

# Basic Geostatistics: Interpolation

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## A SpaceStat Software Tutorial

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## MATERIALS

Project from Basic Geostatistics: Pattern Description or  
[SpaceStat Tutorial Basic Geostatistics Part 1.SPT](#)

## ESTIMATED TIME

20 minutes

## OBJECTIVE

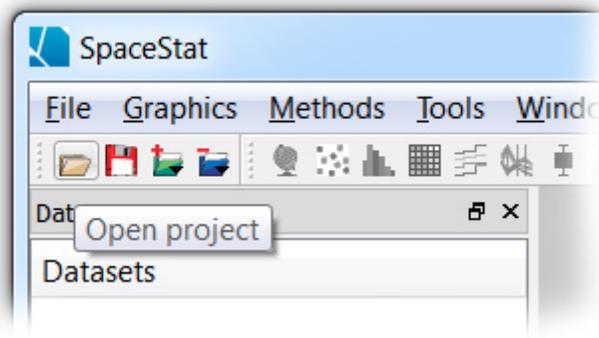
The Basic Geostatistics tutorials will guide you to using basic geostatistical procedures in SpaceStat. In this second tutorial, you will use kriging to interpolate from one set of locations to a separate set of locations. You will also compare the predicted values with observed values at the interpolated locations. The Basic Geostatistics tutorials use data on the arsenic concentrations in Michigan groundwater.

## ABOUT KRIGING

Kriging is a geostatistical process that estimates the values at unobserved locations from other observed locations. It is based on the concept that the estimated value at a location should be based the values of its neighbors weighted by the distance from the neighbor, similar to spatial regression. There are several different types of kriging. SpaceStat supports simple kriging, ordinary kriging and kriging with a trend for univariate kriging. Ordinary kriging assumes an unknown mean. You specify the mean for simple kriging (commonly the arithmetic mean of the data which you can see from the graph statistics of a histogram of the data in SpaceStat). In kriging with a trend, you must select the components to be included in the trend model (e.g. a linear or quadratic trend in X and Y).

## STEP 1: OPEN THE STARTING PROJECT

You can continue with the project that you used in the first tutorial of this series, Basic Geostatistics: Pattern Description or you can open the project below. To open this project, navigate through the menus to File-> Open Project or **click the Open Project button** as shown below.



Using the Open Project button

You can download this project to use from the following link:

[SpaceStat Tutorial Basic Geostatistics Part 1.SPT](#)

## STEP 2: KRIGING OPTIONS

To begin the kriging method, **select Methods->Kriging->Univariate Kriging** from the main SpaceStat menu. This will open the Task Manager panel which is shown on the right side of the SpaceStat user interface by default. You might want to make this panel wider if the settings are hard to read. The Task Manager is organized into a series of vertical tabs, each of which you can expand by clicking on the heading of the tab. This tutorial will guide you through specifying the options in these tabs.

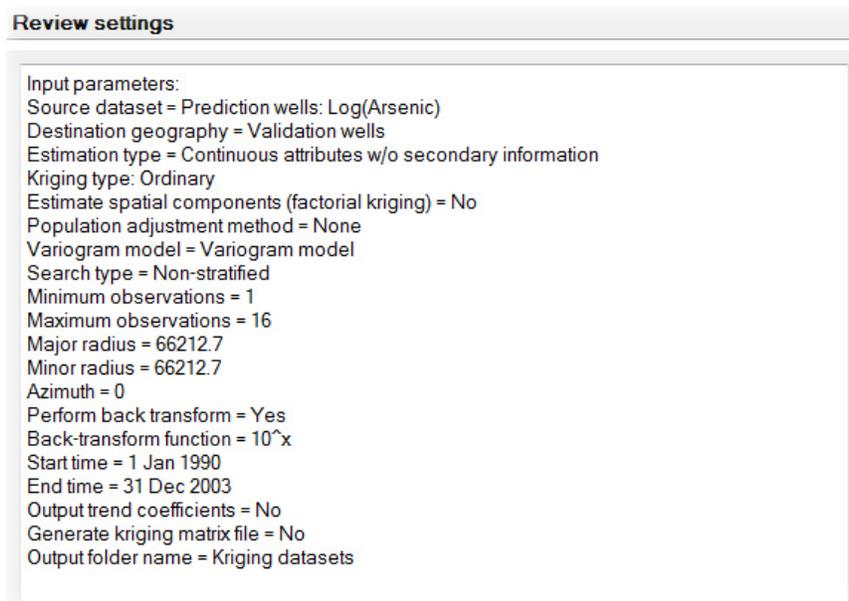
In the Source Geography tab, **specify 'Prediction wells' as the geography** for the source dataset and **'Log(Arsenic)' as the dataset**. Since the observations are point locations, you do not specify discretization options. Next **click the 'Destination Geography' heading**. In this tab, **select the 'Validation wells' as the destination geography**. **Click the 'Kriging type' heading**. Keep the default of 'Ordinary kriging'.

Kriging uses a variogram model that specifies how differences between locations are expected to behave as a function of distance between the locations. **Click the 'Variogram model' heading** to begin specifying the model. In SpaceStat you can use the same variogram model for multiple analyses, but you must create one first. To create a new variogram model, **click the 'Create new' button** on the right. This will bring up the Variogram model specification dialog. There are many parameters that you can specify for creating a variogram model, but at this point you will use an automatically fitted variogram model. When you open this dialog, SpaceStat has already fit a variogram model. You can either use this model, automatically fit another model specifying how you would like for SpaceStat to fit the model, or manually specify the parameters of the variogram model. At this time, you will use the automatically fitted model, so **click the 'OK' button** to accept the model.

**Click the 'Search strategy' heading** to open the next tab. This tab has more options for polygon geography where you can specify to use spatial weight sets to determine how to search adjacent polygons. For points the search strategies are based on distances between observations. Stratified search strategies ensure that neighbors will come from all directions (from each quadrant or octant). For this analysis, keeping the default of a non-stratified search is fine. The default of a minimum of 1 and a maximum of 16 neighbor observations to use are also fine. The default minimum and maximum radius are also fine. If these two values are the same, the search window is a circle, but if they are different the search window is an ellipse and the azimuth determines the angle of the search ellipse.

**Click the 'Back transform' heading** to specify how to back-transform the kriged estimates. In this case the data you are kriging are log-transformed values, so to convert these estimates back to arsenic concentration, you will need a back-transform. **Choose 'Yes'** from the 'Perform back transform' dropdown. **Select '10^x'** as the 'Back-transform function' to properly back-transform the log-transformed estimates.

**Click the 'Other settings' heading** to look at the other options for the kriging. Start and end time parameters are useful if there are several time periods with different variogram models. The defaults of the entire time interval are appropriate for this analysis. The 'Output trend coefficients' is used to generate a dataset of the trend coefficients when you are kriging with a trend. The kriging matrix file option will generate a text file containing with the kriging matrix and weights for each destination geography. The defaults of 'No' are appropriate for these options. Lastly **click on the 'Review settings' header** and verify that your settings match the dialog below:

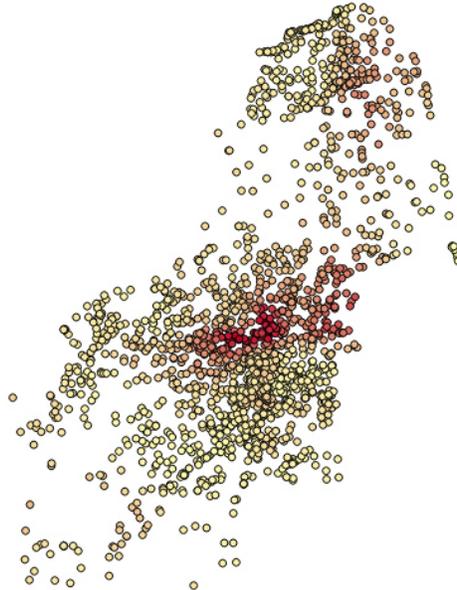


Kriging settings

When your settings match these, **click the 'Run' button** at the bottom of the Task manager pane. This will perform the kriging and create four datasets within the validation wells geography. The estimate and variance datasets are created along with back-transformed versions. All four datasets are placed within the 'Kriging datasets' folder under the 'Validation wells' geography.

### STEP 3: CREATING A MAP OF THE KRIGING ESTIMATES

The next step is to map the kriging estimates of the arsenic concentrations. Right click on the 'kriging estimate, back transformed' dataset. Choose 'Create map' from the popup menu. This will create a map of the back-transformed kriging estimates. Examine the spatial pattern of the estimates and notice that estimates are relatively high in the central areas of the study geography. Your map should look similar to the one below:

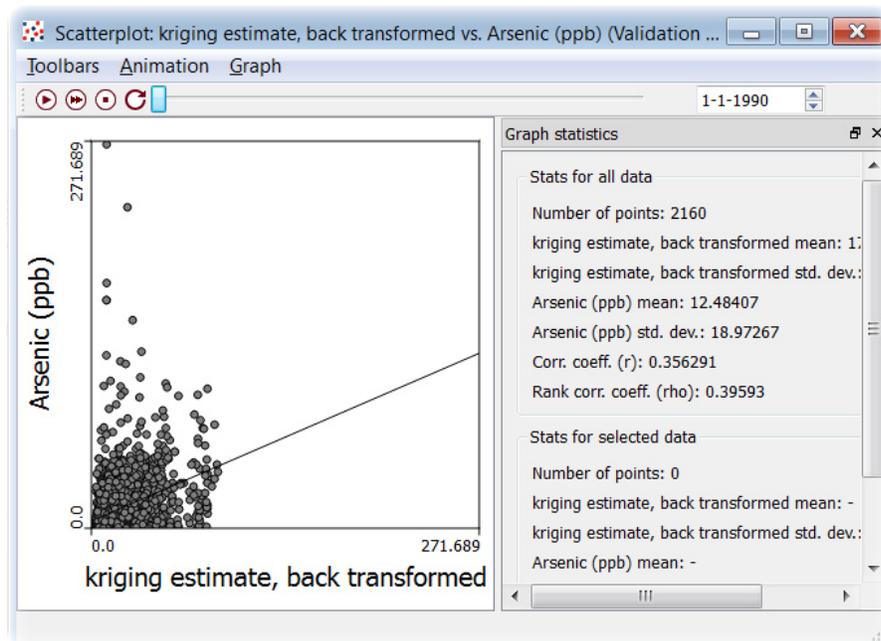


Map of the back-transformed kriging estimates

### STEP 4: COMPARING THE KRIGING ESTIMATES WITH THE VALIDATION DATA

Validation is an important step in the generation of a kriging model. Perhaps the easiest way to compare the kriging estimates with the observed arsenic concentrations at the validation wells is to create a scatterplot of the results. **Click the 'Scatterplot' button** on the SpaceStat toolbar (this is the second button on the second group of buttons and looks like a group of red and blue points). **Select**

**'Validation wells'** as the geography. Make sure that 'Two datasets' is selected for the type. Choose **'kriging estimate, back transformed'** from the X dataset dropdown. Choose **'Arsenic (ppb)'** from the Y dataset dropdown. Click the **'OK' button** to create the scatterplot. On this scatterplot you are looking for how close the kriging estimate is to the observed arsenic concentration, i.e. how well the data falls on the 1:1 line. You might find it easiest to set the axes to the same scale in the Graph->Properties dialog. Outlying points that fall far from this line are points where the values of neighbors do not do a good job of predicting the well concentration. These wells would be ones that you would want to further investigate. You can use cartographic brushing on this scatterplot to see where the outlier wells are located. Also, take note of the correlation coefficient which in this case has a value of 0.356. If your goal was to have the best predictive model, you would want to see if other kriging options could yield a higher correlation. Your scatterplot should look similar to the one below (if the axes are comparable):



Scatterplot of kriging estimates versus validation data

## STEP 5: NEXT STEPS

As you can see from the dialog, there are many options with kriging. Feel free to explore other kriging methods with this dataset, for example kriging with a trend. Also examine the sensitivity of the kriging estimates to changes in the variogram model. Some possibilities that you might want to try when specifying the variogram model: using the variogram cloud within the method to select and delete extreme data pairs, using a variogram map to account for anisotropy in the data, and experimenting with the lag settings.