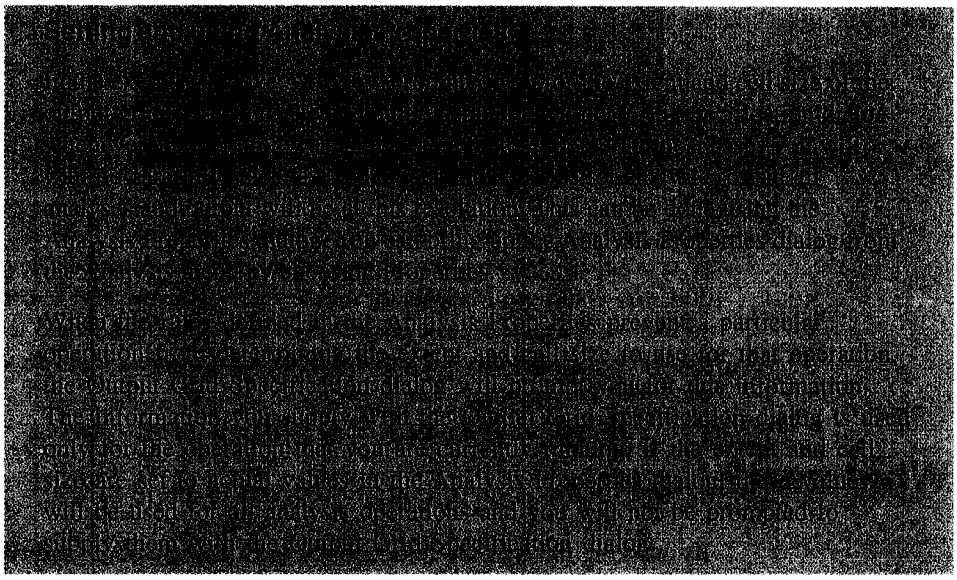
Create a potassium surface from point samples

Your soil samples are measurements scattered across the field. You want to create a continuous map of potassium for every location across the field.

1. Click on the Soilsamp.shp theme to make it active.
2. From the Surface menu choose Interpolate Grid.
3. Change the Output Grid Extent to Same As thefarm.shp, Number of rows to 100, then click OK on the Output Grid Specification dialog.
4. On the Interpolation dialog, set Method to Spline, Z Value Field to Soil_k, then Click the OK button.
5. Draw the newly created grid theme.

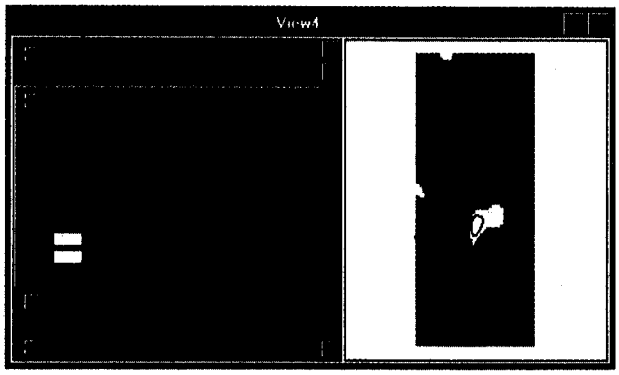


Each cell in the resultant grid theme contains an estimate of potassium content for that location based on the potassium content of the points surrounding it.



Create contours of a surface

1. Click on the Surface from Soilsamp.shp theme to make it active.
2. From the Surface menu choose Create Contours.
3. Change the contour interval to 100.
4. Click OK on the Contour Parameters dialog.
5. Draw the newly created theme.



Now you can look at the content of potassium in your field as a continuous surface or as a set of contours. If you wanted to keep the potassium level in your field above 300, you could use Map Query on the Analysis menu and select all areas on your surface with a potassium content lower than 300. This would tell you where potassium is low but not how low. The contour theme tells you how low in potassium each area is.

LABEL AND PRINT

What next?

By working through the tutorials you have learned about the types of problems the ArcView Spatial Analyst can solve and have gained some hands-on experience in using the interface. From here you can continue reading this book and working through the exercises to learn more about the Spatial Analyst. Or you can use this book for guidance as you use the Spatial Analyst, referring to the part of the book you need as you perform a particular task. You could even start using the Spatial Analyst on your own, referring to the on-line help when you have a question.