

## Natural Neighbour Interpolation

The Natural Neighbour method is a geometric estimation technique that uses natural neighbourhood regions generated around each point in the data set. The method is particularly effective for dealing with a variety of spatial data themes exhibiting clustered or highly linear distributions.

This technique is designed to honour local minimum and maximum values in the point file and can be set to limit overshoots of local high values and undershoots of local low values. The method thereby allows the creation of accurate surface models from data sets that are very sparsely distributed or very linear in spatial distribution.

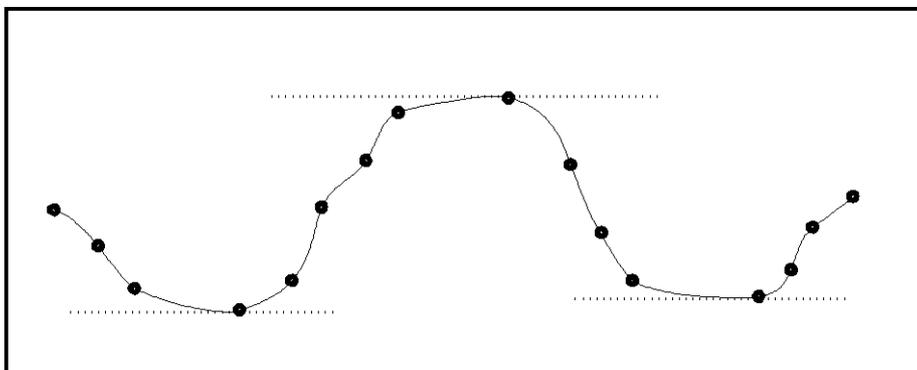


Figure 3.6. The interpolated surface is tightly controlled by the original data points using the slope-based Natural Neighbour interpolation method.

Very simply, the Natural Neighbour method makes use of an area-stealing, or area-weighting, technique to determine a new value for every grid node. As shown in Figure 3.7, a natural neighbourhood region is first generated for each data point. Then, at every node in the new grid, a new natural neighbourhood region is generated that effectively overlies various portions of the surrounding natural neighbourhood regions defining each point. The new grid value is calculated as the average of the surrounding point values proportionally weighted according to the intersecting area of each point.

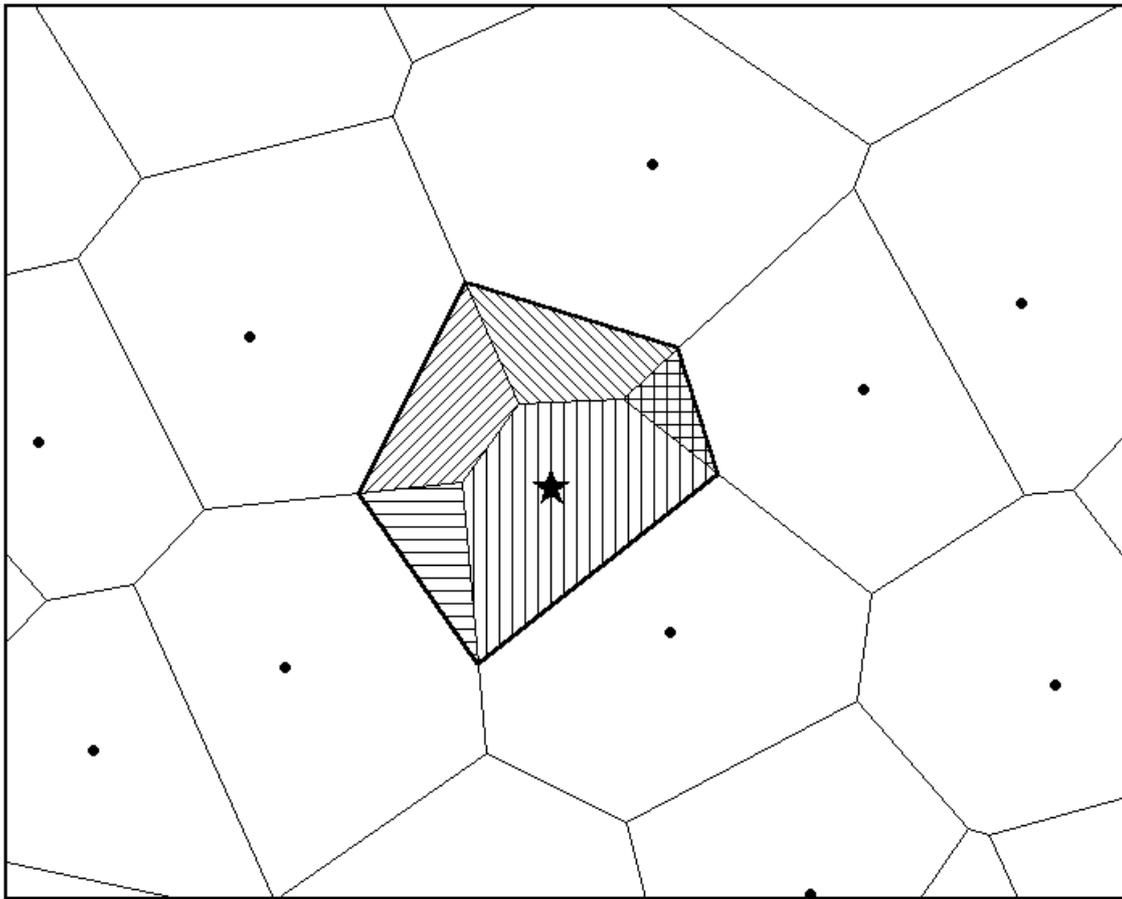


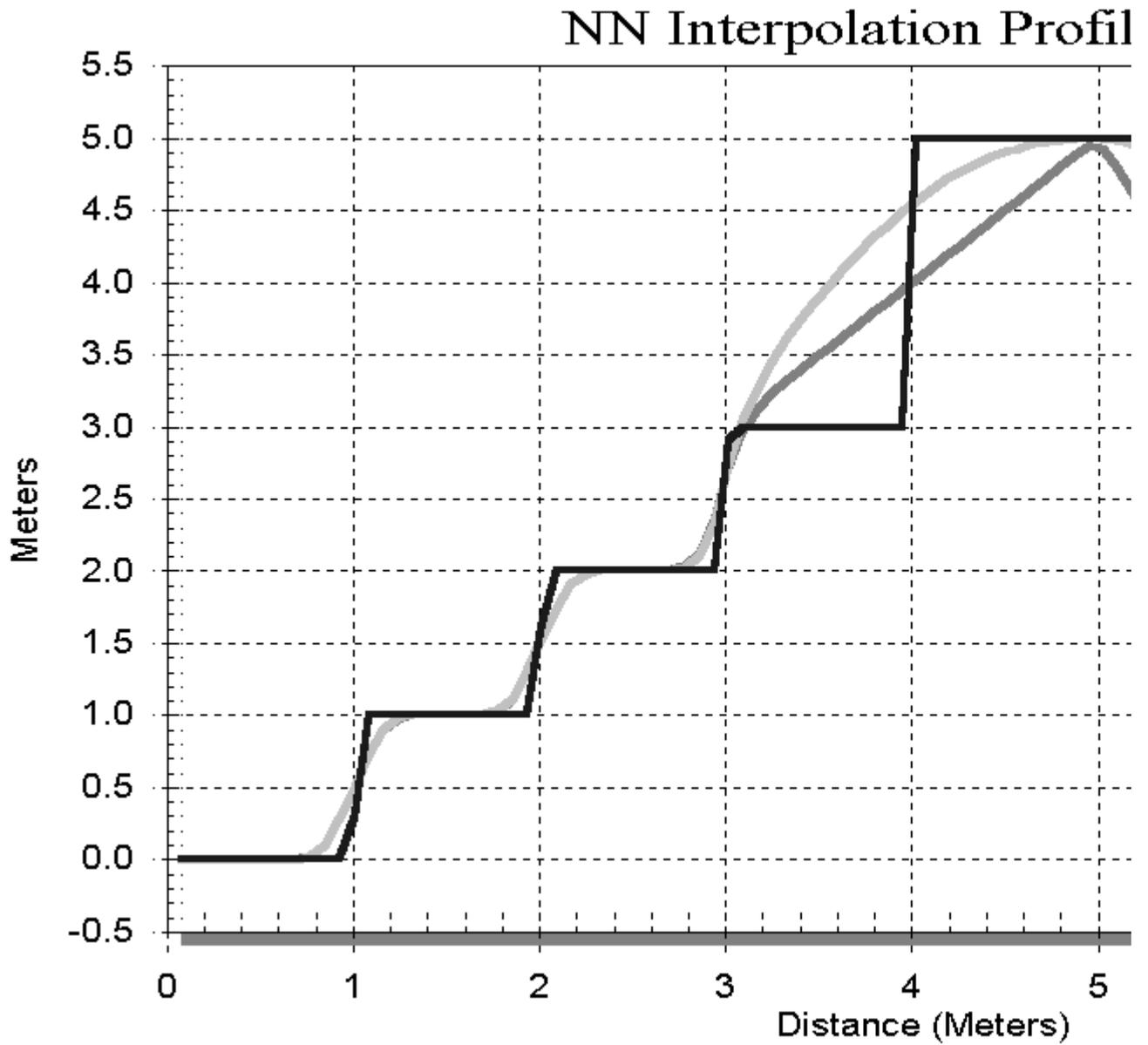
Figure 3.7 A display of the natural neighbourhood regions around the point file as well as the created around a grid node.

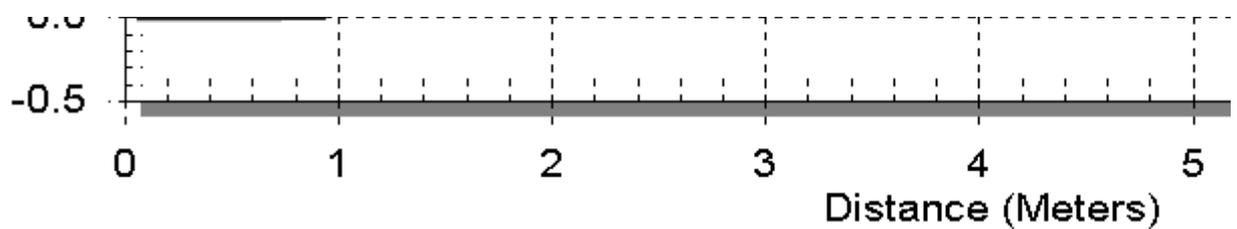
Three variations to this basic technique are incorporated into the Natural Neighbour interpolator and can be selected by the user. Figure 3.8 illustrates the behaviour of each variation.

1. A *Constant Value* interpolator in which each grid node takes on the value of the underlying natural neighbourhood region.
- 2.
3. A *Linear Solution*, where the grid value is determined by averaging the point values associated with surrounding natural neighbour regions and weighted according to the area that

is encompassed by a temporary natural neighbour region generated around the grid cell (see also Figure 3.7).

4.





A *Slope-based Solution* where the grid value is determined by averaging the extrapolated slope of each surrounding natural neighbour region and area weighted as in the *Linear Solution*. By examining the adjacent points, a determination is made as to whether that point represents a local maximum or minimum value. If such is the case, a slope value of zero is assigned to that value and the surface will therefore honour that point by neither overshooting nor undershooting it.

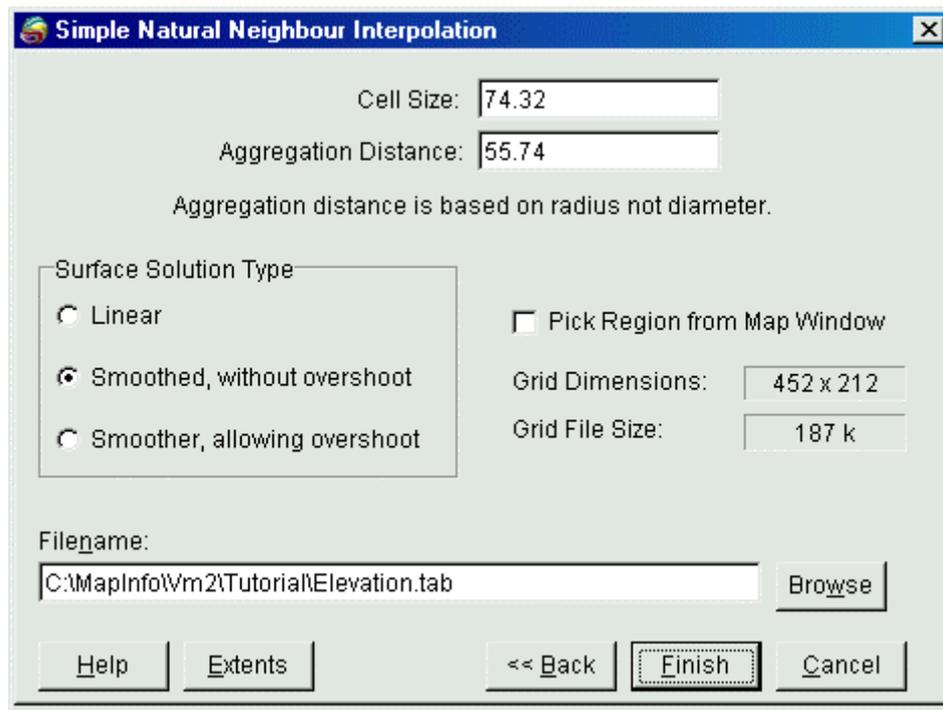
Figure 3.8 A graph showing the three variations of the Natural Neighbour Interpolator.

For an instructional lesson on the Natural Neighbour interpolation method refer to Lesson 3 of the *Installation and Tutorials* manual.

### Simple Natural Neighbour Interpolation

There are two routes to follow in proceeding with Natural Neighbour interpolation. The *Simple* technique offers the first-time user a two-step process for implementing the interpolation method. Many of the controls have been pre-set to generate the most appropriate surface given the distribution of points.

After entering the table and column names in the *Select Table and Column* dialogue box, the *Next* button takes the user into the *Simple Natural Neighbour Interpolation* dialogue box.



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- The *Simple Natural Neighbour Interpolation* dialogue offers basic settings for building a grid file.
  - 1 **Aggregation Distance** is the minimum separation allowed between data points before aggregation of the points is initiated. The aggregation technique makes use of the Forward Stepping method (described in Chapter 12) where the aggregation distance is the radius of circular search zones centred on successive points in the data set. Data points that fall within this search zone are mathematically averaged and a new data point is placed at the geometric centre of the aggregated points. Aggregation is a useful method for quickly grouping points that could be virtually coincident. It is also used as a preliminary data smoothing technique where highly variable data points that are spaced closely together can be aggregated and new values calculated using averaging. If no aggregation is desired, set this value to zero. By default, the aggregation distance is set at 10 percent of the mean distance between the data points.

- 2 **Cell Size** is defined in map units for the interpolated grid file. Note that the grid dimension (in cell units) varies inversely with cell size: the smaller the cell, the larger the grid file. The value chosen should be a compromise between the degree of resolution required for analysis and visualization purposes and the processing time and file size. The default value is calculated by dividing the diagonal width of the point file by 500 (considered an optimum number based on computing power required to solve this slightly more complex algorithm).
- 1 The **Surface Solution Type** settings are used to control the degree of smoothness applied to the new interpolated grid and refer to the different variations of the Natural Neighbour algorithm available to the user. Three solutions are provided.
    - 1 The **Linear Solution** calculates the value of a grid node using the average value of the points surrounding it. The calculation is area-weighted to account for the relative influence of the surrounding points. As shown in the profile in Figure 3.7, the **Linear Solution** produces a profile that is slightly smoother than the **Constant Value Solution**.
    - 2 The **Smoothed, without overshoot** technique refers to the **Slope-based Solution** discussed earlier. This variation of the Natural Neighbour method makes use of the slope of all adjacent points to calculate the area-weighted value of each grid node. Undershoot and overshoot are controlled by assigning a slope value of zero (horizontal) to all local minimum and maximum point values.
    - 3 The **Smother, allowing overshoot** technique uses the same slope-based method but allows overshooting and undershooting of local lows and highs, generating a much smoother surface.
  - The user may choose to select a new boundary region as the outer hull of the point data set. By checking the **Pick Region from Map Window** box, a prompt will appear to **Use the Pick Tool to pick the Hull Boundary** before the interpolation process runs to completion.
  - 1 The **Extents** button opens an information box that summarizes the geographic size and the Z-value range of the original point data base, the density of the points, as well as the data value units.
  - The user may either select the **Finish** button to complete the gridding process or, if modifications to the previous dialogue are required, select the <<**Back** button to return to one or more dialogues back. Once the grid is created, it appears in a MapInfo Map window with a default colour palette applied. The user may change the colour range assigned to the grid file using commands discussed in Chapter 7.

## Advanced Natural Neighbour Interpolation

By selecting the *Advanced* button, the user will be given access to a variety of controls in the Natural Neighbour interpolation method that can be used to make subtle adjustments to the grid surface generated from a MapInfo table of points.

After entering the appropriate table and column names in the *Select Table and Column* dialogue box, the *Next* button takes the user into the *Natural Neighbour Interpolation Aggregation Method* dialogue box.

**Natural Neighbour: Point Aggregation**

Aggregation Type

- Forward Stepping
- Cluster Regions
- Square Cell

Aggregated Value:

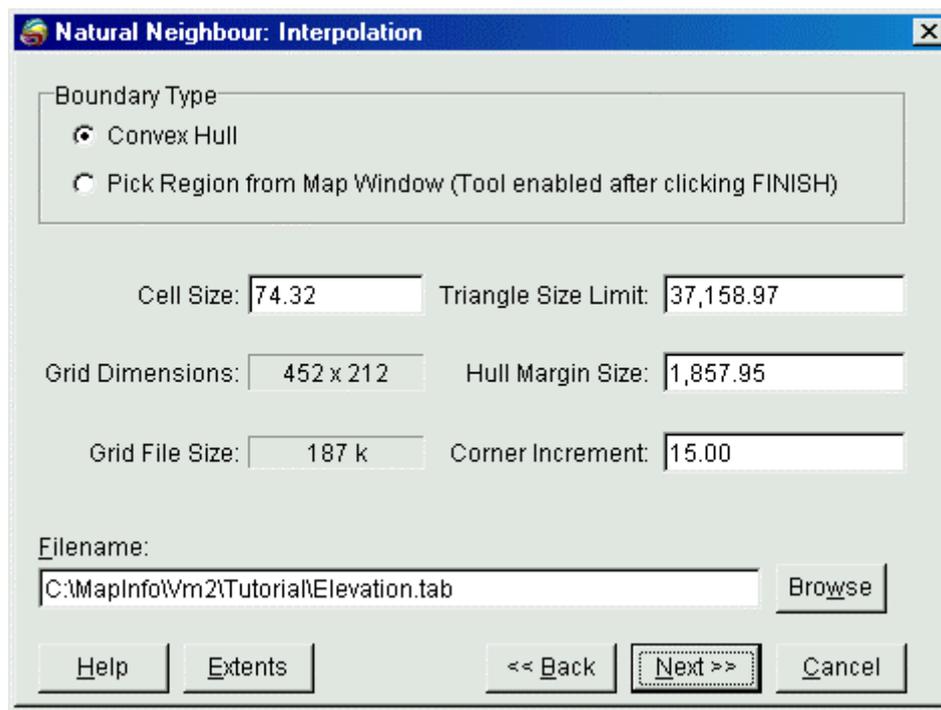
- Minimum Value
- Average Value
- Maximum Value
- Median Value
- Average of Min & Max Values
- Sum of Values
- Expected Value

Aggregation Distance:  
45.61

Aggregation distance is based on radius not diameter.

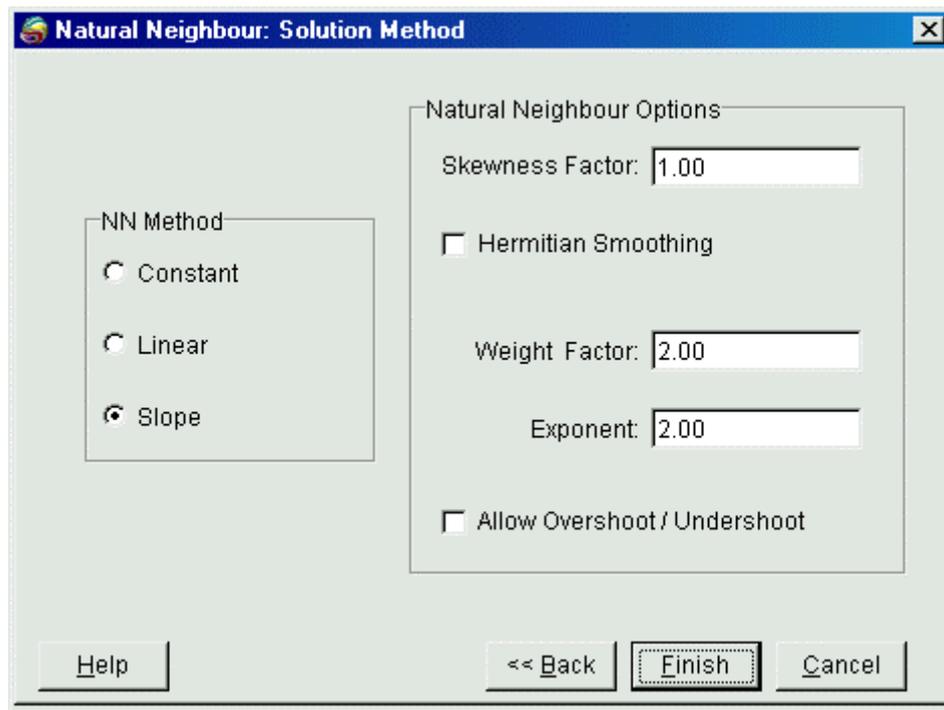
Help Extents << Back Next >> Cancel

- The first step in the Advanced Natural Neighbour method involves selecting an appropriate aggregation type as well as choosing the aggregated value.
  - 1 In the **Aggregation Type** section of the dialogue, choose one of the three major aggregation techniques supported by *Vertical Mapper*. The operation and optimum usage of the **Forward Stepping**, **Square Cell**, and **Cluster Regions** methods are discussed in detail in Chapter 12.
    - 1.
    - 2 The manner in which the new aggregated value is calculated can be selected from the list in the **Aggregation Value** section. The user may chose to average the aggregated values, average the min., max. values, sum the values, or assign the minimum, the maximum, the median, or the expected value to the new aggregated point.
    - 3 The **Aggregation Distance** setting refers to the distance used to group points for aggregation. This distance has a different meaning for each of the three methods. For the *Cluster Density* and *Forward Stepping* techniques, *Aggregation Distance* is defined by the radius of a user-specified circular search area centred about each aggregation cell. For the *Square Cell* technique, *Aggregation Distance* is defined by the width of a square aggregation cell.
- Choose the **Next >>** button to proceed to the next dialogue or, if modifications to the previous dialogue are required, select the <<**Back** button to return to one dialogue back.
- 
- The second step in the Advanced Natural Neighbour method involves setting a number of general parameters
- that control the grid building process.



- 1 The **Boundary Type** refers to the selection of a hull that controls the outward extent of interpolation and forms the outermost boundary of the grid file. There are two choices available.
  - a) The **Convex Hull** of the data set is a natural boundary defined by the outermost extent of the points. The user is prompted to enter a value that extends the boundary beyond the natural **Convex Hull** of the data set.
  - b) A pre-defined MapInfo region can be used as the point boundary. When the *Finish* button is selected, the user is prompted to **Pick Region From Map Window**.
  
- 2 **Cell Size** is defined in map units for the interpolated grid file. Note that the grid dimension (in cell units) varies inversely with cell size: the smaller the cell, the larger the grid file. The value chosen should be a compromise between the degree of resolution required for analysis and visualization purposes and the processing time and file size. The default value is calculated by dividing the diagonal width of the point file by 500 (considered an optimum number based on computing power required to solve this slightly more complex algorithm).

- 3 The ***Triangle Size Limit*** is a Delaunay triangulation setting used to limit the creation of natural neighbourhood regions around adjacent points that the user considers too far apart. Depending upon the geographic distribution of points in a file, this setting will restrict the generation of unnecessarily large and/or extremely long, narrow regions. This will limit interpolation between points across distances that may be inappropriate. For example, a set of field observations may contain large gaps in the coverage due to sampling problems. If the gaps are quite large, it would be inappropriate in most cases to interpret new values lying within these areas. Generally, the user is expected to have a certain understanding of the distribution characteristics of their own data in order to enter an appropriate value.
  - 4 The ***Hull Margin Size*** is a distance value in map units that is added to the Convex Hull of the data set to define the outermost margin of the interpolated grid.
  - 5 The ***Corner Increment*** setting refers to the construction of the four corner segments of the hull of the data set. The value entered represents the incremental arc angle of the segments that make up the imaginary polygon boundary at each corner. The smaller the value, the greater the number of segments that will be added and therefore the smoother the corner. The setting is measured in degrees and is limited to values between 1 and 30.
- Enter a unique file name for the new interpolated grid and either choose the ***Next*** >> button to proceed to the next dialogue or, if modifications to the previous dialogue are required, select the << ***Back*** button to return to one or more dialogues back.
  - The final step in the Advanced Natural Neighbour method involves choosing the solution method and setting a number of interpolation parameters.



1. The choice of *Natural Neighbour Method* is discussed earlier and refers to calculating a new grid values from the natural neighbourhood areas of adjacent points.
  - a) The *Constant* solution assigns the exact value of the underlying natural neighbourhood region to the new grid node. The resulting grid is a very close approximation of the natural neighbourhood region map (Voronoi diagram) that can be generated from the original data points.
  - b) The *Linear* solution assigns the average Z-value of each surrounding point weighted according to the area that is encompassed by a temporary natural neighbour region generated around the grid node.
  - c) The *Slope* solution assigns the area-weighted average slope of each surrounding point. By examining the adjacent points, a determination is made as to whether that point represents a local maximum or minimum value. If such is the case, a slope value of zero is assigned to that value and the surface will therefore honour that point by neither overshooting nor undershooting it. However, the solution can be set to

*Allow Overshoot/Undershoot* by checking the appropriate box. The user will therefore see values in the new interpolated grid that exceed the range of the original point values.

- 1 The *Skewness Factor* is a weighting factor used in the grid node calculation that can be used to assign greater or lesser influence to the data point that is closest to the grid node, i.e. the point whose natural neighbour area directly underlies the grid node. Allowable values range from 0.001 to 999. If the maximum allowable *Skewness Factor* setting was entered, the resulting grid would appear very similar to a grid generated using the *Constant Value* solution since the value at each grid node is almost entirely influenced by the one point lying nearest to it.
  - 2 Choosing *Hermitian Smoothing* applies a weighting curve to the grid node calculation that effectively assigns greater influence to points that are closer to the grid node based on their proportionally larger intersecting areas. Conversely, *Hermitian Smoothing* will assign lower weighting to points that lie farther from the grid node based on their proportionally smaller intersecting areas. Quantitatively, if the proportional natural neighbour area of a point is greater than 50% of the total grid node natural neighbour area, the Hermitian curve applies greater weight to this point. If the proportional natural neighbour area of a point is less than 50% of the total grid node natural neighbour area, the Hermitian curve applies lower weight to this point.
    - 1.
    - 3 In the slope-based method of natural neighbour interpolation, *Weighting Factor* defines the degree of influence imposed by neighbouring triangles in calculating a slope value for each data point. Increasing the weighting factor will increase the relative influence of more distant data points.
    - 4 In calculating a slope value for each data point for the slope-based solution, *Exponent* is the variable that defines the exponential decay of influence of neighbouring points the farther they lie from each point. Increasing the exponent will decrease the relative influence of more distant points.
- The user may select either the *Finish* button to complete the gridding process or, if modifications to the previous dialogue are required, select the << *Back* button to return to one or more dialogues back. Once the grid is created, it appears in a MapInfo Map window with a default colour palette applied. The user may change the colour range assigned to the grid file using commands

discussed in Chapter 7.