

Spatial data analysis: geostatistical tools

Geostatistics studies spatial variability of regionalized variables: Variables that have an attribute value and a location in a two or three dimensional space. Tools to characterize the spatial variability are the *spatial autocorrelation function* and the *variogram*. The variogram is calculated from the variance of pairs of points at different separation. For several distance classes or lags, all point pairs are identified which match that separation and the variance is calculated. Repeating this process for various distance classes yields a variogram: A function in which distance class is plotted versus variance. Similarly, the spatial autocorrelation can be calculated and plotted in a autocorrelogram. These functions can be used to measure spatial variability of point data but also of maps or images. In the case of point data, ILWIS calculates a so-called *omnidirectional variogram*, in which distance classes are considered without considering the orientation in space of the point pairs. For raster maps, ILWIS derives variance and correlation in horizontal and vertical direction. Other directions can theoretically be obtained, by rotating the map prior to calculating the variogram or spatial autocorrelation function.

In this chapter, you will use a point data set consisting of the top and bottom of an oil reservoir sandstone and you will use Landsat TM images for different lithologies, to conduct spatial variability analysis in ILWIS. Furthermore, the spatial interpolation analysis will be done.

Before you can start with the exercises, you should start up ILWIS and change to the subdirectory `c:\ilwis21\data\usrguide\chap11`, where the data files for this chapter are stored.



- Double-click the ILWIS program icon in the ILWIS program group.
- Change the working drive and the working directory until you are in the directory `c:\ilwis21\data\usrguide\chap11`.

11.1 Spatial autocorrelation of point data

The statistical analysis referred to as spatial autocorrelation, examines the correlation of a random process with itself in space. Many variables that have discrete values measured at several specific geographic positions (i.e., individual observations can be approximated by dimensionless points), can be considered random processes and can thus be analyzed using spatial autocorrelation analysis. Examples of such phenomena are: Total amount of rainfall, toxic element concentration, grain size, elevation at triangulated points, etc.

The spatial autocorrelation function, shown in a graph is referred to as spatial *autocorrelogram*, showing the correlation between a series of points or a map and itself for different shifts in space or time. It visualizes the spatial variability of the phenomena under study. In general, large numbers of pairs of points that are close to each other on average have a lower variance (i.e., are better correlated), than pairs of points at larger separation. The autocorrelogram quantifies this relationship and allows to gain insight into the spatial behavior of the phenomenon under study.

In ILWIS, a point map can be used for spatial autocorrelation analysis, if the points in the map are values (a point map with the domain type value). Spatial correlation analysis can also be performed on values, which are stored in a column of the attribute table of a point map, with domain type identifier.

The output of spatial autocorrelation analysis in ILWIS is a table consisting of four columns. The Column *Distance* shows the distance groups created by the program. Column *NrPairs* represent the number of pairs observed in a distance group. The correlation coefficient for each distance group is given in the column *Correlation*. Column *Variance* shows the variance for each distance group.

Data in the output table can also be represented in forms of graphs (*variograms*).

Semivariogram (according to Olea) is: Given two locations x and $(x+h)$, a semivariogram is a measure of the one half mean square error produced by assigning the value $z(x+h)$ to the value $z(x)$. A variogram is twice the semivariogram.

Visualization of the input data

The data set available belongs to synthetic drillhole data from an oil field that is under exploration. Given are the top and bottom (in meters above mean sea level) to a sandstone unit that is considered a potential reservoir rock for both oil and gas. The exploration geologist is asked to provide his judgment on the spatial variability of the thickness of the reservoir, which would intrinsically be important to determine the success ratio in drilling for oil in the area.

The variables include:

- **Top:** Point map of top (in meters above mean sea level) to a sandstone unit.
- **Bottom:** Point map of bottom (in meters above mean sea level) to the same sandstone unit.



- Double-click raster map `Top`. The Display Options dialog box is opened.
- Accept all default settings and click OK. The map is displayed in a map window. Click several points to know their values.
- Close the map window.
- Evaluate the map `Bottom` with the same procedure.

You will first examine the spatial autocorrelogram for the top of the sandstone.



- Double-click the `SpatCorr` operation in the Operations-list. The Spatial Correlation dialog box is opened.
- Select point map `Top` in the list box `Point Map`.
- Click the check box `Show`.
- Type `Top` in the text box `Output Table`.
- Click OK.
- The result of the operation are displayed in a table window.
- In the table window, open the `Options` menu and select the `Show Graph` command. The `Graph` dialog box is opened.
- Select: `Distance` for the X-axis and `Correlation` for the Y-axis and then OK. The `Edit Graph` dialog box is opened.
- Select: `Point` and then OK. The graph is displayed, showing the distance against the correlation.
- In the graph window, open the `Graph` menu and select the `Add Graph` command. The `Graph` dialog box is opened.
- Select: `Distance` for the X-axis and `Variance` for the Y-axis and then OK. The `Edit Graph` dialog box is opened.
- Select: `Point` and then OK. The graph is displayed, showing the distance against the variance.

Now two graphs are prepared for the depth to the top of the reservoir rock: One graph showing the change in correlation with distance and another graph showing the change in variance with distance. Both are based on a table, which also contains the total number of point pairs, used to calculate for each of the individual distance classes, the variance and correlation. Thus the points represent an average value for a large number of pairs of points, in order to filter out some of the erratic behavior of the variables. Note that the pairs are selected, based only on the distance

separating them and not on their orientation, thus the curves are representative for the entire area rather than for a particular direction. This implies that directional components or anisotropies in the data set cannot be detected.

Display the variance versus the distance in a graph. At short distance the variance is low indicating that closely separated points are identical. When moving to larger pair separations, you may observe an increase in variance to a distance of approximately 500 meters. From 500 meters onward the imaginary curve that can be fitted through the points (i.e., this curve is known as the variogram), tends to level off to a constant value. Thus points separated over distances larger than 500 meter are no longer related or correlated (notice this also in the graph showing the correlation versus the distance) to each other. This critical distance in geostatistics is known as the range of influence or correlation length of the data and is a measure of spatial variability: A long range implies homogenous data whereas a short range implies high spatial variability. Therefore, to ensure a proper sampling of the top of the reservoir rock, we need to at least have points with an average sampling spacing of less than 500 meter, to capture the spatial variability. In general a distance in the order of 1/4 of the range values (i.e., 125 meter spacing) is recommended. Note also that when extrapolating the value of the variance for a distance of zero, you find a small but non-zero value for the variance. This implies that there is variability for points separated by a distance of zero meters! This hypothetical variance is known as *nugget* variance and can be attributed to measurement errors and to small-scale variability occurring at a distance smaller than the average sampling interval.



- Close the table window when you have finished the exercise.
- Repeat the same procedure for the map Bottom. Evaluate the results, and close the table window.

Summary: Spatial autocorrelation

- Spatial autocorrelation examines the correlation of a random process with itself in space.
- The spatial autocorrelation function shown in a graph and referred to as spatial *autocorrelogram*, showing the correlation between a series of points or a map and itself for different shifts in space or time, visualizes the spatial variability of the phenomena under study.
- A point map can be used for spatial autocorrelation analysis if the points in the map are values or IDs (linked to a table with a value column).
- The output of spatial autocorrelation analysis is a table consisting of four columns. *Distance*, *NrPairs*, *Correlation* and *Variance*.

11.2 Point interpolation

A point interpolation performs an interpolation on randomly distributed point values and returns regularly distributed point values. The input for interpolation is mostly a point map with the domain type value or domain type identifier. If a point map has a domain type identifier, it is necessary that it has an attribute table, in which the attribute values are stored in a column with the domain type value. The output of a point interpolation, is a raster map in which each pixel has a value calculated by an interpolation on the input point values. The various interpolation methods are: *Voronoi Tessellation*, *moving average*, *trend surface* and *moving surface*.

When interpolating point values it is, for time efficiency reasons, strongly advised to choose a rather large pixel size for the output map. Further interpolation on the raster map values can be performed using the **Densify** operation.

When using a moving average or a moving surface point interpolation, it is important to choose a limiting distance that contains enough points.

You can use the **Spatial Correlation** operation to get some insight into your point data distribution before interpolating.

You will create the *isochore* map (equal thickness map) for the sandstone reservoir, by interpolating the values for the top and the values for the bottom and subtracting these two maps. Make sure you use the same cell sizes for all manipulations.

Nearest Neighbor

In this method (*Voronoi Tessellation* or *Thiessen Polygons*) the value, identifier, or class name of the nearest point is assigned to the pixels. This method can be performed on a point map with domain type Value or Class. It offers a quick way to obtain a Thiessen map from point data (Figure 11.1).

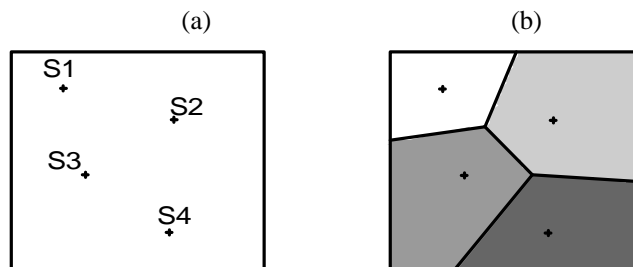


Figure 11.1: (a) An input point map, (b) The output map obtained as the result of the interpolation operation applying the Voronoi Tessellation method.



- Double click on the icon NearestPnt in the Operations-list.

The **Nearest Point** dialog box is opened. The options in this dialog box allow you to select an input point map, a surface order, type a name for the output map, select or create a georeference, display the map immediately after the operation has finished, select or create a domain and type a description for the output map.



- Select point map **Top** in the list box **Point Map**.
- Type **Topnn** in the text box **Output Map**.
- Select **Wells** in the list box **GeoReference**.
- Click the check box **Show**.
- Type **Interpolation from point** in the text box **Description**.
- Accept the defaults by clicking the **OK** button.

The **Display Options - Raster Map** dialog box will be opened.



- Accept the defaults by clicking the **OK** button. The interpolated map is shown. Check the values in the map and close the map window.
- Repeat the same procedure for the map **Bottom** and create the map **Bottomnn** as **Output Map**.

Now that you know the depth of the top and of the bottom, you can calculate the thickness of the sandstone unit.



- Type the following formula on the command line of the main window:
`Thicknn:= Topnn - Bottomnn ↵`
- Accept the defaults in the **Raster Map Definition** dialog box and click **OK**. The map is calculated and the **Display Options** dialog box is opened. Click **OK**.
- Check the values of the map and those of the input maps using the pixel information window.

Notice that the thickness observed in the isochore map, diminishes towards an area stretching from the middle lower left-hand side of the mapped area to the upper right-hand side of the area. This is caused by a normal fault dipping south, cutting out part of the reservoir sandstone in the central part of the area. From the interpolated map you can conclude that the Nearest Neighbor method is very quick, but far too rough for this specific application.

As additional geological exercise, try to sketch a geological cross section from the top (North) to the bottom (South) of the mapped area. Notice that the thickness of the sandstone diminishes in the central part of the area, due to a south dipping normal fault and that the reservoir is also folded.



- Create a cross section through the area from the North to the South, with the method explained in chapter 10 (exercise 10. 7).
- Close the pixel information, the map window and the table window when you have finished the exercise.

Moving Average

This method performs a weighted averaging on point values of a point map with domain type Value or Identifier. The point map with domain type Identifier only, can be used if in its attribute table a column with the domain type Value is available. The output value for a pixel is calculated as the sum of the products of weights and point values, divided by sum of weights. Weight values are calculated in such a way that points close to an output pixel obtain large weights and points further away obtain small weights. Thus, the values of points close to an output pixel are of greater importance to the output pixel value, than the values of points that are further away. You have two options (*inverse distance* and *linear*), to specify the method to calculate weight values (see [On-line Help](#) or [Reference Guide](#)). Further more, you also have to specify a *limiting distance*. Points that are further away from an output pixel than the limiting distance, obtain weight zero and thus have no influence on the output value for that pixel.



- Double-click the **MovAverage** operation in the Operations-list.

The Moving Average dialog box is opened.



- Select point map **Top** in the list box **Point Map**.
- Type **Topma** in the text box **Output Map**.
- Select **Wells** in the list box **GeoReference**.
- Click the check box **Show**. Accept **Inverse Distance** as **Weight Function**.
- Type **Interpolation from points** in the text box **Description**.
- Accept the defaults by clicking the **OK** button.

After calculating, the Display Options - Raster Map dialog box will be opened.



- Accept the defaults by clicking the OK button. The map is displayed.
- Check the values of the map and those of the input maps using the pixel information window.
- Close the map window and the pixel information window.
- Repeat the same procedure for the map Bottom and name the result map Bottomma.

Now that you know the depth of the top and of the bottom, you can calculate the thickness of the sandstone unit.



- Type the following formula on the command line of the main window:
`Thickma := Topma-Bottomma ↵`
- Accept the defaults in the Raster Map Definition dialog box by clicking OK.

The Display Options - Raster Map dialog box will be opened.



- Accept the defaults by clicking OK.
- Compare the map with the result from the Nearest Neighbor interpolation (Thicknn).
- Close the map window when you have finished the exercise.

From the resulting map you can conclude that the Moving Average interpolation method is a useful method for this specific problem. The erratic behavior near the fault trace can be due to natural variation/ inhomogeneity. A more continuous area of low values could be achieved by directional interpolation (i.e. using a search ellipse in stead of a search radius).

Trend Surface

In this method, pixel values are calculated by fitting a surface through all point values in the map. The surface may be of the first up to the sixth order. A trend surface may give a general impression of the data. Surface fitting is performed by a least squares fit. This method can be performed on the point map with domain type Value or Identifier.



- Double-click the TrendSurface operation in the Operations-list.

The Trend Surface dialog box is opened.



- Select point map Top in the list box Point Map.
- Type Topts in the text box Output Map.
- Select Wells in the list box GeoReference.
- Select 2nd degree in the list box Surface.
- Click the check box Show.
- Type Interpolation from point in the text box Description.
- Accept the defaults by clicking the OK button.

After calculating, the Display Options - Raster Map dialog box will be opened.



- Accept the defaults by clicking the OK button.

The result of the interpolation is a map consisting of surfaces representing homogeneous areas.



- Close the map window.
- Repeat the same procedure for the map Bottom and name the result map Bottomts.
- Calculate the thickness of the sandstone unit by subtracting the map Bottomts from the map Topts. Name the output map: Thickts .
- Compare the map Thickts with the result from the Nearest Neighbor interpolation (Thicknn), and the Moving Average interpolation (Thickma).
- Close all map windows when you have finished.

From the resulting map you can conclude that the Trend Surface method is not useful for this particular data set. The result only shows a very general trend, without any local detail.

Moving Surface

In this method pixel values are calculated by fitting a surface through weighted point values. Weights for all points are calculated by a weight function. Weights may, for instance, equal the inverse distance. Points outside a user-specified limiting distance obtain weight zero by the weight function. Surface fitting is performed by a least squares fit. This method can be performed on the point map with domain type Value or Identifier.



- Double-click the **MovSurface** operation in the Operations-list.

The **Moving Surface** dialog box is opened. The options in this dialog box allow you to select an input point map, a surface order, type a name for the output map, select or create a georeference, display the map immediately after the operation has finished, select or create a domain and type a description for the output map.



- Select point map **Top** in the list box **Point Map**.
- Accept **Inverse Distance** as **Weight Function**.
- Type **Topms** in the text box **Output Map**.
- Select **Wells** in the list box **GeoReference**.
- Select **2nd degree** in the list box **Surface**.
- Click the check box **Show**.
- Type **Interpolation from point** in the text box **Description**.
- Accept the defaults by clicking the **OK** button.

After calculating, the **Display Options - Raster Map** dialog box will be opened.



- Accept the defaults by clicking the **OK** button.

The result of the interpolation is a map consisting of surfaces representing homogeneous areas.



- Close the map window.
- Repeat the same procedure for the map **Bottom** and name the result map **Bottomms**.

- Calculate the thickness of the sandstone unit by subtracting the map Bottomms from the map Topms. Name the output map: Thickms .
- Compare the map Thickts with the result from the Nearest Neighbor interpolation (Thicknn), the Moving Average interpolation (Thickma), and the Trend Surface interpolation (Thickts).
- Close all map windows when you have finished.

From the resulting map you can conclude that the Moving Surface method is not suitable for this data set. The result doesn't make much sense.

Summary: Point interpolation

- A point interpolation performs an interpolation on randomly distributed point values and returns regularly distributed point values.
- The input for interpolation is mostly a point map with the domain type value or domain type identifier (which should be linked to a table containing a value column).
- The output of a point interpolation, is a raster map in which each pixel has a value calculated by an interpolation on the input point values.
- The various interpolation methods are: *Voronoi Tessellation*, *moving average*, *trend surface* and *moving surface*.

11.3 Calculating spatial autocorrelation of a raster map

This operation calculates the autocorrelation and the semi variance, between pixel values of a raster map and pixel values of the same raster map for different shifts (lags), in horizontal or vertical directions. This method is based on the assumption that a regional variable becomes random at a great distance; the correlation of a regional variable with other pixels will normally decrease with increasing distance. The maximum shift allowed is $m/2$, with m the number of the rows or columns in the raster map, e.g. for a map of 200 rows the maximum allowed shift in vertical direction is 100 pixels. The default maximum shift is determined by dividing number of rows or columns to 4 ($m/4$), e.g. for a map of 200 rows 50 pixels is in vertical direction.

The results of auto-correlation in vertical and horizontal directions are stored in a table. The data of this table can also be represented as a graph. In the table the record number corresponds to the shift. The table contains the following columns:

- `VertCorr`: Vertical Auto Correlation.
- `HorCorr`: Horizontal Auto Correlation.
- `VertVar`: Vertical Semi Variance.
- `HorVar`: Horizontal Semi Variance.

To assess the effect of spatial resolution on image statistics and spatial structure of the image, variograms can be used.

Visualization of the input data

The data set available contains parts (250 by 250 pixels) of Landsat TM scenes, with three characteristic lithologies: a *gneissic* unit from a TM scene acquired on the 25th of March 1989 over an area near Malaga in southern Spain, and a terrain consisting of *schists* and a folded *carbonate* sequence, from a TM scene acquired on the 19th of July 1984, over an area near Montalbán in central Spain.

For more information on the use of variograms on these image data set refer to: Van der Meer, F. (1997). What does multisensor image fusion add in terms of information content for visual interpretation? *International Journal of remote sensing* 18(2) 445-452.

The available data set includes:

- `Carbstr`: Raster map of folded carbonate sequence, extracted from a TM scene acquired on the 19th of July 1984 over an area near Montalbán in central Spain.
- `Schist`: Raster map of schist, extracted from a TM scene acquired on the 19th of July 1984 over an area near Montalbán in central Spain.
- `Gneiss`: Raster map of gneissic units, extracted from a TM scene acquired on the 25th of March 1989 over an area near Málaga in southern Spain.



- Double-click raster map `Carbstr`. The Display Options dialog box is opened.
- Accept all default settings and press OK. The map is shown.
- Check the values in this map by clicking some pixels. Close the map window.
- Repeat the same procedure for the maps `Gneis` and `Schist`.

Now you will calculate semivariograms for the three lithologies.



- Double-click the `AutoCorr` operation in the Operation - list.

The `AutoCorrelation` and `SemiVariance` dialog box is opened. The option `Maximum Pixel Shift` allows you to determine a maximum shift in vertical and horizontal directions. The output is a table.



- Select raster map `Carbstr` in the list box `Raster Map`.
- Type `Carbstra` in the text box `Output Table`. Click check box `Show`. Accept the defaults by clicking the OK button. The result of the operation is displayed in the table window.
- From the `Options` menu select the `Show Graph` command. The `Graph` dialog box is opened. Select: `Key value` for the X-axis and `HorCorr` for the Y-axis and click OK. The `Edit Graph` dialog box is opened. Select: `Point` and then OK.
- In the graph window, open the `Graph` menu and select the `Add Graph` command. The `Add Graph` dialog box is opened.
- Select: `Key value` for the X-axis and `VertCorr` for the Y-axis and then OK. Select: `Point` and then OK. Close the graph window.
- Select: `Options, Show Graph`. Select: `Key value` for the X-axis and `HorVar` for the Y-axis and then OK.
- Select: `Point` and then OK. Close the graph window.
- Select: `Options, Show graph`. Select: `Key value` for the X-axis and `VertVar` for the Y-axis and then OK.
- Select: `Point` and then OK. Close the graph window and the table window.
- Repeat the same procedure for the maps `Gneis` and `Schist`.

In general, the semivariograms show low values for short lag spacings, indicating that pixels that are close or adjacent are relatively similar (i.e., the variance is low). In some cases the curve does not seem to approach the origin of the plot, but tends to reach a small y-intercept known as nugget. This indicates that there is variability at very short (almost zero pixel) distances. In remote sensing, this variance can be attributed to noise in the images. At larger lag spacings, the increase in semivariance tends to level off to a constant value, known as the sill of the semivariogram. The distance at which this sill is reached is known as the range of the variogram.

Specific features that can be observed in the semivariograms for the different lithologies are:

- *Gneiss*: The semivariogram has a very short range due to the fact that the gneisses lack bedding or other kind of structurization. The vertical and horizontal semivariograms are identical, again due to the homogenous and isotropic landforms on the gneissic terrain lacking any preferred orientation. The sill is high, due to strong differences in absolute digital numbers between the sunlit slopes and the shadowed slopes.
- *Schist*: The range of the semivariograms of the schist is very long pointing to very continuous data with less spatial variability. The sill value is very low due to small spectral variation observed in the image.
- *Carbonate*: The carbonate image has again a long range and a low sill value. Notice the differences between the vertical and horizontal semivariograms. The long range in the horizontal semivariogram points to more continuity and the short range in the vertical semivariogram to more variability in the respective direction. This can be attributed to the bedding that predominantly strikes east-west and is pronouncedly clear, due to the alternation of carbonates and marls.

11.4 Pattern analysis

Data in a point map represent the spatial occurrence of a particular phenomenon. The spatial distribution of the points in the map, can be examined to acquire more knowledge about the phenomenon and the responsible process. *Point pattern analysis* is a technique that is used to examine arrangement of points data in space and to obtain information about the phenomenon.

Spatial arrangement of point data in a point map can be one of the following three fundamental types (Figure 11.2): *Complete spatial randomness (CSR)*, *clustered pattern* and regular pattern. In case of complete spatial randomness (CSR), no correlation exists between locations of points. In a clustered pattern, subgroups of points tend to be significantly closer to each other than to other subgroups of points. In a regular pattern, individual point items tend to repel each other and distances between adjacent points tend to be further apart than for CSR.

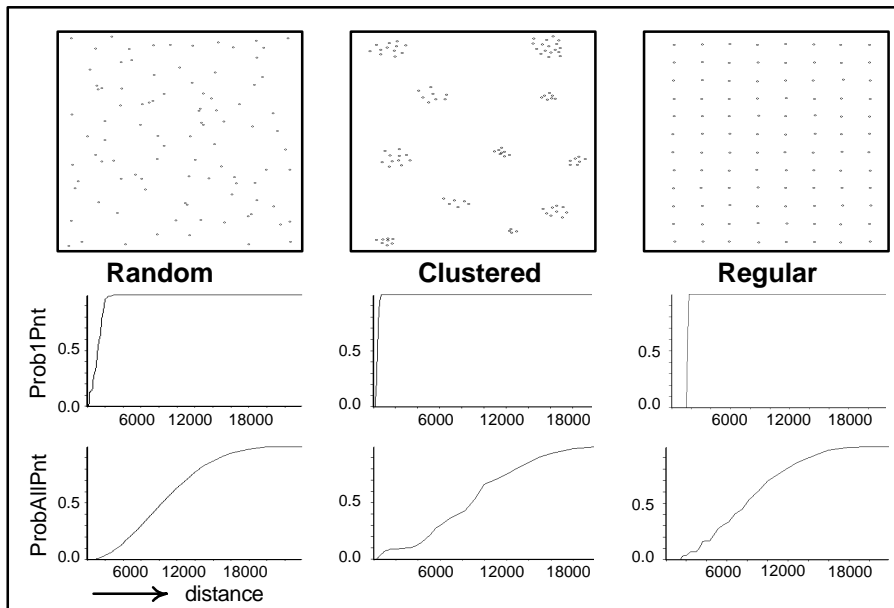


Figure 11.2: Fundamental types of patterns: Complete spatial randomness (CSR), clustered and regular.

There are two basically different techniques that are used in ILWIS to examine the spatial pattern of points in a point map:

- *The nearest neighbor distance*: this method involves analyzing spatial distribution of the points, using characteristics of the distances between individual points in the map. The pattern is analyzed by calculating distances between individual points and its first to sixth nearest neighbor points in the pattern. The results are tested against the expected distances in CSR. If the individual points are closer than they would be for CSR, this indicates a

clustered pattern. If, on the other hand, individual points are further apart than they would be in CSR, a more regular pattern is assumed.

- *The reflexive nearest neighbors:* By this method two points are considered first order of reflexive nearest neighbors (RNN) if they are each other's nearest neighbor. This definition can be extended to higher orders; second order RNNs are points that are each others second-nearest neighbors etc. The frequencies are calculated for RNNs of first to sixth order.

The output of the pattern analysis, is a table in which measured frequencies of occurrences of RNNs, are compared with expected frequencies of occurrences in a situation of CSR. The CSR is simulated for the same area and the same number of points. If the number of observed RNNs are almost the same as the expected one in a situation of CSR, the points pattern are CSR. The points have a clustered pattern, when the number of observed RNNs are less than the expected ones in a situation of CRS. They have a regular pattern when the number of observed RNNs are higher than the expected ones in a situation of CSR.

The output of the pattern analysis in ILWIS is a table with eight columns and additional information. Column `Distance` lists distances that should be considered as distance from any point in the input point map. Column `Prob1pnt` lists the probability that, within the specified distance (column `Distance`) of any point, another point will be found. `Prob2pnt` lists the possibility that, within that distance, from any point, two other points will be found. The same goes for columns `Prob3pnt`, `Prob4pnt`, `Prob5pnt` and `Prob6pnt`. For a data set of n points `ProbAllpnt` is the summation of `Prob1pnt + Prob2pnt + + Probnpnt - 1`, divided by $(n - 1)$. Additional information on pattern analysis is displayed in a table with three columns. First to sixth order nearest neighbor are listed in column `order`. Observed values for each order calculated using reflexive nearest neighbors and mean distance to nearest neighbor, are displayed under column `observed value`. The assumed values with CSR, for each order calculated using the mentioned techniques, are listed in column `assumed with CSR`. These data together with the data in the table can be used to define the type of spatial distribution of the points in the map.

In this exercise pattern analysis operation is performed on map `Rainfall` (containing fictitious rainfall stations in the Cochabamba area). To start the operation:



- Double-click `PattAnal` in the Operations-list.

The Pattern Analysis dialog box is opened.



- Select point map Rainfall in the list box Point Map.
- Type Rainpat in the text box Output Table.
- Click the check box Show.
- Click OK.

A table window containing the result of the analysis is opened. Display the table data in graphs and compare them with the graphs in Figure 11.2, to define a pattern for the point map. You can also use additional information to define how the points are distributed in the point map. To create a graph from the table data:



- From the Options menu of the table window, select the Show Graph command. The Graph dialog box is opened.
- Select column Distance from X-Axis list box and column Prob1pnt from Y-Axis list box.
- Click OK. The Edit Graph dialog box is opened.
- Select Line for graph type.
- Accept the default by clicking the OK button.
- Repeat the exercise but select column ProbAllPnt from Y-Axis list box.
- Close the graph window.

To view the additional information:



- From the Edit menu of the table window select the Properties command.
The Table Properties dialog box is opened.
- Click Additional Info button in this dialog box.

The additional information is displayed in a box.



- Close the box and the table window when you have finished the exercise.

