COA 690 / 790 Introduction to GIS

Lab 8

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There are three exercises in this lab. You need to turn in the answers to the three questions and the final map for each exercise.

Exercise 1 Explore different interpolation methods

In this exercise, you will use a sample point layer that represents elevation points at specific locations on and around the Shivwits Plateau in Arizona. You will use each of the interpolation methods available in ArcGIS Spatial Analyst (except “kriging”) to create terrain surfaces from the sample point layer and visually compare the results.

Step 1 Open the map document

Start ArcMap™ and open the **InterpIntro.mxd** map document from your **\Interpolate** folder.

The map document contains two layers: a point layer named Sample points, and a polygon layer named Study area.
If necessary, load the ArcGIS Spatial Analyst extension and make the ArcToolbox™ window visible.

Step 2 Investigate the sample point layer

In the ArcMap table of contents, right-click the Sample points layer and choose Open Attribute Table.

The ELEV field contains an elevation value (z-value) for each record. In this case, the elevation values are in meters.
Close the table.
Turn off the Sample points layer.

Step 3 Use Inverse Distance Weighted (IDW) to interpolate a surface

If necessary, expand the Spatial Analyst Tools toolbox. Expand the Interpolation toolset and open the IDW tool.
Fill out the parameters as follows:

Input point features: Sample points
Output raster: ...\SampleptsScratch.gdb**IDW**
Click OK.

Step 4 **Use Spline to interpolate a surface**

From the Interpolation toolset, open the Spline tool.
Fill out the parameters as follows:
Input point features: Sample points
Output raster: ...\SampleptsScratch.gdb**Spline**
Change the optional Weight value to **2**.
Click OK.

Step 5 **Use Natural Neighbor to interpolate a surface**

From the Interpolation toolset, open the Natural Neighbor tool.
Fill out the parameters as follows:
Input point features: Sample points
Output raster: ...\SampleptsScratch.gdb**NatNeighbor**
Click OK.

Step 6 **Create hillshades for each of the surfaces**

From the Surface toolset, open the Hillshade tool.
Fill out the parameters as follows:
Input raster: **IDW**
Output raster: ...\SampleptsScratch.gdb**IDWHill**
Click OK.
Follow the same procedure to create a hillshade surface for the Spline and NatNeighbor layers, remembering to select these layer names from the Input surface drop-down list.
Name the new hillshade layers **SplineHill**, and **NatNeighborHill**.
In the table of contents, collapse the legends of all of the new layers you made by clicking the minus sign next to each layer name.

Step 8 **Group the layers and set transparency**

In the table of contents, click the IDW layer and, while holding down your Ctrl key, click the IDWHill layer so that both layers are highlighted simultaneously.
In the table of contents, right-click the highlighted IDW layer, and click Group.
Right-click New Group Layer, and choose Properties.
Click the General tab and rename the group layer **IDW**.
Click the Group tab.
If necessary, move the IDWHill layer to the bottom of the Layers list.
In the Layers list box, click IDW, then click the Properties button.

In the Layer Properties dialog box, click the Display tab. Change the transparency to **45**, then click Apply.
Click OK to close both the Layer Properties dialog box and the Group Layer Properties dialog box.
Drag and drop the IDW group layer just below the Sample points layer in the table of contents.

Follow the same procedure to group the Spline layers together, and name the new group layer **Spline**. Move the hillshade layer to the bottom and set the transparency for the interpolated surface to **45** percent.

Next, group the NatNeighbors layers together and name the new group layer **NatNeighbor**. Move the hillshade layer to the bottom and set the transparency for the interpolated surface to **45** percent.

Step 9 **Compare the elevation ranges in the interpolated surfaces**

At this point, you should have three group layers named IDW, Spline, and NatNeighbor. If necessary, arrange the layers in the table of contents so that the NatNeighbor group layer is above the Spline group layer, which is above the IDW group layer.
Expand the NatNeighbor layer in the NatNeighbor group layer.
Next, expand the Spline layer in the Spline group layer.
Finally, expand the IDW layer in the IDW group layer.

Notice that each interpolation method resulted in a different range of elevation values.

Question 1 Why do the ranges of values for IDW, Spline, and Kriging surfaces differ?

Step 10 **Visually compare the interpolated layers**

You may not see much difference between the layers. Based on the information you have so far, it is difficult to tell whether one interpolation method is better than the other. The interpolation method you choose to use at any given time is mainly a matter of preference and depends mostly on your familiarity with the data. The purpose of this exercise was to introduce you to basic interpolation methods. You will explore them in more detail in the exercises that follow.

Exercise 2 Model snow depth with IDW

In this exercise, you will use the Inverse Distance Weighted (IDW) interpolation method and experiment with changing different options, such as the Power setting and the search radius. You are provided with a set of sample points for snow depth measurements at specific locations throughout the Homewood quadrangle, which includes a portion of southwest Lake Tahoe, California. The sample points are regularly spaced throughout the area and, therefore, any of the interpolation methods may be suitable for creating the surface.

Step 1 Open the map document

Start ArcMap and open the **HomewoodSnow.mxd** map document from your **\Interpolate** folder.

The red triangles represent sample points where the depth of snow has been recorded in inches.
If necessary, load the ArcGIS Spatial Analyst extension and make the ArcToolbox window visible.

Step 2 Create a snow depth surface using the IDW interpolation method

When you use the IDW interpolation method with a Power setting of 2, each sample point exerts a strong influence over the estimated values of cells near it.

Question 2 What happens when sample points strongly influence estimated cell values?

From the Interpolation toolset, open the IDW tool.
Fill out the parameters as follows:
Input point features: Snow depth samples
Z value field: SNOWDEPTH
Output raster: ...\HomewoodScratch.gdb\Idw_hvsnow1
Make sure that Power is set to **2** and the Search radius type is Variable.
Click OK.
Turn off the Snow depth samples layer.
Rename the new surface **IDW Power 2** then collapse its legend in the table of contents.
Turn off the IDW Power 2 layer.

Step 3 Change the Power setting and run IDW again

To decrease the influence of the sample points on local cell values, you can reduce the Power setting. Lowering the Power setting is one way to create a smoother surface, that is, a surface with more gradual changes in cell values.

Question 3 One way to smooth an IDW surface is to decrease the power. What is another way?

From the Interpolation toolset, open the IDW tool.
Fill out the parameters as follows:
Input point features: Snow depth samples
Z value field: SNOWDEPTH
Output raster: ...\HomewoodScratch.gdb\Idw_hvsnow2
Change the Power to **0.5** and leave the Search radius set to Variable.
Click OK.
Rename the new surface **IDW Power 0.5** then collapse its legend in the table of contents.
Turn off the IDW Power 0.5 layer.

Step 4 Constrain the search radius and run IDW again

So far, the IDW function has been calculating the value of each cell by searching the entire set of points to find the nearest 12. This means that the value of a cell might be calculated based on point values that are relatively far away.
In this step, you will change the IDW interpolation settings so that its calculations are made based on fewer points and within a specified distance. You will change the settings to reduce the minimum number of nearest points to search to 5, and search for points within a radius of 1609.344 meters (1 mile). Constraining IDW will reveal how the estimated snow depth value of a cell is more like its neighboring sample point values and less like its sample point values further away.

From the Interpolation toolset, open the IDW tool.
Fill out the parameters as follows:
Input point features: Snow depth samples
Z value field: SNOWDEPTH
Output raster: ...\HomewoodScratch.gdb\Idw_hvsnow3
In the Power text box, set the power to **0.5** and leave the Search radius set to Variable.
Set the Number of points to **5**.
Set the Maximum distance to **1609.344**.
Click OK.
Rename the new layer **IDW 1609** then collapse its legend in the table of contents.

Step 5 Apply a new color ramp and set transparency for the IDW 1609 layer

Symbolize the IDW 1609 layer using the Cyan to Purple color ramp.
Set the transparency for the IDW 1609 layer to **45** percent.

Step 6 **Save the map document**

Save the map document as **HomewoodSnow2.mxd** in your **\Interpolate** folder.

IDW is a good interpolator for a phenomenon whose distribution is strongly correlated with distance. A classic example is noise, which falls off very predictably with distance. IDW does less well with phenomena whose distribution depends on more complex sets of variables because it can account only for the effects of distance.
One potential advantage of IDW is that it gives you explicit control over the influence of distance.

Exercise 3 Create a terrain surface with Spline

Your goal in this exercise is to create a representative terrain surface from a recently collected sample point dataset. Elevation (in feet) was recorded at each location. A small portion of the Tallgrass Prairie National Preserve in the Flint Hills region of Kansas has been designated the special study area.

The point locations are not very close together, given the size of the study area. The topography for this site is mostly rolling hills and does not include any cliffs or other abrupt changes in elevations; however, every hilltop and every ravine bottom was not surveyed. The elevation for those areas will need to be estimated.

Given these factors, you will use the Spline interpolation method to create surfaces from the sample points.

Step 1 Open the map document

Start ArcMap and open the **Tallgrass.mxd** map document from your **\Interpolate** folder.

The map document contains three layers: Study area, Sample points for Tallgrass, and Cottonwood River.

The Sample points for Tallgrass layer represents ground locations at specific elevations.

Turn the Sample points for Tallgrass layer off.

If necessary, load the ArcGIS Spatial Analyst extension, then make the ArcToolbox window visible.

Step 2 Run Spline using default settings

Spline interpolation can estimate values that are below the minimum or above the maximum values found in the sample data. This makes the Spline interpolation method good for estimating lows and highs where they are not included in the sample data.

While this surface does pass through all the sample points, estimates of cell values are influenced more by the direction of change inherent in the data. This means that the estimation of values in adjacent cells is less abrupt, resulting in a surface that appears more continuous and smooth.

From the Interpolation toolset, open the Spline tool.

Fill out the parameters as follows:

Input point features: Sample points for Tallgrass

Z value field: ELEVATION

Output raster: ...\FlintHillsScratch**SplineReg01**

Accept the default settings and click OK. **Note:** Please be patient, it may take a few moments to calculate the surface.

Rename the new surface **Spline Regular 0.1** then collapse the legend for the new surface in the table of contents.

Step 3 **Increase the weight setting and run Spline again**

Based on field observations, you might recall that the changes in elevation are more distinct. Increasing the weight setting of the Spline interpolator will cause more dramatic bending of the surface between the sample points.
From the Interpolation toolset, open the Spline tool.
Fill out the parameters as follows:
Input point features: Sample points for Tallgrass
Z value field: ELEVATION
Output raster: ...\FlintHillsScratch**SplineReg1**
This time, change the Weight from 0.1 to **1**.
Click OK. **Note:** Again, please be patient while ArcMap calculates the surface.

Rename the new surface **Spline Regular 1** then collapse its legend in the table of contents.
Compare your two Spline surfaces by turning Spline Regular 1 off and on.
The difference between this surface and the previous surface is subtle, but a regularized spline with a higher weight should appear smoother than one with a lower weight.

Step 4 **Run Spline again with tension settings**

Regularized Spline interpolation may estimate values that depart too much from the sample data. Running a tension spline will flatten out the surface bending effect (very slightly) around the sample points.

From the Interpolation toolset, open the Spline tool.
Fill out the parameters as follows:
Input point features: Sample points for Tallgrass
Z value field: ELEVATION
Output raster: ...\FlintHillsScratch**SplineTen01**
Click the Spline type drop-down arrow and choose TENSION.
Click OK. **Note:** Be patient, it may take a few moments to calculate the surface.
Rename the new surface **Spline Tension 0.1** then collapse its legend in the table of contents.

Step 5 **Create hillshade relief surfaces for each of the Spline surfaces**

Create a hillshade relief surface from the Spline Regular 0.1 layer.
Rename the new hillshade layer **Hillshade of Spline Regular 0.1**.

Next, create hillshade relief surfaces from the Spline Regular 1 and Spline Tension 0.1 layers.
Rename the new hillshade layers to **Hillshade of Spline Regular 1** and **Hillshade of Spline Tension 0.1**.
Note: If any of your resulting hillshade layers are symbolized with unique values, change their symbolization to stretched black and white. To do this, open the layer's properties dialog box and click the Symbology tab. For Show, change Unique to Stretched. Make sure the color ramp is black to white, then, in the Stretch area, change the Type to Minimum-Maximum.
In the table of contents, collapse the legends of all the hillshade layers.

Step 6 **Group the layers and set transparency**

Group the Spline Regular 0.1 and the Hillshade of Spline Regular 0.1 layers.
Name the new group layer **Spline default**.
Set transparency for the Spline Regular 0.1 layer to **45** percent and stack the layers in the group so that the hillshade is at the bottom.
Move the Spline default layer directly underneath the Cottonwood River layer.

Group the Spline Regular 1 and Hillshade of Spline Regular 1 layers. Name the new group layer **Spline Bend**. Make sure to move the hillshade layer to the bottom of the layer list and set the transparency for the Spline Regular 1 layer to **45** percent.
Move the Spline Bend layer directly underneath the Cottonwood River layer.

Group the Spline Tension 0.1 and Hillshade of Spline Tension 0.1 layers. Name the new group layer **Spline Tension**. Move the hillshade layer to the bottom of the layer list and set the transparency for the Spline Tension 0.1 layer to **45** percent.
Move the Spline Tension layer directly underneath the Cottonwood River layer.

In the table of contents, collapse the group layers.

Step 7 **Compare the splined surfaces**

The differences between the splined surfaces are not remarkable, but subtle differences might make a difference for your project. Compare the differences.
Turn off all layers except Study area and Spline default.
Turn on the Spline Bend layer.
Turn on the Spline Tension layer.

Step 8 **Save the map document**

An advantage of the Spline interpolator is that it can make estimates outside the range of input sample points. There are two types of Spline interpolators. The regularized spline creates a more elastic surface. The tension spline creates a less flexible surface.