
TUTORIAL: INTERPOLATION OF HYDROLOGICAL VARIABLES USING ARCVIEW SPATIAL ANALYST

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1 PROBLEM

Conductivities and Chloride content of soil water have been measured in several observation points. These data shall be analysed and appropriately interpolated. We are supposed to assess the influence of the selected interpolation method on the resulting map.

2 TRAINING OBJECTIVES

- Display a map of our observed data
- As a first step, visualise areal characteristics by a THIESSEN map
- Deterministic interpolation methods: IDW and splines
- Geostatistical methods: Ordinary and Universal Kriging
- Comparison of methods

3 GIVEN DATA

Our data are recorded in a simple ASCII table *sample1.txt*. Column ID is a unique point identifier, columns X and Y are coordinates and Lf is conductivity, Cl is Chloride. A few lines of this table are displayed below:

```
"ID", "X (m)", "Y (m)", "Lf", "Cl"  
1, 3410119, 5473056, 66.85, 24.93  
2, 3411113, 5470085, 72.31, 34.57  
3, 3412490, 5471066, 53.64, 26.29  
4, 3410720, 5471365, 107.96, 54.9
```

4 SOFTWARE REQUIREMENTS

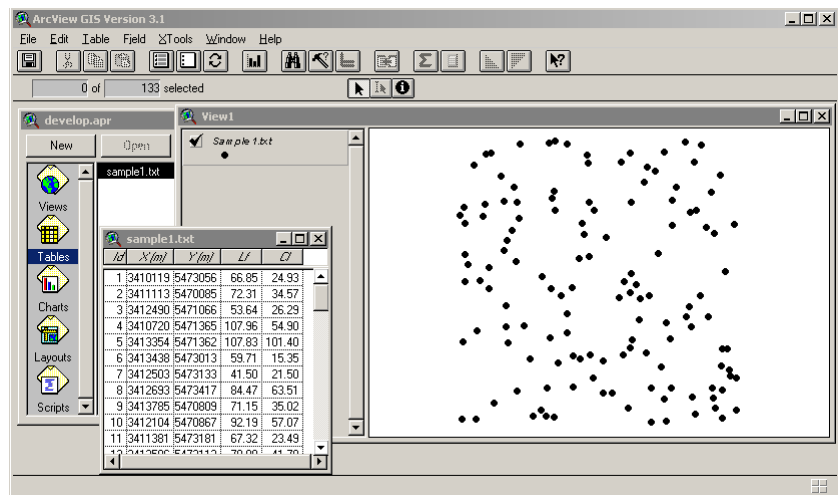
ArcView 3.1 or later

Extensions: Spatial analyst, Spatial Tools 3.3, Kriging Interpolator 3.2 SA, Xtools

5 TASKS

5.1 Display a map of the sample points

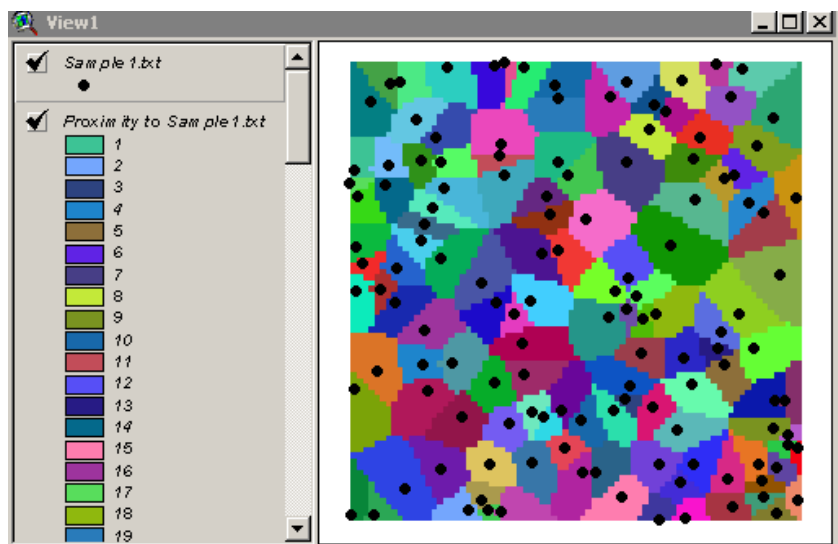
- Start ArcView and load the extensions listed above
- Add a new table document from *sample1.txt*
- Open a new view and add the event theme *sample1.txt*. Make the source directory the working directory of the project.



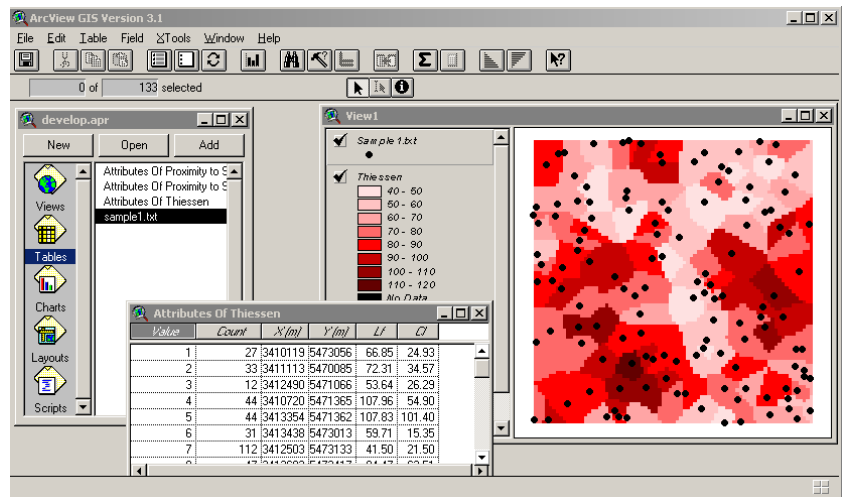
5.2 Visualise areal characteristics by a THIESSEN map

A very simple regionalisation method is to assign each point in the domain the value of the closest observation point.

- With *sample1.txt* the active theme, select **Analysis** → **Assign proximity**. In the following dialogs, set the desired extent and resolution of the resulting grid. Pick field ID for cell values. The resulting grid has in each cell the ID of the closest point:

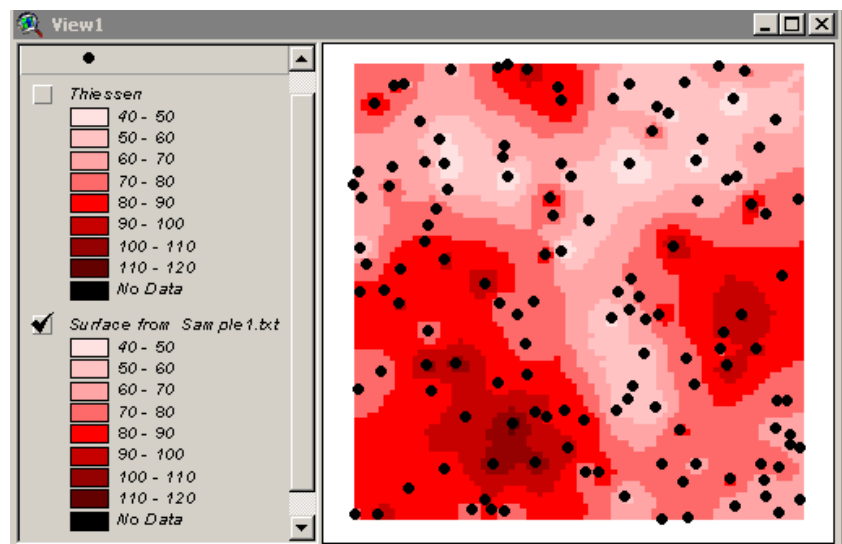


- Open the attribute table of the grid and join the *sample1.txt* table by columns *Value* and *ID*. The grid can now be displayed with a classification of any attribute in the table, e.g. *Lf* by graduated color:

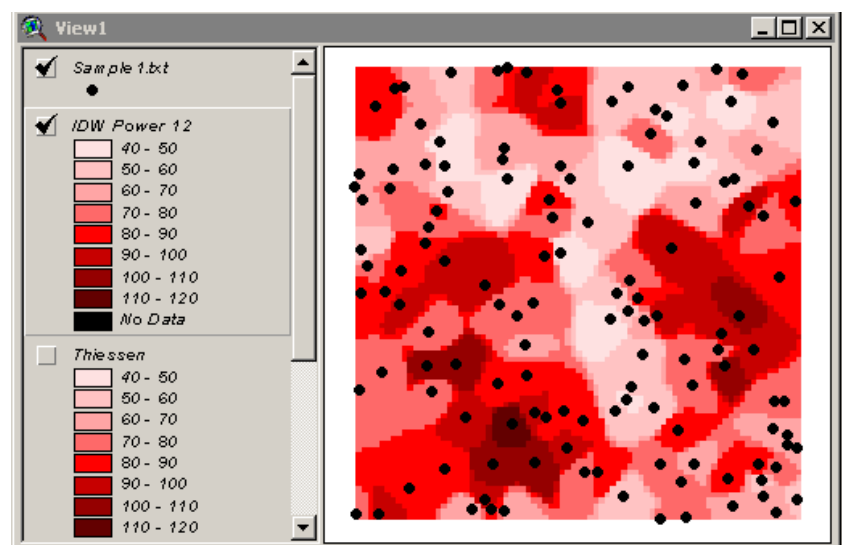


5.3 Deterministic interpolation methods: IDW and splines

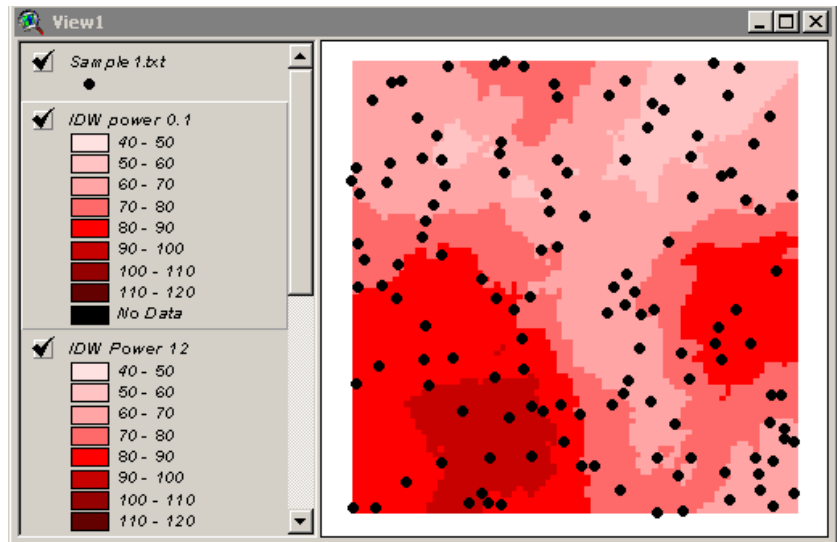
- Default IDW interpolation with exponent 2 → bull's eye effect



- IDW with power 12: approximates THIESSEN (proximity assignment)

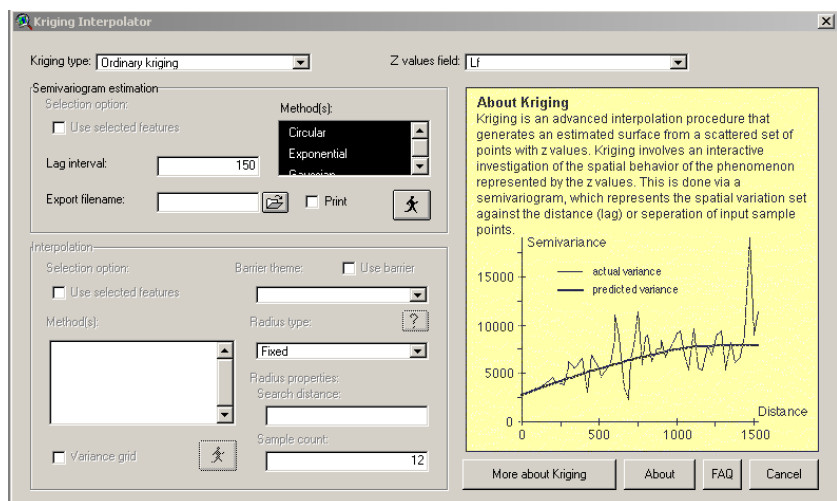


- IDW with power 0.1: approximates global mean

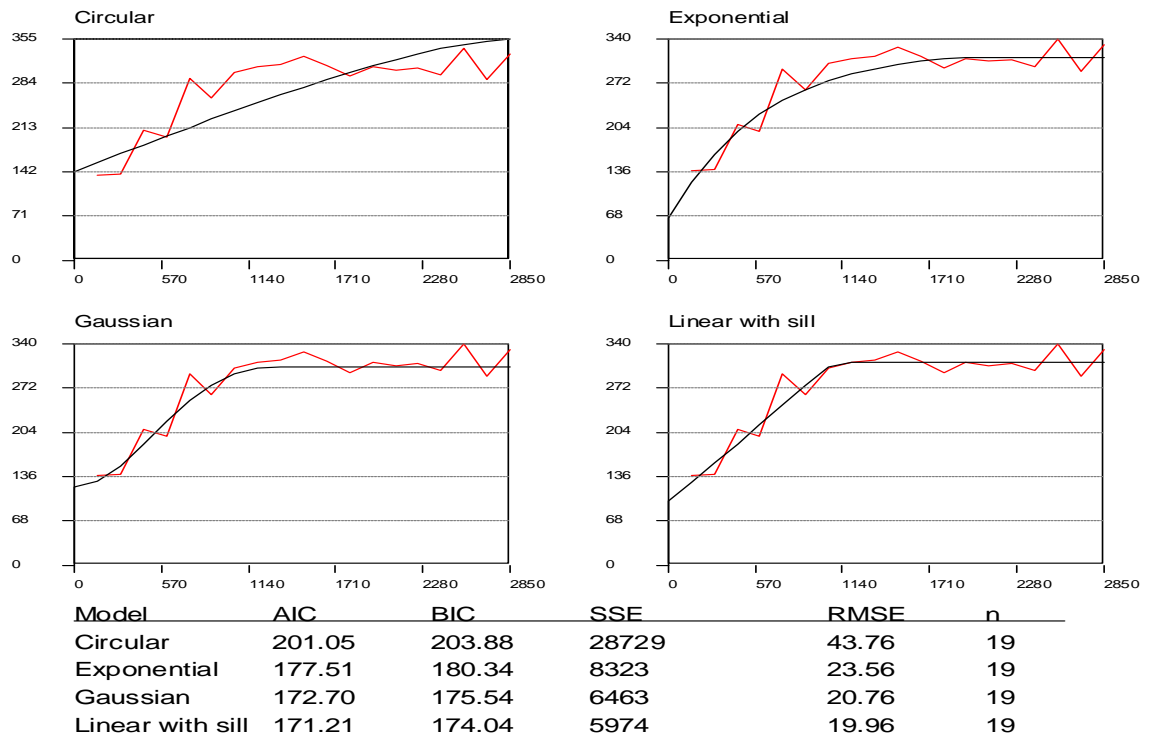


5.4 Geostatistical methods: Ordinary and Universal Kriging

- We use the Kriging Interpolator Interface by Nieuwland (NL). Make sample1.txt the active theme. **Surface** → **Interpolate Grid via Kriging ...** and fill the dialog first for Ordinary Kriging and variography.



- We will get a display of the selected semivariograms and a comparison of the goodness of fit.



LAG INTERVAL = 150

We can see that the models „Gaussian“ and „Linear with sill“ perform with similar goodness of fit.

How are the measures of Goodness of Fit calculated (AIC,BIC,RMSE)?

The documentation is from the FAQ of Kriging Interpolator 3.2.

The measures are calculated according to the following formulas:

$$\text{AIC} = n \cdot \ln(\text{SSE}) + 2 \cdot \text{no. of parameters}$$

$$\text{BIC} = n \cdot \ln(\text{SSE}) + \text{no. of parameters} \cdot \ln(n)$$

$$\text{SSE} = \sum_{i=1}^n ((\text{Actual} - \text{Fitted semivariance})^2)$$

$$\text{RMSE} = \sqrt{\text{SSE} / (n - 1 - \text{no. of parameters})}$$

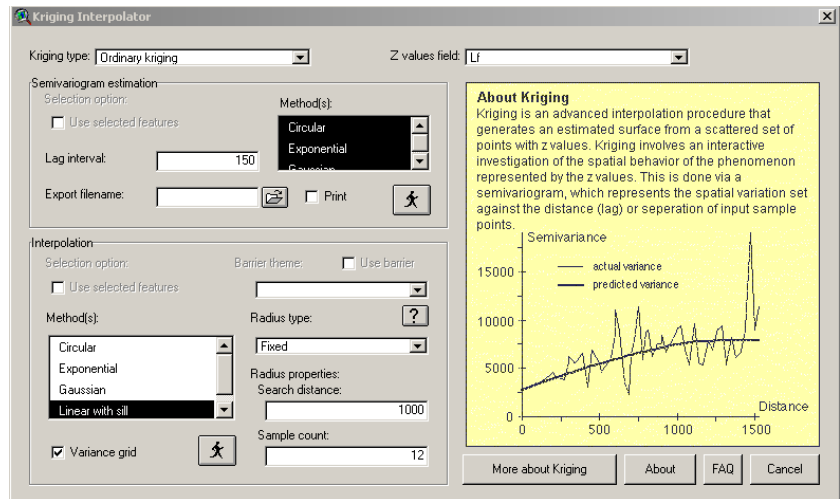
n = number of records / lag intervals for the Actual semivariance in semivariogram table and graphs.

The no. of parameters was hardcoded to 3, because all semivariograms that Arcview fits have three parameters.

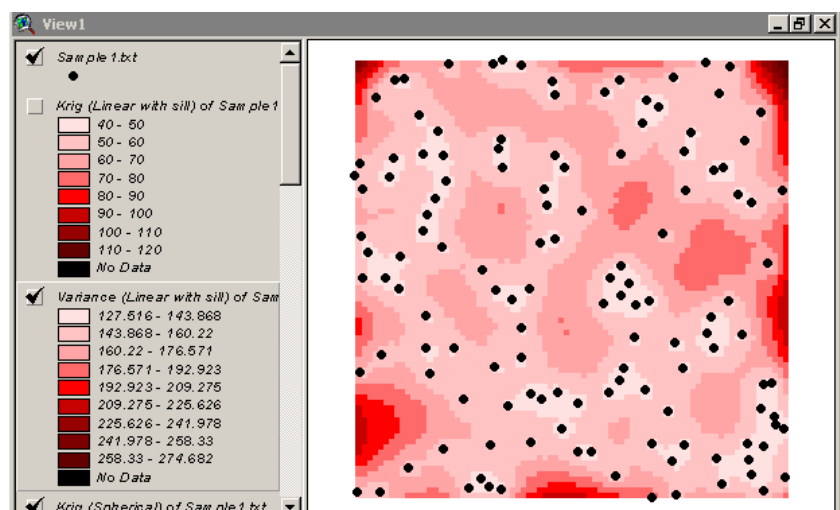
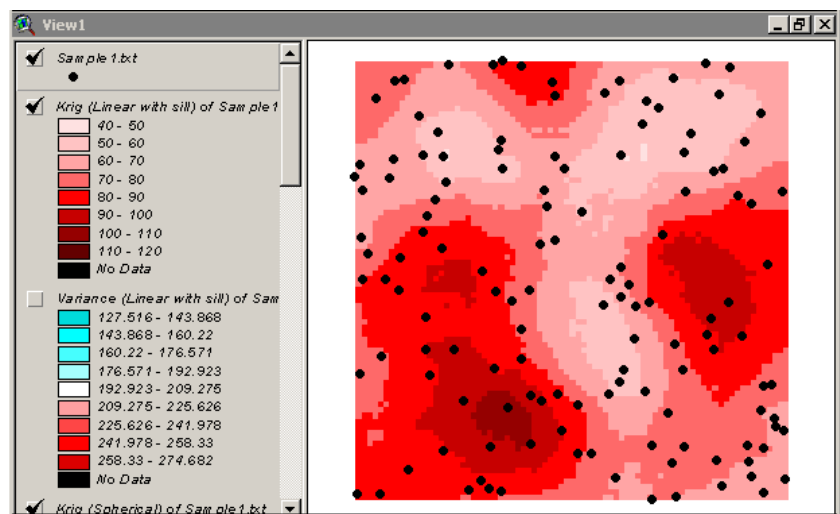
AIC = Akaike Information Criteria (AIC)

BIC = Bayesian Information Criteria (BIC)

- Going back to main dialog of Kriging Interpolator, we can now perform the interpolation, using one of the offered methods. We select a Variance grid also and a fixed search radius of 1000 m.



- And the results:



- Extra exercise: Use universal kriging

5.5 Comparison of methods

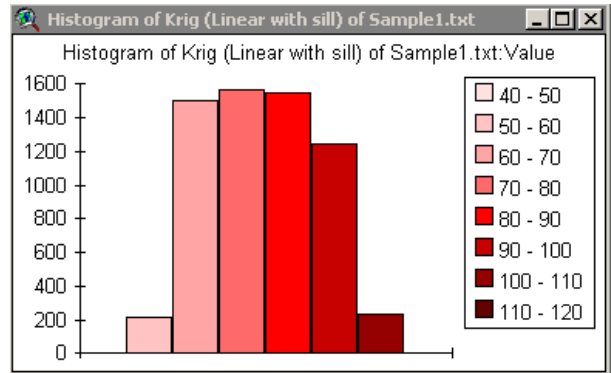
- There are several methods in ArcView to compare the results of interpolation, but there is no procedure to do a rigid cross-validation.
- Statistics of field *Lf* in *sample1.txt*: open attribute table of *sample1.txt*. select field *Lf*. **Field** → **Statistics**:

Sum: 10421.94
 Count: 133
 Mean: 78.36
 Maximum: 119.53
 Minimum: 40.15
 Range: 79.38
 Variance: 287.67
 Standard Deviation: 16.96

- Statistics of a grid: There is no direct function in the user interface. We can make a Polygonshape covering the extent of the grids and then – with poly.shp active - do a **Analysis** → **Summarize zones**.

Count	Area	Min	Max	Range	Mean	Std	Sum
6478	16195000.000	54.5179	108.6168	54.0989	79.5286	12.0522	515186.5

- Other methods of comparison are building differences of 2 grids in the map calculator and displaying histograms of grids.



- With some AVENUE programming, we can also produce a nice table, comparing multiple grids. See script *Grid.Statistics.ave*

Grid	Rows	Cols	N	Mean	Sum	Std	Min	Max	Range
Krig (Universal with linear drift)	80	79	6320	79.329654	501363.416	14.79219	40.98007	118.87972	77.89965
Krig (Universal with quadratic d	80	79	6320	79.022152	499419.998	15.90769	40.80765	119.03099	78.22334
Krig (Linear with sill) of Sample1	80	79	6320	79.499986	502439.911	12.13962	54.51791	108.61678	54.09887
Krig (Spherical) of Sample1.txt	80	79	6320	79.363646	501578.245	12.26790	53.59389	110.02856	56.43467
Regularised splines	80	79	6320	78.902150	498661.580	22.39260	6.04400	148.22140	142.1773
IDW power 0.1	80	79	6320	78.730675	497577.863	10.39603	59.53912	102.18196	42.64284
IDW Power 12	80	79	6320	79.275938	501023.931	17.01853	40.15000	119.53000	79.38000