Surfer - Gridding Methods

Introduction – *The most common application of Surfer is to create grid-based maps from XYZ data files; these include contour maps, image maps, shaded relief maps, vector maps, surfaces and wireframes. XYZ based source data typically comprises of irregularly spaced values and as such cannot be used directly to generate a grid-based map. Consequently, the source data must be converted into an evenly spaced grid of data values which may in turn be mapped. The gridding process effectively extrapolates or interpolates data values at locations where data values are absent. There are a variety of alternative methods which may be utilised to complete the gridding process; naturally, the resultant grid files produced via each method will inherently be different. An overview of the gridding methods available are outlined below. In addition, each gridding method has been applied to a single source data set consisting of 47 values (Graphic - Centre Plot); the resultant processed grid files are presented as a series of contour maps (Graphic – Satellite Plot 1 to 11) radiating from the central source. The aim is to provide a visual overview and comparison of the gridding methods.*

Inverse Distance to a Power – *The Inverse Distance to a Power gridding method is a weighted average interpolator, and can be either an exact or a smoothing interpolator. With Inverse Distance to a Power, data is weighted during interpolation such that the influence of one point relative to another declines with distance from the grid node. Weighting is assigned to data through the use of a weighting power that controls how the weighting factors drop off as distance from a grid node increases. The greater the weighting power, the less effect points far from the grid node have during interpolation. As the power increases, the grid node value approaches the value of the nearest point. For a smaller power, the weights are more evenly distributed among the neighbouring data points. One of the characteristics of Inverse Distance to a Power is the generation of 'bull's-eyes' surrounding the position of observations within the gridded area. However, a smoothing parameter may be applied during interpolation in order to reduce the 'bull's-eye' effect. The method does not extrapolate elevation values beyond those found in the source data (Graphic - Satellite Plot 1).*

Kriging – *Kriging is a geostatistical gridding method which attempts to express trends suggested within the source data; for example, high points might be connected to form a ridge rather than being represented as isolated peaks. Kriging is a very flexible gridding method whereby the default parameters may be accepted to produce an accurate grid of the source data; alternatively, Kriging can be custom-fit to a data set by specifying an appropriate variogram model. Kriging can be either an exact or a smoothing interpolator depending on the user-specified parameters. The method may extrapolate elevation values beyond the limits found in the source data (Graphic – Satellite Plot 2).*

Local Polynomial – *The Local Polynomial gridding method assigns values to grid nodes by using a weighted least squares fit with data within the grid node's search ellipse. The method is most applicable to data sets that are locally smooth (Graphic – Satellite Plot 3).*

Minimum Curvature – *The interpolated surface generated by Minimum Curvature is analogous to a thin, linearly elastic plate passing through each of the data values with a minimum amount of bending. Minimum Curvature generates the smoothest possible surface while attempting to honor source data as closely as possible. However, Minimum Curvature is not an exact interpolator consequently source data is not always honored exactly. Minimum Curvature produces a grid by repeatedly applying an equation over the grid in an attempt to smooth the grid; each pass over the grid is counted as a single iteration. The grid node values are recalculated until successive changes in the values are less than the Maximum Residuals value, or the maximum number of iterations is reached. The method may extrapolate elevation values beyond the limits found in the source data (Graphic – Satellite Plot 4).*

Modified Shepard's Method – *The Modified Shepard's Method uses an inverse distance weighted least squares method. As such, Modified Shepard's Method is similar to the Inverse Distance to a Power interpolator, but the use of local least squares eliminates or reduces the 'bull's-eye' appearance of the generated contours. Modified Shepard's Method can be either an exact or a smoothing interpolator. Initially, the Modified Shepard's Method computes a local least squares fit of a quadratic surface around each observation. The Quadratic Neighbours parameter specifies the size of the local neighbourhood by specifying the number of local neighbours. The local neighbourhood is a circle of sufficient radius to include exactly this many neighbours. The interpolated values are generated using a distance-weighted average of the previously computed quadratic fits associated with neighbouring observations. The Weighting Neighbours parameter specifies the size of the local neighbourhood by specifying the number of local neighbours. The local neighbourhood is a circle of sufficient radius to include exactly this many neighbours. The method may extrapolate elevation values beyond the limits found in the source data (Graphic – Satellite Plot 5).*

Moving Average – *The Moving Average gridding method assigns values to grid nodes by averaging the data within the grid node's search ellipse. For each grid node, the neighbouring data is identified by centring the search ellipse on the node. The output grid node value is set equal to the arithmetic average of the identified neighbouring data. If there are fewer than the specified minimum numbers of data within the neighbourhood, the grid node is blanked. The moving average is most applicable to large and very large data sets; for example, >1000 data points. It extracts intermediate scale trends and variations from large noisy data sets. This gridding method may be used as an alternative to Nearest Neighbour for generating grids from large, regularly spaced data sets (Graphic – Satellite Plot 6).*

Natural Neighbour – *What is Natural Neighbour interpolation? Consider a set of Thiessen polygons, if a new point (target) were added to the data set, the Thiessen polygons would be modified. In fact, some of the polygons would shrink in size, while none would increase in size. The area associated with the target's Thiessen polygon that was taken from an existing polygon is called the 'borrowed area'. The Natural Neighbour interpolation algorithm uses a weighted average of the neighbouring observations, where the weights are proportional to the 'borrowed' area. The Natural Neighbour method does not extrapolate contours beyond the convex hull of the data locations. The gridding method uses a weighted average of the neighbouring observations and generates good contours from data sets containing dense data in some areas and sparse data in other areas. The method does not extrapolate elevation values beyond those found in the source data (Graphic – Satellite Plot 7).*

Nearest Neighbour – *The Nearest Neighbour gridding method assigns the value of the nearest point to each grid node. This method is useful when data is already evenly spaced. Alternatively, in cases where the data points are nearly on a grid with only a few missing values, this method is effective for filling in the holes in the data. The method does not extrapolate elevation values beyond those found in the source data (Graphic – Satellite Plot 8).*

Polynomial Regression – *Polynomial Regression is used to define large-scale trends and patterns in source data. Polynomial Regression is not really an interpolator because it does not attempt to predict unknown elevation values. There are several options which may be used to define the type of trend surface. The method may extrapolate elevation values beyond the limits found in the source data (Graphic – Satellite Plot 9).*

Radial Basis Function – *Radial Basis Function interpolation is a diverse group of data interpolation methods. In terms of the ability to fit source data and to produce a smooth surface, the Multi-quadric method is considered by many to be the best. All of the Radial Basis Function methods are exact interpolators, so they attempt to honor the source data. In addition, a smoothing factor may be applied in an attempt to produce a smoother surface (Graphic – Satellite Plot 10).*

Triangulation with Linear Interpolation – *The Triangulation with Linear Interpolation method utilises Delaunay triangulation. The algorithm creates triangles by drawing lines between data points; the original points are connected in such a way that no triangle edges are intersected by other triangles. The result is a patchwork of triangular faces over the extent of the grid. Each triangle defines a plane over the grid nodes lying within the triangle, with the tilt and elevation of the triangle determined by the three original data points defining the triangle. All grid nodes within a given triangle are defined by the triangular surface. Because the original data is used to define the triangles, the data is honored very closely. Triangulation with Linear Interpolation is most effective when the source data is evenly distributed over the grid area, therefore data sets that contain sparse areas result in distinct triangular facets on the map. The method tends to produce angular contours for small data sets. The method does not extrapolate elevation values beyond those found in the source data (Graphic – Satellite Plot 11).*