Surface Interpolation Methods

ArcGIS provides a number of different tools for creating an estimated surface from sample data points. Selection of the proper tool is dependent on your modeling needs, knowledge of how the tools operate, and the sample data set.

**Spline** estimates grid cell values by fitting a minimum-curvature surface to the sample data. It’s like a flexible sheet of plastic that passes through each data point but otherwise bends as little as possible. The difference between regularized and tension splines is one of flexibility: a regularized spline has more "give" in it and produces smooth surfaces with estimated values that may fall well outside the sample data range. Tension splines are less smooth but conform more closely to the sample range.

Spline is usually better when:
- the range of sample values may not include the extremes of the phenomenon being interpolated
- the number of sample values is relatively small. (Spline generally produces better surfaces than IDW with sparse sample data sets.)
- you want to see a surface with a smooth distribution of values.

**IDW (Inverse Distance Weighted)** estimates cell values by averaging the values of nearby sample data points. The closer a point is to the center of the cell which is being estimated, the more weight it is given.

IDW is usually better when:
- you know that your sample data points represent the minimum and maximum values of your surface. (Because IDW is an averaging process, all interpolated values are within the sample range.)
- you have line data that you want to use to interrupt the interpolation process. (For example, you wouldn't want to interpolate elevation data over a cliff, or animal habitat data across a river the animal couldn't cross.) IDW lets you set interpolation barriers of this kind.
- you are more interested in the spatial variation near your sample points than in the smoothness of the overall surface.
- you have a large set of sample values

For most purposes, either an IDW or Spline interpolation with default settings will give you good results.

**Natural Neighbor**
This is a tool that operates in 3D Analyst. It interpolates a surface from points using a natural neighbor technique. The technique uses a weighted average of neighboring sample points and creates a surface that does not exceed the minimum or maximum values in the sample data set.

**Kriging**
Like IDW interpolation, kriging forms weights from surrounding measured values to predict values at unmeasured locations. As with IDW interpolation, the closest measured values usually have the most influence. However, the kriging weights for the surrounding measured points are
more sophisticated than those of IDW. IDW uses a simple algorithm based on distance, but kriging weights come from a semivariogram that was developed by viewing the spatial structure of the data. To create a continuous surface or map of the phenomenon, predictions are made for locations in the study area based on the semivariogram and the spatial arrangement of measured values that are nearby.

Semivariogram(distance $h$) = $0.5 \times \text{average} \left[ (\text{value at location } i - \text{value at location } j)^2 \right]$

**Trend**

The Trend Analysis tool provides a three-dimensional perspective of the data. The locations of sample points are plotted on the x,y plane. Above each sample point, the value is given by the height of a stick in the z dimension. The unique feature of the Trend Analysis tool is that the values are then projected onto the x,z plane and the y,z plane as scatter plots. This can be thought of as sideways views through the three-dimensional data. Polynomials are then fit through the scatter plots on the projected planes. An additional feature is that you can rotate the data to isolate directional trends through the values. There are many other features that allow you to rotate and vary the perspective of the whole image, change size and color of points and lines, remove planes and points, and select the order of the polynomial that is to fit the scatter plots.

Two other methods, Trend and Kriging, can be used with Avenue requests in the Map Calculator. Trend estimates grid cell values by fitting a polynomial surface to the sample points. Kriging uses geostatistical methods to create an optimal surface.