Lesson 2: Using ArcView Spatial Analyst

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Goals

In this lesson, you will learn:

- how to access help for ArcView Spatial Analyst
- how to query grids
- how to work with contours and surfaces
- what overlay analysis is
- what proximity analysis is

- how grid-based data is visualized in ArcView Spatial Analyst

TOPIC 1: **ArcView Spatial Analyst basics**

The main component of the ArcView Spatial Analyst is the grid theme, which is the raster equivalent of the feature theme. ArcView Spatial Analyst allows you to create, query, map, and analyze cell-based raster data and perform integrated vector-raster analysis.
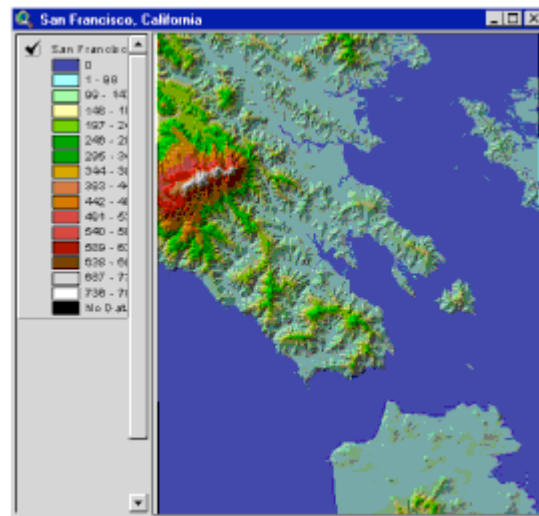
ArcView Spatial Analyst allows you to perform spatial analysis on grid themes. Here you see a grid theme of elevation for San Francisco. A hillshade theme is applied as a brightness theme to help visualize elevation. [Click to enlarge]

In this topic, you will learn the basics of displaying and querying grids and of map algebra. You will also get familiar with the online help

Concept

Displaying grids

Grid themes are symbolized in a Legend Editor just as feature themes are. Grid theme cells are assigned a solid fill color based on cell value or zone. You can select from several predetermined classification methods, or you can customize.

To choose an appropriate legend type, you first need to understand what the cell values contained in your grid theme represent.

Cell values can represent one of two data value types: discrete or continuous.

Discrete data is always stored as an integer grid theme, and its values are codes that represent the real data value. Discrete data is often--but not always--composed of phenomena whose boundaries are sharply drawn. Examples of discrete value types are state names, land use types, soil types, ZIP Codes, road types, and land ownership.

In the case of land use type, for example, the cell value will represent an arbitrary code number (industrial = 2, agricultural = 3), not a real value.

Discrete grids have Value Attribute Tables (VATs) and can be displayed based on attributes in the VAT.
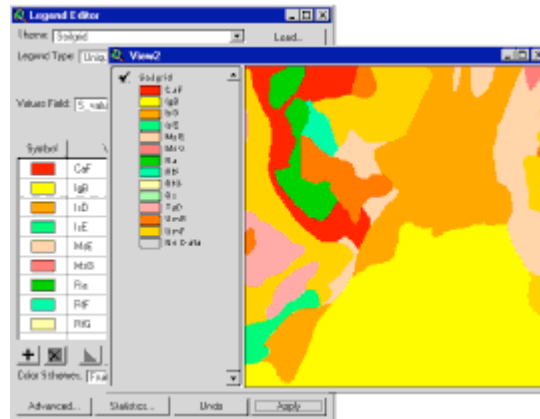
Discrete data of a soil grid classified by soil types.
[Click to enlarge]

Continuous data can be stored as either an integer or floating point grid theme. Continuous values represent real values, not code representations of those values.

Often, but not always, continuous data represents phenomena whose boundaries change more gradually. Examples of continuous value types are population density, soil acidity (pH), average income, speed limits, elevation, and the price of land.

In the case of soil acidity, for example, a cell value of 7.6 would represent the real pH value found in the soil at that spot.

The graphic below shows the continuous data of a grid classified by actual elevation.
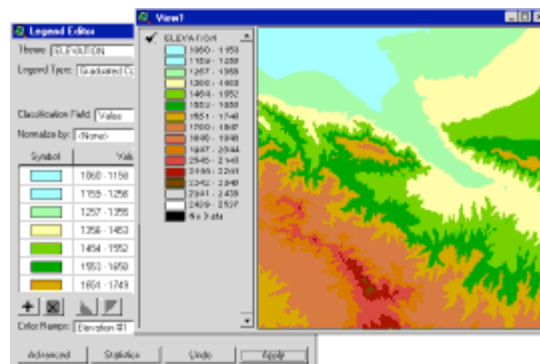
Discrete grid of soils data. The legend shows soil abbreviation codes

Concept

Querying grids

ArcView Spatial Analyst lets you query grid themes using the Map Query dialog. Map Query is available by selecting Map Query from the Analysis menu or by clicking the Map Query button

.

The Map Query dialog allows you to select areas spatially by defining a Boolean query based on the values of one or more grid themes. The output will be 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). If you change the query, it will change the values in the temporary output grid theme.

The following example shows how to use Map Query to select agricultural land use from a land use grid.
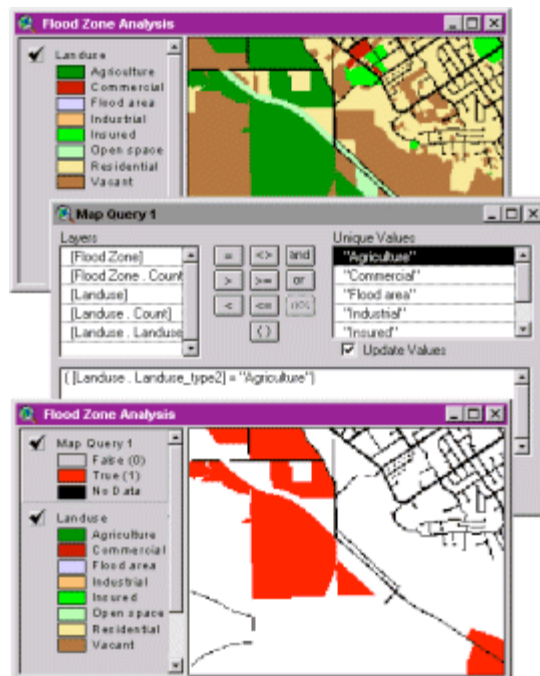
From top: An integer grid of landuse. A map query selecting areas that have a landuse type of agriculture. An integer grid showing the results of the map query. Areas in red represent the features that met the requirements of the query. In this case, they represent agricultural areas. [Click to enlarge]

Multiple grid themes can be compared in the Map Query dialog to determine where their features overlap. The resulting theme is a new grid theme that contains only the features that meet the requirements of your query.

The following example shows how to use Map Query to locate residential areas within the flood zone.
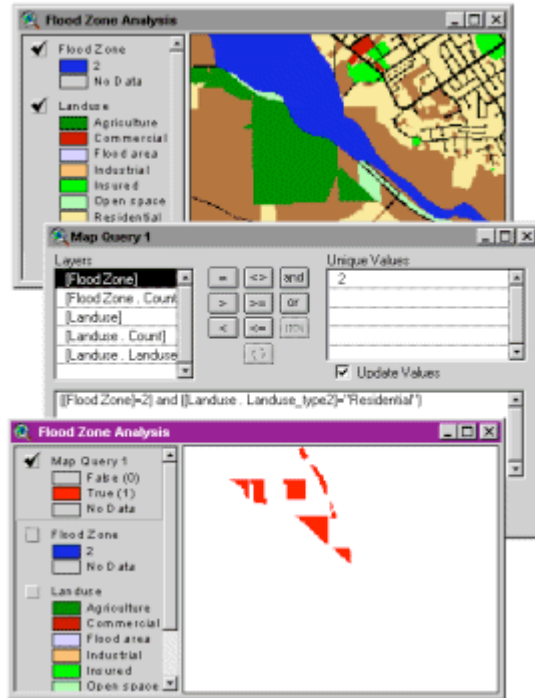
Top: A grid of a flood zone displayed over a grid of landuse. Multiple themes can be compared using the Map Query dialog. Bottom: The results of the map query. Areas in red indicate residential areas in the Landuse theme within the flood zone theme

Concept

Introduction to map algebra

Map algebra is a high-level computational language used to perform spatial analysis using grid (raster) data. Map algebra uses expressions that normally return numeric values to an output grid. Map algebra expressions are similar to overlay operations, but when comparing layers, map algebra adds a mathematical or algebraic component.

Map algebra provides a way to create mathematical operations that compare grid themes. In this diagram, the cell values for coincident cells in two grids are being added together to create a new grid. An example of such an expression is: [grid1] + [grid2]

Map algebra expressions are entered into the Map Calculator, where they perform analysis on one or many grid themes. Evaluating map algebra expressions in the Map Calculator results in a

new theme. You create these expressions either by typing into the expression box or by clicking on the layers, operators, and requests.
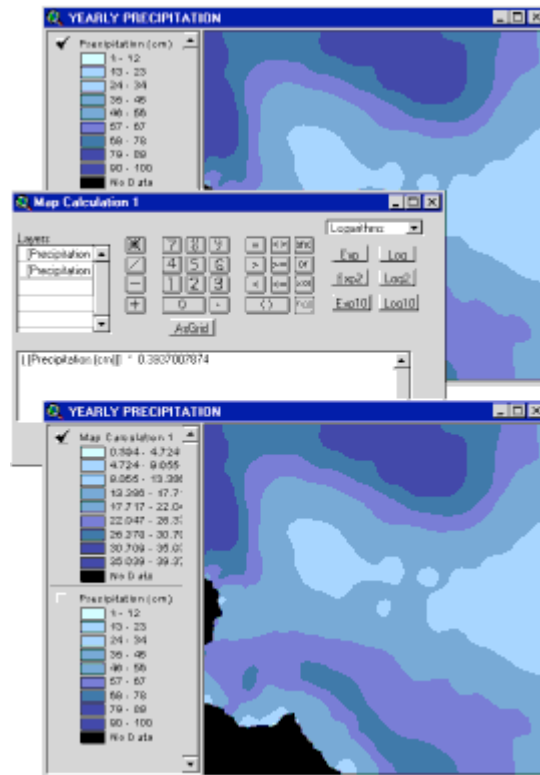
The Map Calculator is being used to convert the units of a precipitation grid from centimeters to inches.
[Click to enlarge]

Expressions are entered into the Map Calculator in the syntax of Avenue, ArcView 3.x's native programming language. Avenue provides a way to access many more ArcView Spatial Analyst functions and operations than are normally available from the interface (the Analysis menu and other menu choices, buttons, and tools).

You do not have to know Avenue to be successful in using these other functions. Knowing some basic Avenue syntax, however, will be very useful

Concept

Getting help

The ArcView Spatial Analyst Help is found with other online ArcView Help Topics. From the Help menu, choose Help Topics. Double-click the Extensions book icon, then the Spatial Analyst icon.

Available online Help includes the overview topics listed under the Spatial Analyst book as well as those under the help topics for associated Avenue classes and requests. By clicking the Help Index, you can search for any grid help topic.
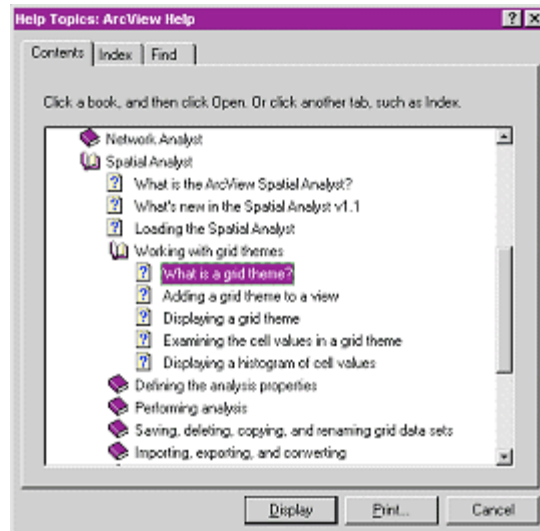
Help for ArcView Spatial Analyst is available from the Help menu. Help includes the overview topics that are listed under the Spatial Analyst book and help for associated Avenue classes and requests. [Click to enlarge]

ArcView Help provides a description of every request and type of object, also called a class. The help topic for each request gives a description of what the request does and what parameters are required for it to work. It also includes a generic example of how you might use the request. This syntax example is important because it shows you the type of object (Grid, Number, etc.) that the request is sent to and the type of objects required for each parameter

Exercise

Explore online help

In this exercise, you'll learn how to access the online ArcView Spatial Analyst help and its associated Avenue classes and requests. Before performing any unfamiliar ArcView Spatial Analyst operations, it is always a good idea to look at the online Help.

If you have not downloaded the exercise data for this module, you should download the data now.

Step 1 Start ArcView

If necessary, start ArcView.

Note: If you are running ArcView GIS 3.1, you see a Welcome to ArcView GIS dialog. Click Cancel to close this dialog.

Step 2 Open the Help

From the Help menu, choose Help Topics.

When the ArcView Help opens you see the Contents, Index, and Find tabs. Click the Contents tab.

Step 3 **Explore the available online help topics**

Find the Extensions book and double-click on it. Next, find the Spatial Analyst book and double-click on it.

The book opens to several subtopics and other books.

Double-click on the Working with grid themes book.

You will be performing some of these functions in the next exercise, including adding and displaying grid themes and examining values in a grid theme table.

Explore topics on your own within the Spatial Analyst book to become more familiar with using Help.

Step 4 **Explore Help for available Avenue requests**

In the Help Topics browser, click the Index tab. Where ArcView Help asks you to "Type the first few letters of the word you are looking for," type **grid**.

Notice that Grid (Class) has been highlighted.

Click the Display button or double-click on Grid(Class).

The help for the Grid class displays.

You can read a little about grids in the Discussion section. Then scroll down to the section labeled Surface Functions.

As you are scrolling, you will see many requests that can be used on grids. Any green text is a hypertext link that takes you to another help topic.

In the list of Surface Functions, find the HillShade request and read about it.

You may want to keep help open for the remainder of the exercises in this module.

You have completed this exercise

Exercise

Examine the relationship between a grid theme table and grid cells

In this exercise, you'll learn to examine and display the data
associated with a grid theme. You will find that grid themes have

a lot in common with feature themes. However, because grid themes are stored as a matrix of cells, there are some distinct differences in their attribute tables and display characteristics.

This exercise will also help you start thinking about how geographic features can be represented with cells rather than with points, lines, and polygons.

If you have not downloaded the exercise data for this module, you should download the data now.

Step 1 **Start ArcView**

Start ArcView and load the Spatial Analyst extension.

Note: If you are running ArcView GIS 3.1, you see a Welcome to ArcView GIS dialog. Click Cancel to close this dialog.

If ArcView is already running, close any open projects.

Step 2 **Open a project**

From the File menu, choose Open Project. Navigate to the **basicssa\lesson2l2_ex02.apr.**

Note: If you are running ArcView GIS 3.1, you see an Update l2_ex02.apr message box. Click No to dismiss this box.

When the project opens, you see a Landuse view without any themes.

VIEW RESULT

Step 3 **Add and display a grid theme**

Click the Add Theme button to display the Add Theme file browser. In the Data Source Types dropdown list, choose Grid Data Source. Then, from the **basicssa** folder, select the landuse grid and click OK.

Turn on the Landuse theme by checking its box.

VIEW RESULT

Notice that it is classified/symbolized according to cell values. The cell values (1-8) are not very meaningful, so you will open the theme table and look for a field that describes the land use codes. The Landuse grid theme has a theme table because it is an integer grid. It stores only integer values.

With the Landuse theme active, click the Open Theme Table button.

The Landuse_type2 field contains character strings of land use types (e.g., Agriculture, Vacant, etc.). This field can be used to better classify the grid theme.

After examining the table, make the view active and open the Legend Editor for the Landuse theme. Set the Values Field to Landuse_Type2. Apply the changes.

The legend no longer displays the cell values; it now displays the land use descriptions from the Landuse_type field in the grid theme table.

Close the Legend Editor.

In the next step, you'll make some selections in the table to see the relationship that exists between records in the grid theme table and cells in the grid.

Step 4 **Examine the grid theme table**

With the Attributes of Landuse table active, click the Select Record tool and select the record that has the Residential Landuse.

Notice that the selected record is highlighted in the table and the corresponding cells in the view are also highlighted. You can increase or decrease the size of the selection set by selecting or unselecting more records.

Next, you will add to the selection set.

Hold down the Shift key on your keyboard and click on the record with the Agricultural Landuse.

Selected records in the grid theme table are highlighted, along with the corresponding cells in the view.

Step 5 **Close the project**

Close the project without saving any changes.

You have completed this exercise

TOPIC 2: Overview of ArcView Spatial Analyst functionality

ArcView Spatial Analyst has tools for performing spatial queries, overlay analysis, and surface analysis.

- Overlay is a GIS operation used to compare two or more themes to reveal new relationships between features in different themes.
- Distance tools let you analyze the distance between features.
- Contours and surfaces help you analyze an attribute's change over space

Concept

Classification

Classification refers to ordering a theme's data values into a specified number of groups (classes) according to a particular classification method.

A classification contains a value or a range of values and a label for symbolization. The values may be either numeric or text. The label is the name associated with the classification.

Themes are classified in ArcView Spatial Analyst using the Legend Editor. Keep in mind that the classification is for display only. The real values in the classified theme are not changed in any way. If you want to reclassify themes permanently, you can use the Reclassify option, accessible from the Analysis menu. Reclassify allows you to change a value, a range of values, or a list of values of a grid theme to another value in a new grid theme.

Floating point grid themes are divided by default into nine classes, according to their cell values. The default classification method is Equal Interval; another choice is Standard Deviation. Classes can be added or deleted and their value ranges changed manually. The display of the No Data class (which contains all cells that have no data values in them) can be turned on or off.

Integer grid themes, when their legend type is set to Graduated Color rather than Unique Value, can be classified by any of the five methods available in ArcView: Equal Area, Equal Interval, Natural Breaks, Quantile, or Standard Deviation

Concept

Contours and surfaces

ArcView Spatial Analyst can create isolines (a line theme) or a continuous surface (a grid theme) using a theme of sample points. Isolines and surfaces help you analyze continuous change of an attribute over space (e.g., elevation, temperature, or a soil's pH level).

Isolines are lines on a map connecting defined points of equal Z value. The Z value (x,y, and z) is an attribute such as elevation, temperature, or rainfall.

Contour lines are isolines of constant elevation with a specified interval and are a common way to represent terrain. A major drawback of contours is that they indicate surface value only along the isolines.
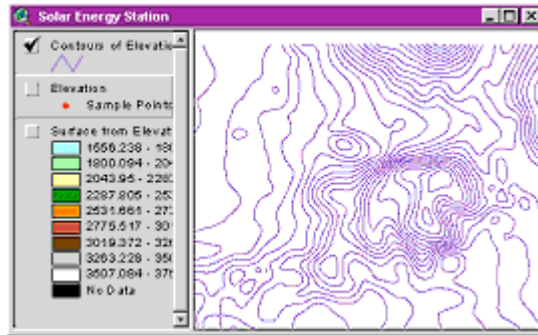
Isoline theme created from sample elevation points.
[Click to enlarge]

A surface grid usually contains zones or region polygons. Zones or region polygons consist of two or more cells with the same value. A zone can consist of cells that are connected or disconnected or both. Zones whose cells are connected usually represent single features of an area, such as a building, lake, road, or power line.
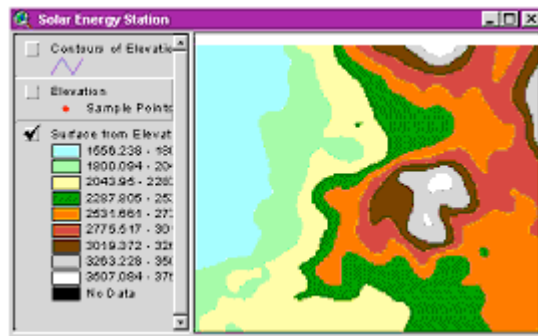
Surface grid theme created from sample elevation points. [Click to enlarge]

A cost surface is a grid defining the impedance, friction, or cost to move across a cell. A cost surface is used to determine the least cost path between a source and destination. The value at each location represents the cost per unit distance for moving through a cell. These costs may be travel time, dollars, fuel, or preference, for example.
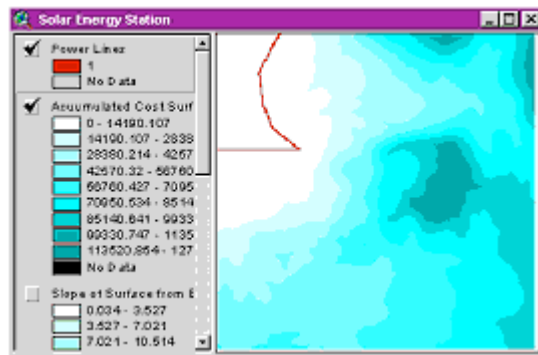
Accumulated cost surface grid based upon elevation. The higher the slope, the higher the impedence or friction. [Click to enlarge]

The cell values in the cost surface can be either integer or floating point, but must not contain negative values. You cannot have a negative travel cost. Cell locations with No Data in the cost surface act as barriers in the cost surface functions and are impassable.

Concept

Proximity analysis

Proximity analysis refers to analyzing the distance between features to help answer questions like "How many customers are within 2 miles of each of these stores?" Proximity grids can be used to determine the area of space allocated to each feature or to find the closest feature in another theme.

You can use point, line, polygon, and non-null cells when calculating distance. Distances are calculated from each location (cell) to features in the active theme and stored in a new output distance grid theme. The continuous distance grid can then be used to create buffers--i.e., zones of specified distance around a feature.
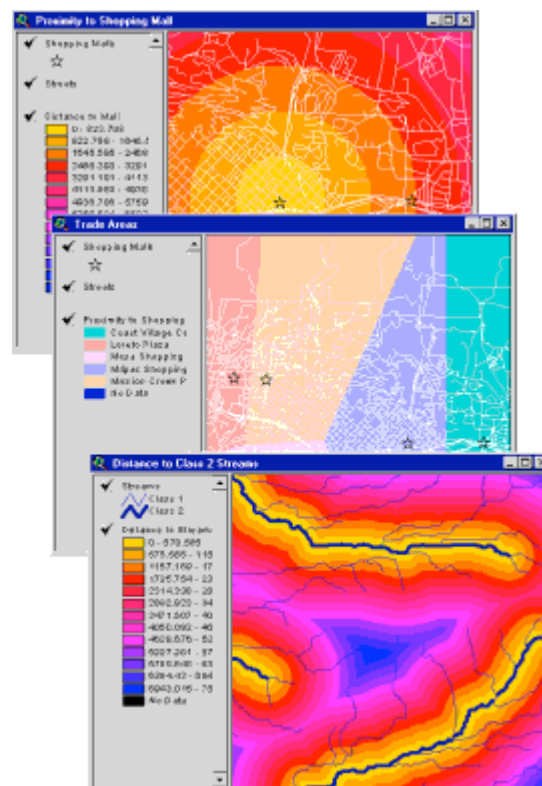
Proximity analysis is a useful function of ArcView Spatial Analyst. [Click to enlarge]

Concept

Overlay analysis

If you want to answer a question like, "Which land use types are inside the flood zone?", you need to use overlay. Overlay is a GIS operation used to compare two or more themes (layers) to reveal new relationships between features in the different themes.

Simple overlay analysis (performed using the Summarize Zones option on the Analysis menu) produces a table and chart of the overlap of features, shapes, or sections of two themes.
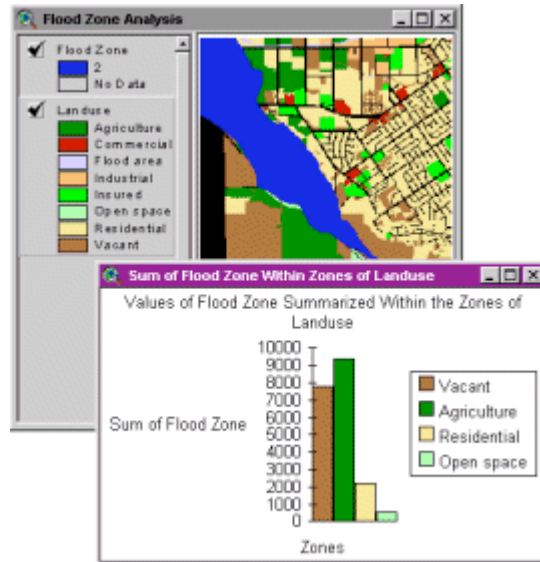
This example shows simple overlay analysis being used to find out which land use types are inside the flood zone. [Click to enlarge]

Theme overlay compares relationships between two or more themes. Multiple grid themes can be compared within ArcView Spatial Analyst to determine where their features overlap. The resulting new grid theme contains only the features that meet the requirements of your query.
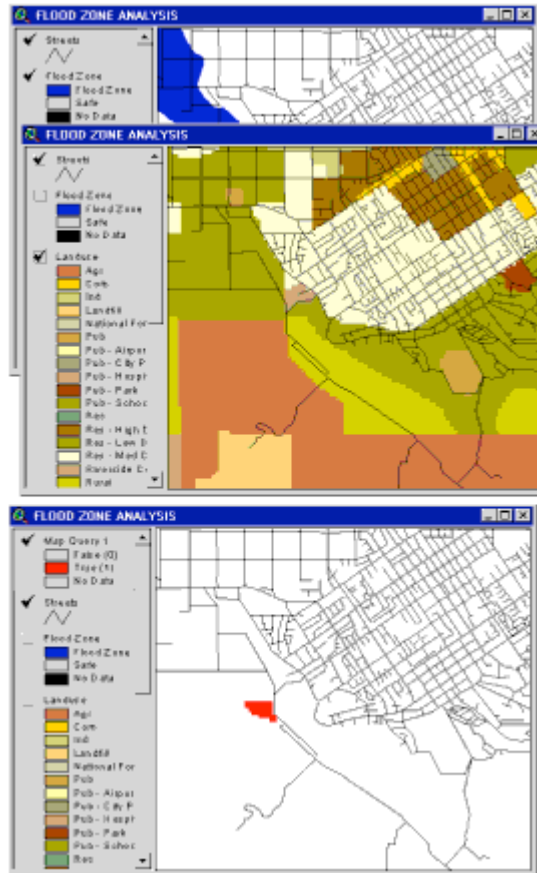
Here, areas with a land use of agriculture are found.
[Click to enlarge]

Concept

Visualization

Visualization refers to the ways in which you can present geographic data so that others can easily understand it. In GIS, you can accomplish this through visual aids such as topographic and thematic maps, graphs, and charts.

Grid themes, whether integer or floating point, are symbolized by colors that use a solid fill pattern and no outline. The colors can be changed, and symbols accessed through the Legend Editor.

A color ramp is an important tool for visualizing spatial data. A color ramp is used with a series of symbols and begins with one color, ends with another, and distributes the intervening colors of the spectrum proportionately along the range of symbols. Color ramps are primarily used to symbolize scalable numeric data, such as elevation, population, or distance from a store.

The following example uses a color ramp to visualize elevation surface.
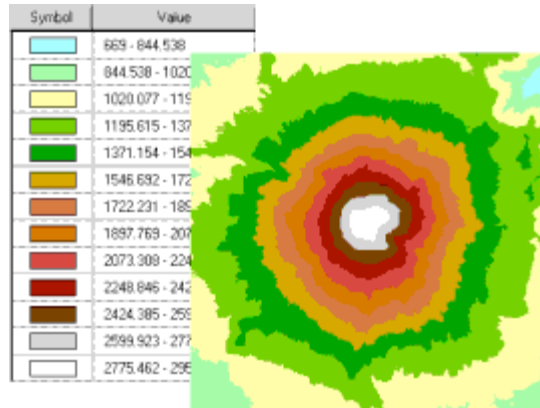
Left: A predefined elevation color ramp (Terrain Elevation #1). There are 13 colors in the ramp. Right: An elevation grid theme with the color ramp applied to it. [Click to enlarge]

Hillshading is a visualization tool that helps display hills and valleys in relief. Hillshading calculates the effects of illumination on a surface and creates a shaded relief grid theme from a surface theme. A hillshade theme can enhance the relief of a surface when used as the brightness theme for displaying another grid theme.

The following graphic shows a hillshade theme used to enhance the display of an elevation grid of Redlands, California.
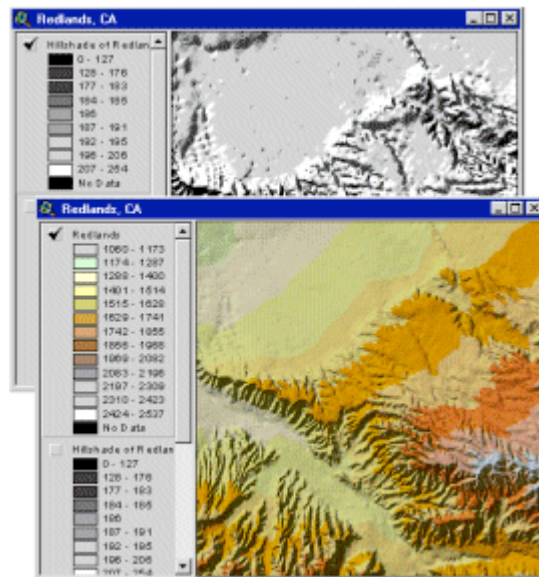
Top: A hillshade grid of an elevation grid for Redlands, California. Bottom: In the Legend Editor, the hillshade grid has been applied as a brightness theme for the elevation grid. [Click to enlarge]

Another important visualization tool is the histogram, a chart of the distribution of cell values in a grid theme. One chart marker is created for each unique cell value or category. Histograms are useful because you can check the distribution of values.

Below is a typical histogram, showing the distribution of the land use values you saw earlier.
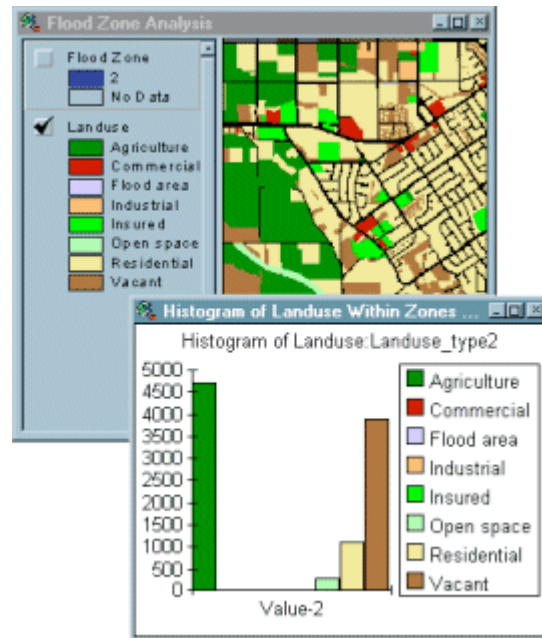
Top: A land use grid theme. Bottom: A histogram created from the land use theme.

Example

Using the ArcView Spatial Analyst: Creating a weighted distance model

A straight line may be the shortest distance as the crow flies, but it's not necessarily the most desirable route for someone on the ground. It may be a lot cheaper and easier to build a road around a mountain rather than straight through it.

Finding the best, or least-cost, path is a common problem in spatial analysis. By weighting distances (that is, incorporating factors such as the cost or difficulty of moving through terrain) it's possible to build a model of the "best" path between two points.

Steve, a Park Service employee, has been asked to design a bike path between a campground and scenic overlook. He has several problems to solve to do this. The path can't go through the lake. He doesn't want to disturb the butterfly habitat. It's more time-consuming and costly to build through forest than through grassland.

To account for these factors, Steve will create a weighted distance model. He'll reclassify a terrain grid to assign difficulty values to each kind of terrain. Spatial Analyst will then be able to calculate the "cost" (measured in units of difficulty) of traveling through each cell in the grid. This will let him find the best path from the campground to the scenic overlook.

Here is the proposal of the design:

Step 1   Step 2   Step 3

Destination location
(point B)

Starting Location
(point A)

Weighted path
from A to B

Travel difficulty or "cost"
from all points to point A

Weighted Terrain
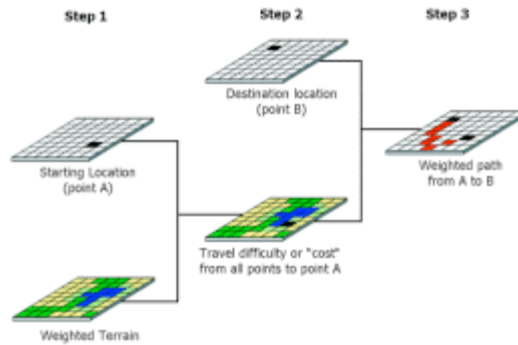
Steve diagrams his process for finding the "best"
path between the campground and scenic overlook.
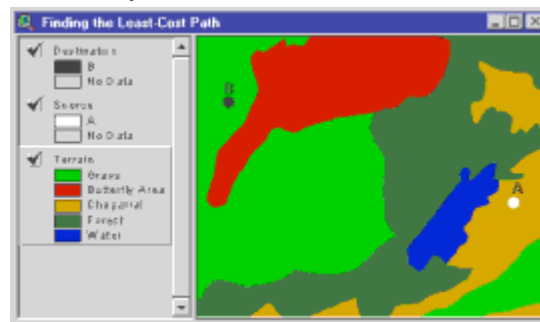[Click to enlarge]

Steve's terrain grid shows the different kinds of land cover in the area. It also shows a lake and
an environmentally sensitive butterfly habitat.

The best path from A to B must take into account
barriers, such as the lake; impedances, such as
dense vegetation; and environmentally sensitive
land, such as the butterfly area. [Click to enlarge]

Steve reclassifies the terrain grid according to a scale that measures the difficulty of traveling, or
building a path through, each cell. The difficulty scale can have any range that makes sense for
the model. Steve chooses a scale of one to nine, where 1 represents the least difficult and 9 the
most difficult.

It's easier to build the path on grass, so grass is assigned a value of 1 in the reclassified grid.
Chaparral is more difficult, because more labor is required to clear the land. Chaparral gets a 3"
Forested land gets a 6. As for the butterfly habitat, Steve assigns it a value of 9, meaning that it's
nine times as difficult to travel through a cell of butterfly area as through a cell of grassland.

(The difficulty in this case represents a subjective value, concern for the environment, rather than
an economic cost or a technical challenge.) The lake is reclassified as No Data, which prohibits
Spatial Analyst from putting a path through it. Steve's reclassified theme is called Weighted
Terrain (step 1 of the model diagram).
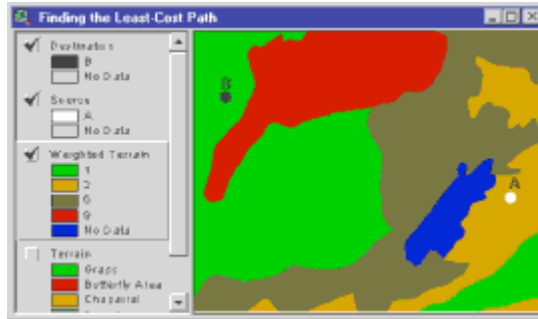
In the Weighted Terrain grid, the travel cost through one cell of grass equals the travel cost through three cells of chaparral, six cells of forest, or nine cells of butterfly area. (Spatial Analyst prefers a path through grass to a path through butterfly area until it becomes nine times as long.) The lake can't be traveled through. [Click to enlarge]
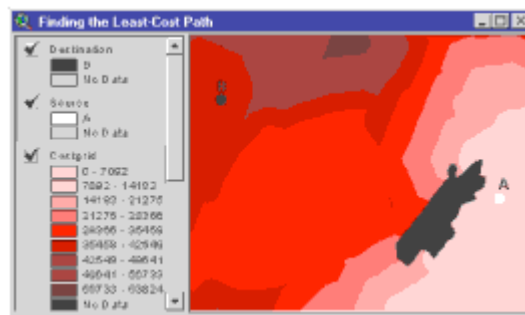
Now that a difficulty value has been assigned to each cell in the Weighted Terrain grid, Spatial Analyst can calculate the total cost (cumulative difficulty) of reaching the campground from any other cell in the grid (step 2 of the diagram). In the Cost grid, each cell's value is the cumulative travel cost of moving from that cell back to the campground.

RELATED CONCEPT

The cells in the Cost grid are classified by cumulative travel cost to point A. The higher the travel cost, the darker the shade of red. In a cell adjacent to point A, the cumulative travel cost would be "3." In a cell in the heart of the butterfly area, the cost would be around sixty thousand. Think of this as a long path of cell values whose sum is 9+9+9...+6+6...+3. Cells that can't be traversed are black. [Click to enlarge]

Finally, Steve combines the Cost grid with a destination grid to find the least-cost bike path from the campground to the scenic overlook. The Result grid displays this path (step 3 of the diagram). As you might have expected, it drops down to the grassland and avoids heavily weighted cells, such as those in the butterfly area.
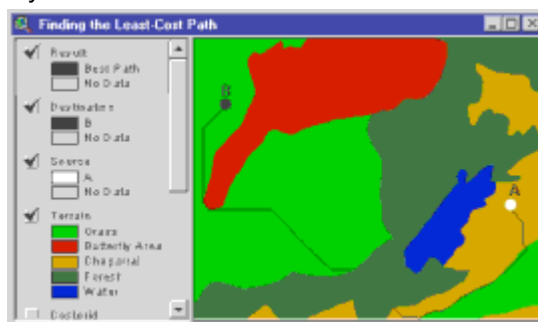
The least-cost path is not the shortest path, but it

All kinds of costs, values, and preferences can be built into a weighted distance model. In a full-scale model, the final weighted grid would be the product of several reclassified grids, each reflecting a different kind of cost or value.

Exercise

Introduction to raster overlay

In this exercise, you'll learn how to use basic overlay techniques to locate parcels that are inside a flood zone area. Insurance companies and city planners examine flood zone areas to locate buildings and other assets susceptible to flood damage. Their predictions can be used to target insurance sales or control development.

If you have not downloaded the exercise data for this module, you should download the data now.

Step 1 **Start ArcView**

Start ArcView and load the Spatial Analyst extension.

Note: If you are running ArcView GIS 3.1, you see a Welcome to ArcView GIS dialog. Click Cancel to close this dialog.

If ArcView is already running, close any open projects.

Step 2 **Open a project**

From the File menu, choose Open Project. Navigate to the **basicssa\lesson2** folder and open the project **l2_ex03.apr**.

Note: If you are running ArcView GIS 3.1, you see an Update l2_ex03.apr message box. Click No to dismiss this box.

When the project opens, you see the Flood Zone Analysis view.

The view contains flood zone and land use grid themes. The Landuse theme contains land use descriptions.

VIEW RESULT

Step 3 **Examine a theme**

Turn on the Flood Zone theme.

VIEW RESULT

You can see areas that would be affected by a flood.

Next, you will compare the two themes by creating a statistical summary table to report the amount of each land use type inside the flood zone area.

Step 4 **Create a statistical summary table**

Make the Landuse theme active. From the Analysis menu, choose Summarize Zones.

Next, you will be prompted by two message boxes for a theme and a statistic to chart. A table and chart will be created.

When prompted for the theme containing the variable to summarize, choose the Flood Zone theme and click OK.

The result of the summary operation is a table of statistical data called Stats of Flood Zone Within Zones of Landuse. One record in the table represents one land use type (there should be four records).

VIEW RESULT

When prompted for a statistic to chart, choose Sum. Click OK.

Because you selected Sum, a chart called Sum of Flood Zone Within Zones of Landuse is created.

VIEW RESULT

Examine the chart and table. You see that there are residential areas within the flood zone. A more detailed analysis is needed to pinpoint the residential locations within the flood zone area.

Close the table and the chart.

In the next step, you will use a map query on the Landuse theme to create a new theme that contains only residential areas. You will then compare the flood zone and residential areas. Using another map query, you'll locate the residential areas inside the flood zone. The results of these operations will be a new theme called Wet Homes.

REVIEW CONCEPT

Step 5 **Create a map query to isolate residential areas**

Make sure the Landuse theme is active. From the Analysis menu, choose Map Query. In the Map Query dialog, build the following expression:

[Landuse.Landuse_type2] ="Residential"

Click Evaluate.

The result of the map query is a new theme named Map Query 1. It contains only residential areas.

Change the name of the new theme from Map Query 1 to **Residential**, then turn it on. Turn off the Landuse theme.

The new theme contains only residential areas.

VIEW RESULT

Close the Map Query 1 dialog.

REVIEW CONCEPT

Step 6 Overlay the themes

From the Analysis menu, choose Map Query. In the Map Query dialog, build the following expression:

([Residential]) and ([Flood Zone])

Click Evaluate.

The result of the map query is a new theme named Map Query 1. It contains only residential areas in the flood zone.

Close the Map Query 1 dialog.

Change the name of the Map Query 1 theme to **Wet Homes** and turn it on. Turn off the Residential theme.

VIEW RESULT

The Wet Homes theme contains residential areas inside the flood zone. These parcels could be targeted for flood insurance. City planners could also use this information to plan for the future.

REVIEW CONCEPT

Step 7 Close the project

Close the project without saving any changes.

You have completed this exercise

Exercise

Introduction to contours and surfaces

In this exercise, you will learn how to create contour and surface themes from a theme of sample points. You'll learn to use both the Create Contours and Interpolate Surface functions of ArcView Spatial Analyst.

You will help a farmer balance the pH levels in a field that is being prepared for the next growing season. Some crops have a better yield when their soil has a balanced pH level (7). Areas in the field with a pH of less than seven are treated with lime to raise the pH

level. Areas with a pH level of more than seven are treated with
ammonium sulfate to lower it.

If you have not downloaded
the exercise data for this
module, you should
[download the data now](#).

Step 1 **Start ArcView**

Start ArcView and load the Spatial Analyst extension.

Note: If you are running ArcView GIS 3.1, you see a Welcome to ArcView GIS dialog.
Click Cancel to close this dialog.

If ArcView is already running, close any open projects.

Step 2 **Open the project**

From the File menu, choose Open Project. Navigate to the **basicssa\lesson2** folder
and open the project **l2_ex04.apr**.

Note: If you are running ArcView GIS 3.1, you see an Update l2_ex04.apr message
box. Click No to dismiss this box.

When the project opens, you see the Life on the Farm view. The view contains The
Farm theme and a theme of points called Field Samples.

The Field Samples theme represents soil samples that were collected in the field and
tested for chemical composition. The Field Samples theme table contains several
attributes for chemical levels at each sample point.

VIEW RESULT

Step 3 **Create a contour line theme from sample points**

Make the Field Samples point theme active. From the Surface menu, choose Create
Contours.

REVIEW CONCEPT

In the Surface Grid specifications dialog, set the Output Grid Extent to Same As The
Farm. Click OK.

Setting the Output Grid Extent to Same As The Farm means the new theme will not
extend beyond the farm's rectangle. You could set the output extent equal to the
display, but if you were zoomed out too far, your new theme would be huge,
extending to the edges of the view. It is also important to choose the same extent as
the farm because the sample points are concentrated inside the farm field.

In the Interpolate Surface dialog, choose Spline in the Method dropdown list, and pH
for the Z Value Field. Click OK.

The Z Value field contains the sample pH values that are used to create the contour lines.

Interpolating a surface may take a few moments.

When the processing is finished, enter **0.3** (pH) for the Contour interval in the Contour Parameters input box. Click OK.

The Contour interval is the distance between the contour lines. The smaller the Contour interval, the more lines in the new theme.

Turn on the Contours of Field Samples theme.

VIEW RESULT

Examine the areas of different pH concentration.

Lines that are close together indicate quickly changing pH levels. Without labeling, it is difficult to determine which areas represent high or low concentration. Labeling the lines, however, may be confusing since some of the lines are very close together.

To better see the areas of high and low concentration, you will create a grid theme of pH levels using the same sample points.

Step 4 **Create a grid theme of sample points**

Make sure the Field Samples point theme is active. Turn off the Contours of Field Samples theme. From the Surface menu, choose Interpolate Grid.

In the Output Grid Specification dialog, set the Output Grid Extent to Same As The Farm, then click OK.

In the Interpolate Surface dialog, choose Spline for the Method and choose pH for the Z Value Field. Click OK and wait a few moments for the surface to be created.

Turn on the Surface from Field Samples theme.

VIEW RESULT

Open the Legend Editor for this theme and click the Reverse Symbol button to reverse the gray shades of the Surface for Field Samples theme, so the high pH areas have darker gray shades.

Click Apply and close the Legend Editor.

VIEW RESULT

The farmer can use the pH contour line and surface themes to identify treatment areas. Any pH areas higher than seven may require ammonium sulfate treatment.

Step 5 **Close the project**

Close the project without saving any changes.

You have completed this exercise

Exercise

Introduction to proximity queries

In this exercise, you'll learn how proximity queries can help in making decisions about a location. You will help make a decision about the best locations to open a new store.

If you have not downloaded the exercise data for this module, you should <u>download the data now</u>.

Step 1 **Start ArcView**

Start ArcView and load the Spatial Analyst extension.

Note: If you are running ArcView GIS 3.1, you see a Welcome to ArcView GIS dialog. Click Cancel to close this dialog.

If ArcView is already running, close any open projects.

Step 2 **Open the project**

From the File menu, choose Open Project. Navigate to the **basicssa\lesson2** folder and open the project **l2_ex05.apr**.

Note: If you are running ArcView GIS 3.1, you see an Update l2_ex05.apr message box. Click No to dismiss this box.

When the project opens, you see the Coffee House Locations view with a streets theme turned on.

Turn on the Stores theme. Examine the locations of existing stores.

VIEW RESULT

Possible sites for new stores should be more than a mile from any existing stores. If any stores are closer than a mile, they may compete with each other for customers. In some cases, the distance between stores may be more or less than one mile. For this study, you will use one mile as the standard.

Step 3 **Find distances**

Make the Stores theme active. From the Analysis menu, choose Find Distance. In the Output Grid Specification dialog, set the Output Grid Extent to Same as Streets. Click OK.

Move the Distances to Stores theme to the bottom of the Table of Contents and turn it

on. Areas farthest away from existing stores would be good locations for new stores.

VIEW RESULT

When you're finished viewing it, turn off the Distance to Stores theme.

REVIEW CONCEPT

Step 4 **Calculate density of customers**

Turn on the Customers theme.

By looking at the display of customers, it is difficult to tell if some of the points are just really close together or on top of each other; those with the same address may be an apartment building.

VIEW RESULT

ArcView Spatial Analyst can calculate density of points.

Make the Customers theme active. From the Analysis menu, choose Calculate Density.

In the Output Grid Specifications dialog, set the Output Grid Extent to Same As Streets and click OK. In the Calculate Density dialog, keep all the current settings and click OK.

When the new Density from Customers theme appears, open the Legend Editor for this theme. Change the Color Ramp to Green monochromatic. Click Apply and close the Legend Editor.

Move the Density from Customers theme to the bottom of the Table of Contents and turn it on. Turn off all other themes except Stores.

VIEW RESULT

Examine the display of customer density. The dark green areas have the most customers.

Ideally, you would want the new store to be located near the customers spending the most money.

In the next step, you will calculate density again, but this time you will use the customers' spending patterns. The Customers theme table has a spending field, which indicates the amount of money that customers spent on their accounts over the last year.

Step 5 **Calculate density of customers based on spending**

Make the Customers theme active. From the Analysis menu, choose Calculate Density.

In the Output Grid Specifications dialog, set the Output Grid Extent to Same as Streets and click OK. In the Calculate Density dialog, set the Population Field to

Spending and click OK.

Change the name of the Density from Customers theme to **Spending Density**. Use the Legend Editor to change this theme's color ramp to Green monochromatic. Click Apply and close the Legend Editor.

In the Table of Contents, move the Spending Density theme below the Stores theme and turn it on. Turn off the Density from Customers theme.

VIEW RESULT

Step 6 Find suitable locations

From the Analysis menu, choose Map Query.

Build the following query, where 5280 feet equals 1 mile, and 400 equals the number of dollars spent by that customer in a year:

([Distance to Stores]>5280)and([Spending Density]>400)

Click Evaluate.

When the Map Query 1 theme appears, close the Map Query 1 dialog. Then, change the name of the Map Query 1 theme to **Best Locations**. In the Table of Contents, move the Best locations theme below the Streets theme. Turn on Best Locations and Streets.

VIEW RESULT

The Best Locations theme displays areas where you might focus efforts to find a new store location. These are areas more than 1 mile (5280 feet) from an existing store and which also have the greatest spending density (more than $400 per year).

Before choosing a final location, remember that there are many other factors to consider: for example, the characteristics of existing store neighborhoods, traffic counts, proximity to an interstate, income levels, population density, and age.

Step 7 Close the project

Close the project without saving any changes. You've completed the exercise

Summary

In this lesson, you learned some basic principles about using ArcView Spatial Analyst. For example:

Cells in a grid theme are assigned a solid fill color based on cell value or zone. You symbolize grid themes in the Legend Editor.

A theme's data values are classified with one classification per symbol. Each symbol represents either a single value or a range of values. Map Algebra is a computational language for performing spatial analysis on grids. Grid themes can be queried just like feature themes.

Contours and surfaces allow you to analyze continuous change of an attribute over space. You learned how to create isolines and a continuous surface from a set of sample points. Isolines are lines connecting points of equal value. A cost surface is a grid defining the friction or cost of moving through a cell. A cost surface is useful for defining a least-cost path between two locations.

ArcView Spatial Analyst can perform proximity analysis to analyze the distance between features or determine the area allocated to each feature. Buffering is a type of proximity analysis; a buffer is a zone of a specified distance around a feature. ArcView Spatial Analyst can also perform overlay analysis. You can use overlay analysis to compare two or more themes and determine where their features overlap.

You learned the importance visualization plays in presenting, understanding, and interpreting spatial data. Color ramps can be used to symbolize grids as a series of colors and they are primarily used to symbolize scalable data, such as elevation. Hillshading can be used to visualize the effects of illumination on a surface, creating a shaded relief grid theme from a surface theme.

In the exercises, you used ArcView Spatial Analyst to perform proximity analysis and overlay analysis and to create an isoline feature theme and a surface grid theme from sample points

This is the **Basics of ArcView Spatial Analyst - Lesson 2 Self test**.
⏰ **Please watch your time—you have 2 hours to complete this test.**

Use the knowledge you have gained in *Basics of ArcView Spatial Analyst* to answer the following questions. You will need to correctly answer 7 of the following questions to pass.

Netscape Users: Do not resize this browser window. This can cause the page to reload and generate new questions.

GOOD LUCK!

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1. Expressions can be entered into the Map Calculator in the following format:

    ⊙ Arc Macro Language (AML)

    ⊙ Mapping syntax language (MSL)

    ⊙ Avenue request format

    ⊙ Simple Macro Language (SML)

2. What are isolines?

    ⊙ Lines that represent a sharp and sudden change in the distribution of surface data

    ⊙ Lines on a map connecting points of equal value

    ⊙ Lines on a map connecting cells that share the same size

    ⊙ All of the above

3. A series of symbols that begins with one color, ends with another, and distributes intervening colors of the spectrum proportionately among the symbols in between is known as a:

    ○ Color range

    ○ Color ramp

    ○ Color spectrum

    ○ Color wheel

4. Only two grid themes can be compared in the Query Builder at any given time.

    ○ True

    ○ False

5. A cell's color brightness can be varied with values from another grid theme.

    ○ True

    ○ False

6. Which of the following classification methods can be used on floating point grid themes?

    ○ Equal Interval

    ○ Equal Area

    ○ Quantile

    ○ All of the above

7. You can change the colors used to symbolize a grid theme in the Project Properties dialog.

    ○ True

    ○ False

8. Use ArcView Spatial Analyst and the L2_ex03.apr project file to answer this question. Which land use type has the greatest area in the flood zone?

    ○ Agriculture

    ○ Residential

    ○ Vacant

    ○ Open space

9. Proximity analysis sets the value of each cell to either 1 or 0.

    ○ True

    ○ False

10. Map Query creates a new grid theme containing values of 1 and 2.

    ○ True

    ○ False

Calculate My Grade