Image from NASA:
https://commons.wikimedia.org/wiki/File:Earth_Western_Hemisphere_transparent_background.png#filelinks

GIScience

Spatial Interpolation

WV VIEW

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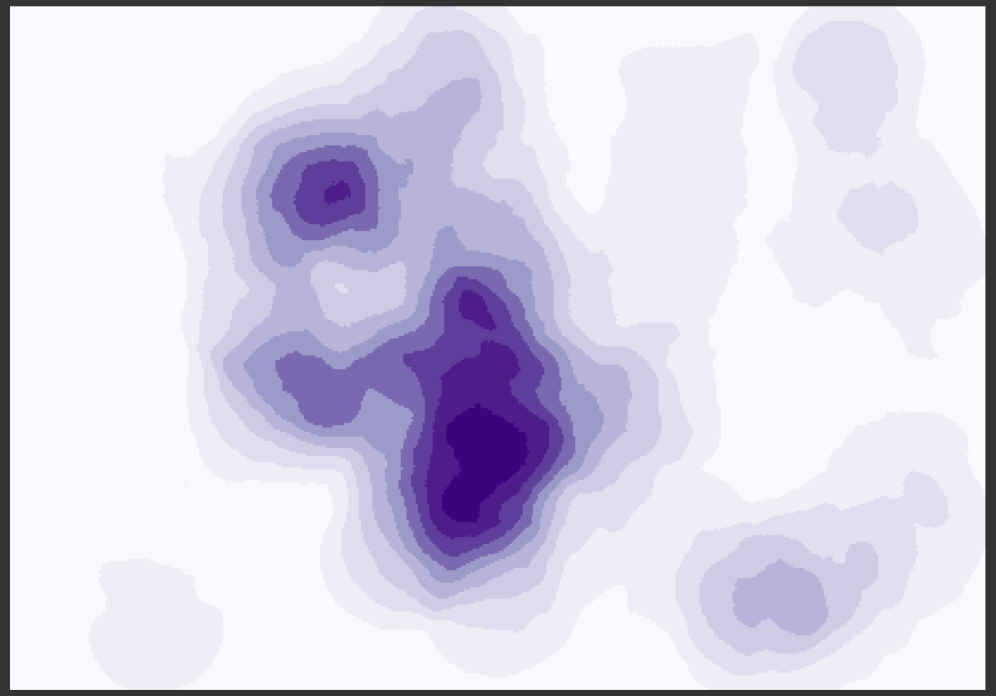
Review of Density Estimation

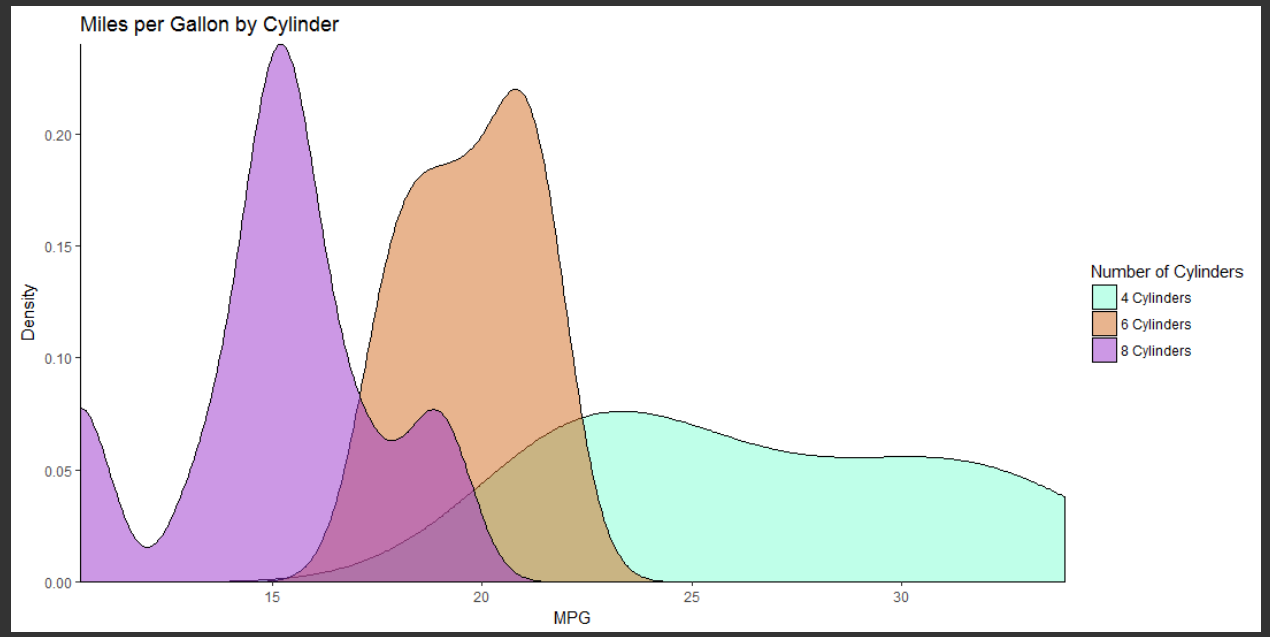
Point Density/Line Density

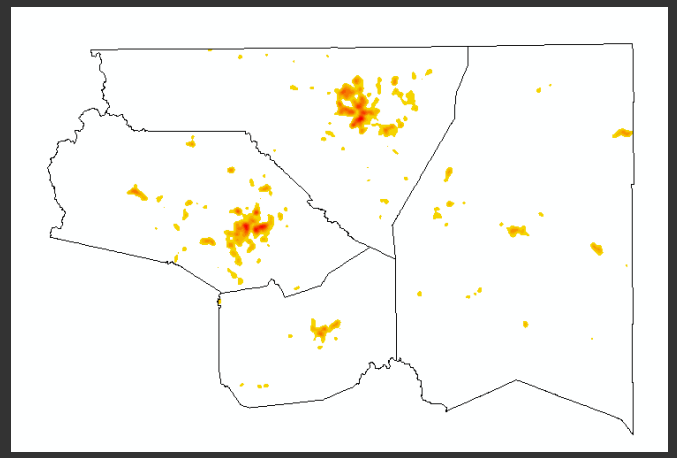
- Calculates the magnitude per unit area for point or line features that fall within a neighborhood around each cell
- Line length/area
- Number of points/area
- Can incorporate weights
- Must specify neighborhood shape and size

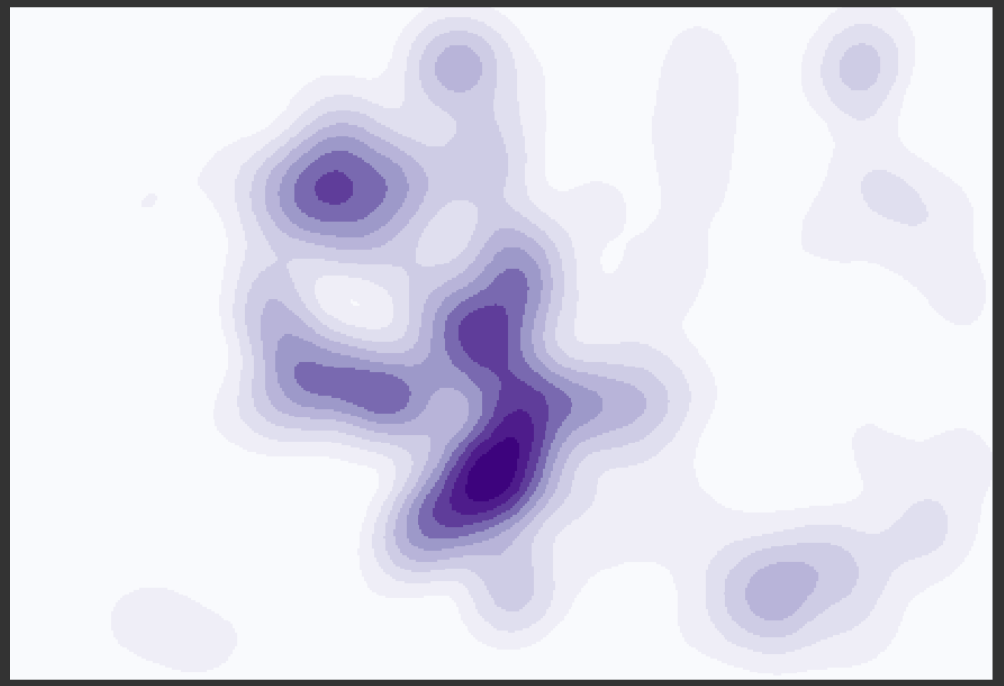


Kernel Density

- Fits a kernel function to estimate density



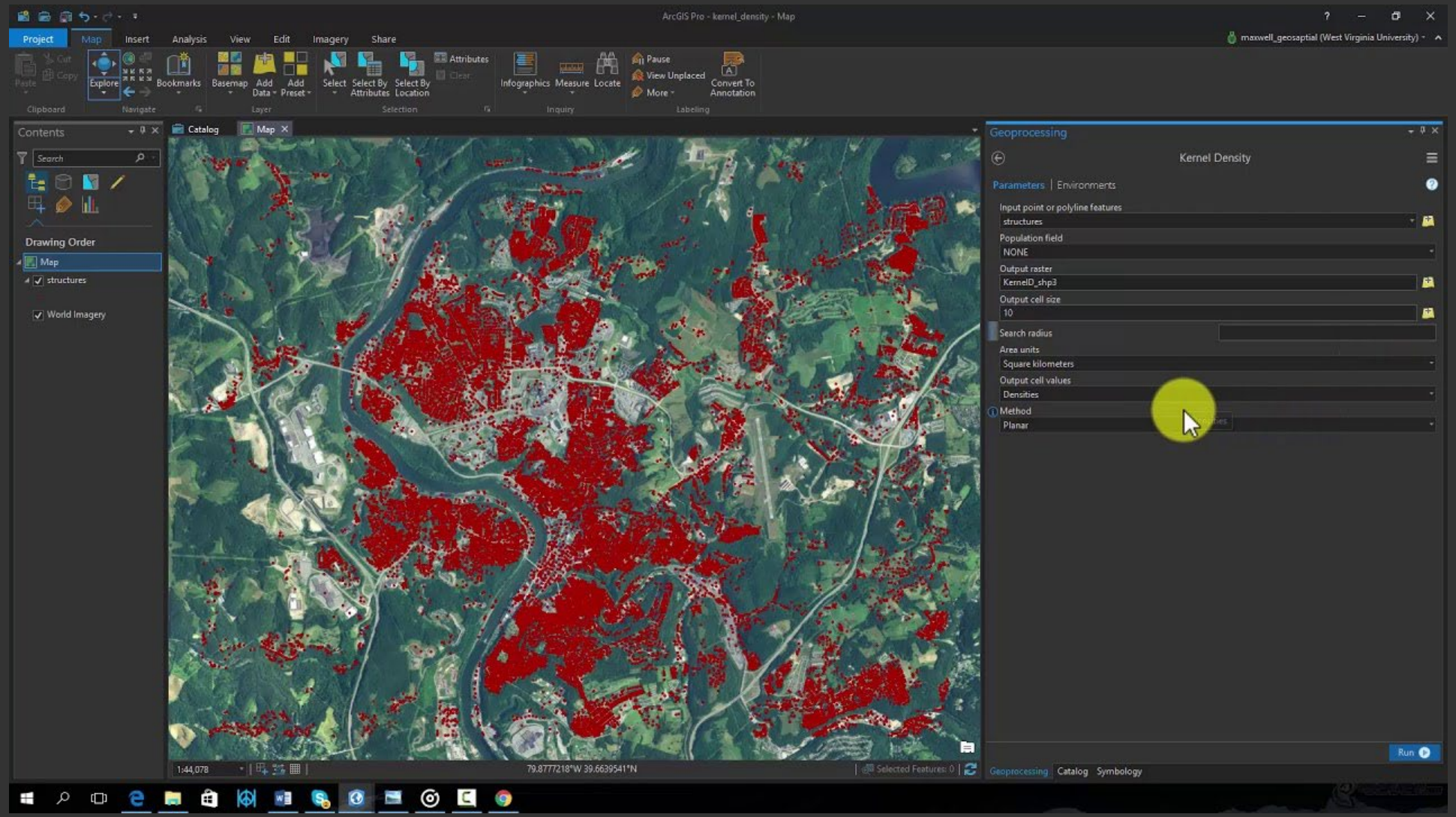




Point Density vs. Kernel Density

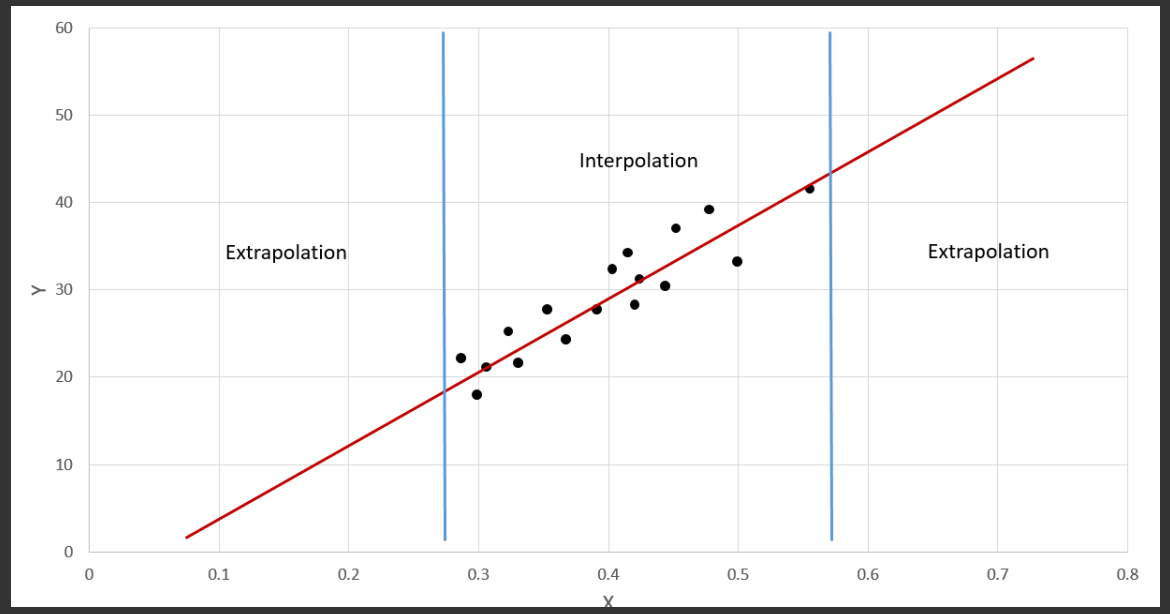
- In point and line density, a neighborhood is specified that calculates the density of the population around each output cell.
- Kernel density spreads the known quantity of the population for each point out from the point location.
- The resulting surfaces surrounding each point in kernel density are based on a quadratic formula with the highest value at the center of the surface (the point location) and tapering to zero at the search radius distance. For each output cell, the total number of the accumulated intersections of the individual spread surfaces is calculated.

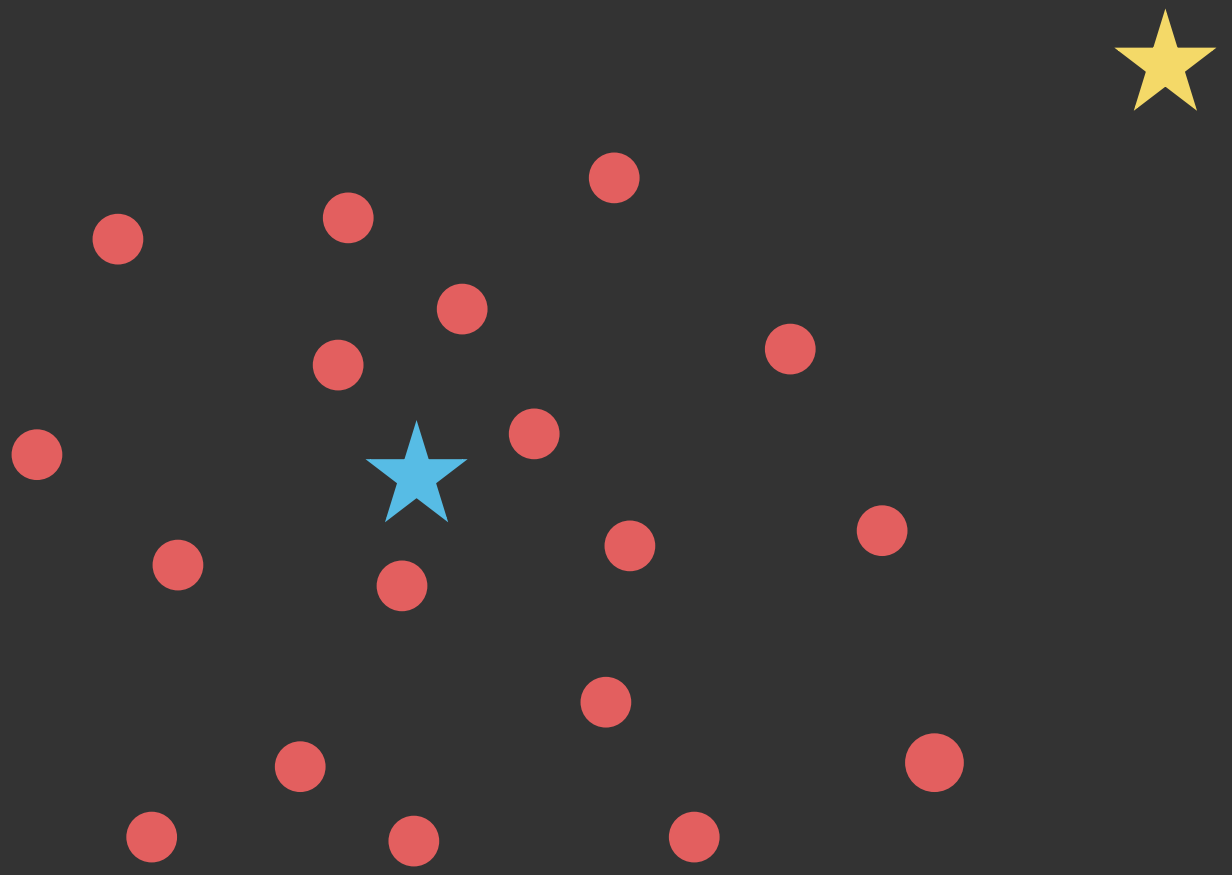
Video: Density Estimation



Spatial Interpolation Methods

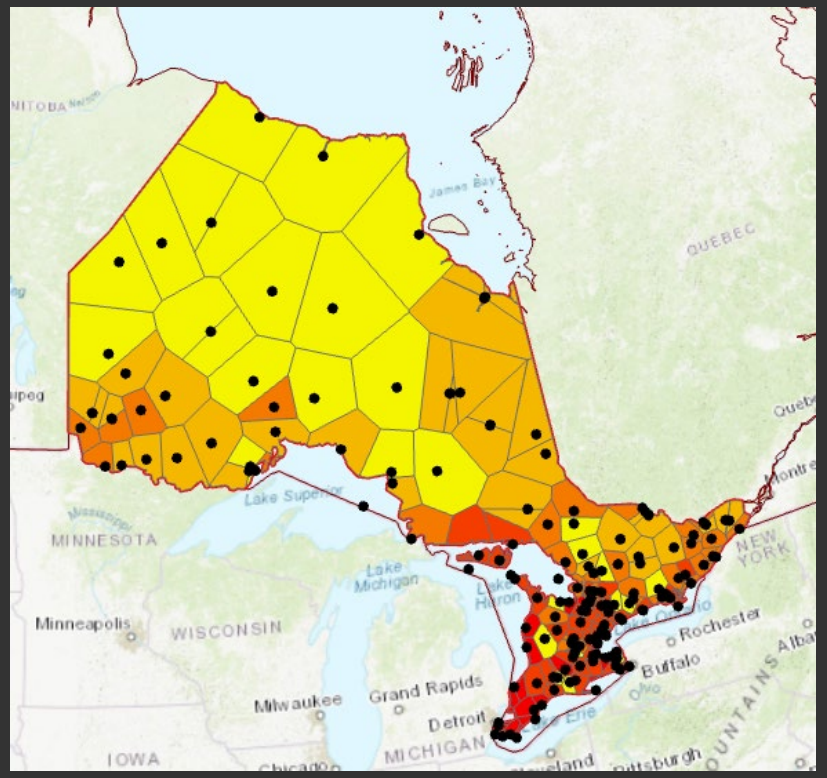
What is Spatial Interpolation?

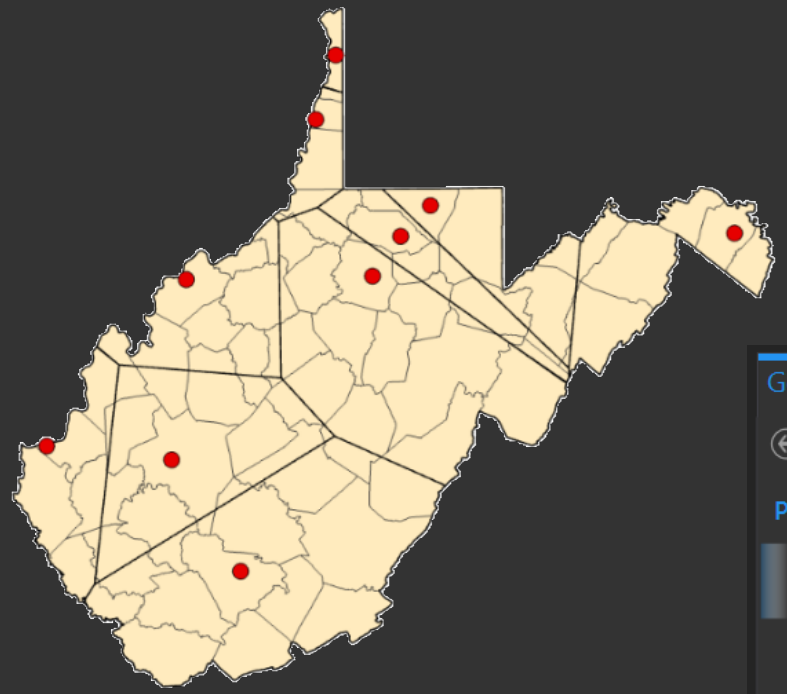


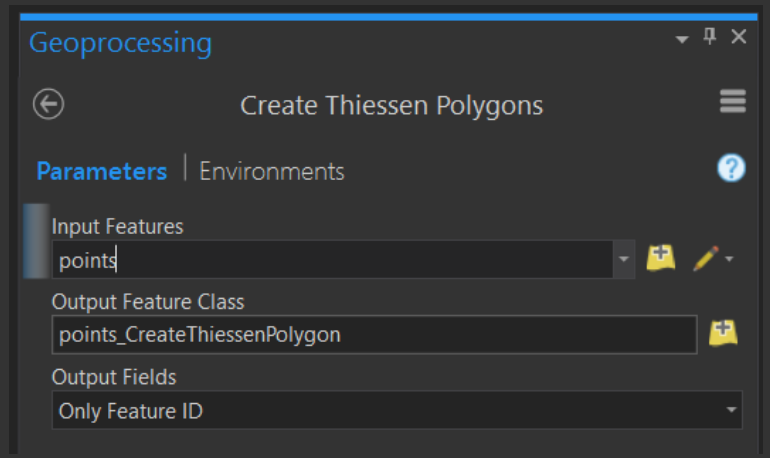


Thiessen (Voronoi) Polygons

- Defines the area that is closer to one point than any other points in a dataset



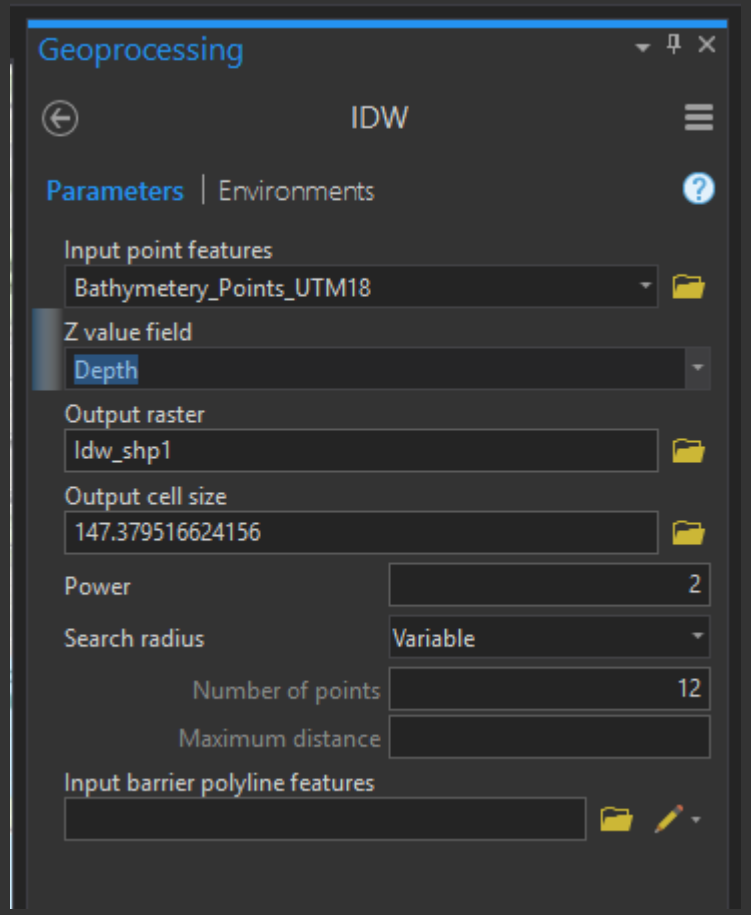


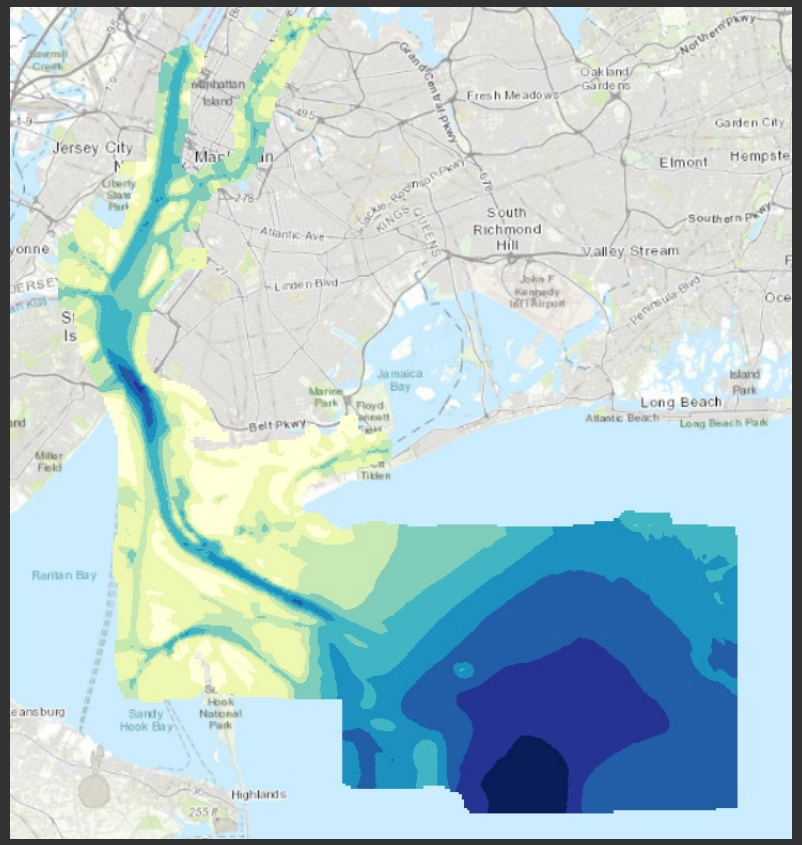


Inverse Distance Weighting (IDW)

- Inverse distance weighted average of near sample points
- Power = controls the significance of surrounding points
  - Higher power = less influence by distant points
  - Lower power = more influence by distant points
- Radius = specifies which input point will be considered
  - Variable = does not specify a distance but a number of points
    - Can specify number of points to use
    - Can specify the maximum distance over which to search
  - Fixed = specify a distance over which to search
    - Can specify a minimum number of points that is used to increase the search radius

Inverse Distance Weighting (IDW)





Spline

- Points extrude to the height of their magnitude
- Spline bends a sheet of rubber that passes through the input points while minimizing the total curvature of the surface
- Fits a mathematical function to a specific number of near input points while passing through the sample points
- Surface passes through sample points and has minimum curvature
- This method is best for interpolating smooth surface that do not change abruptly

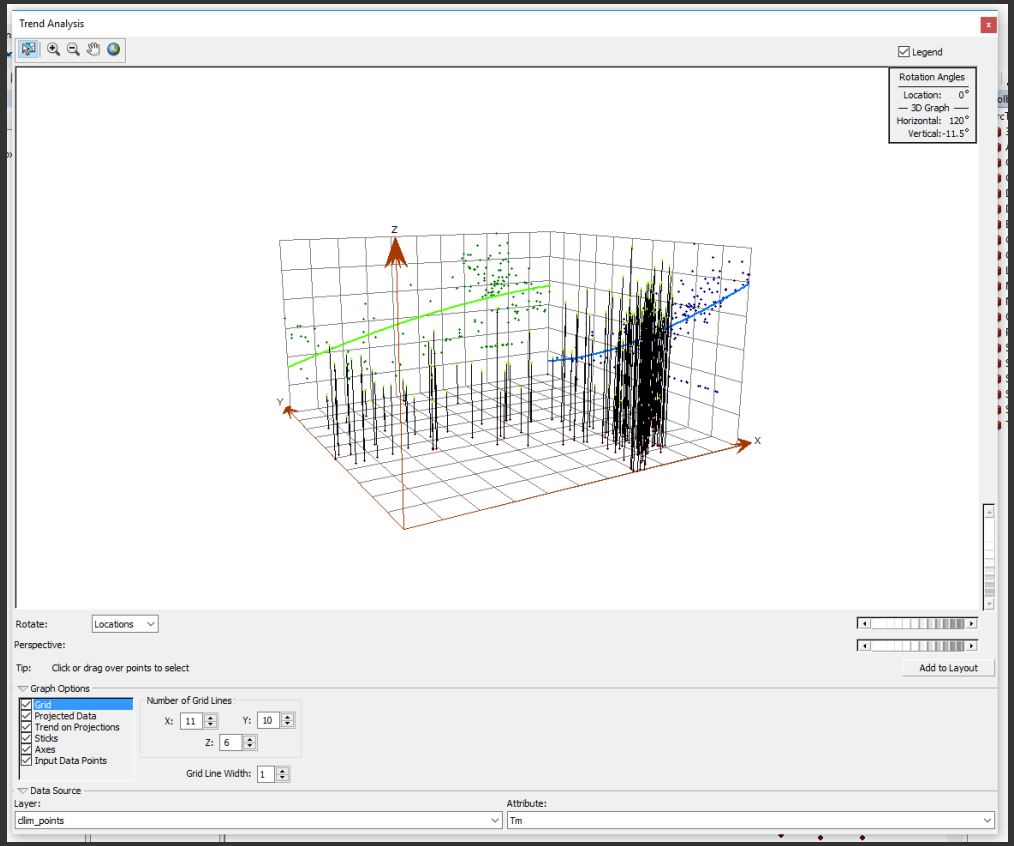
Kriging

What is Kriging?

- Spatial variability consists of two components:
  - Global trends
  - Local spatial autocorrelation
- Need a model of global trends
- Need a model of spatial covariance
- A geostatistical method

Global Trends

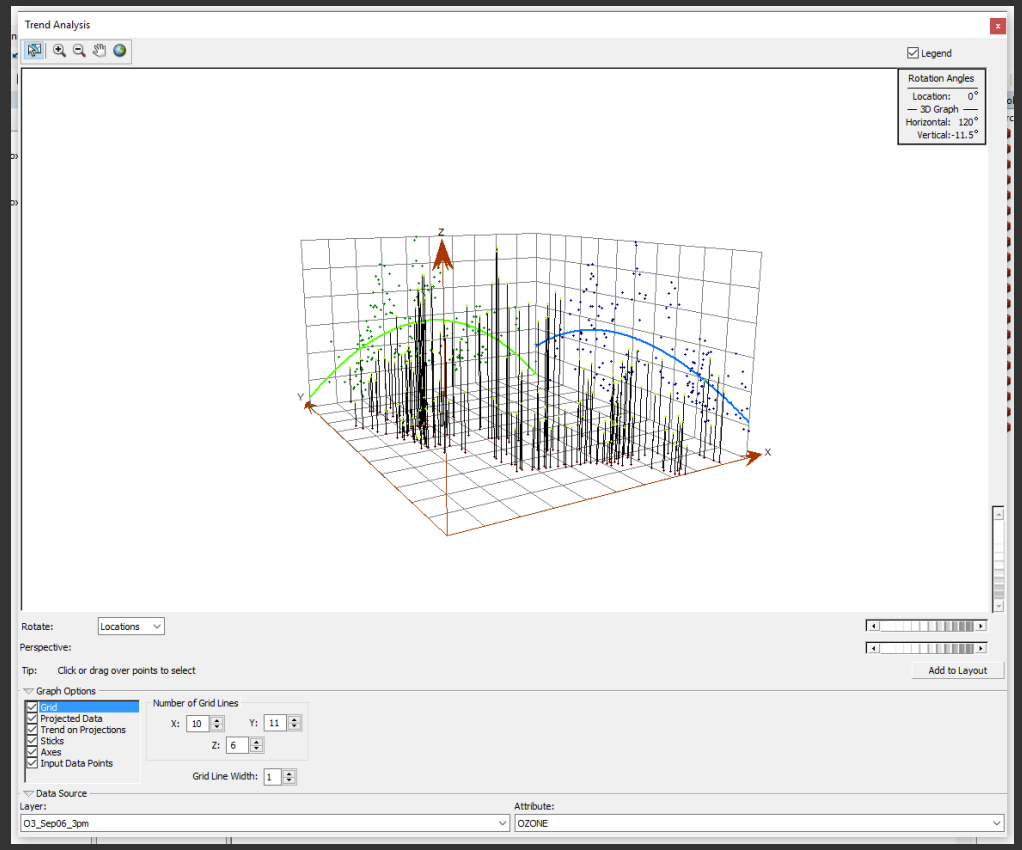
- Global geographic trend approximated with a mathematical model



Temperature in Ontario

Global Trends

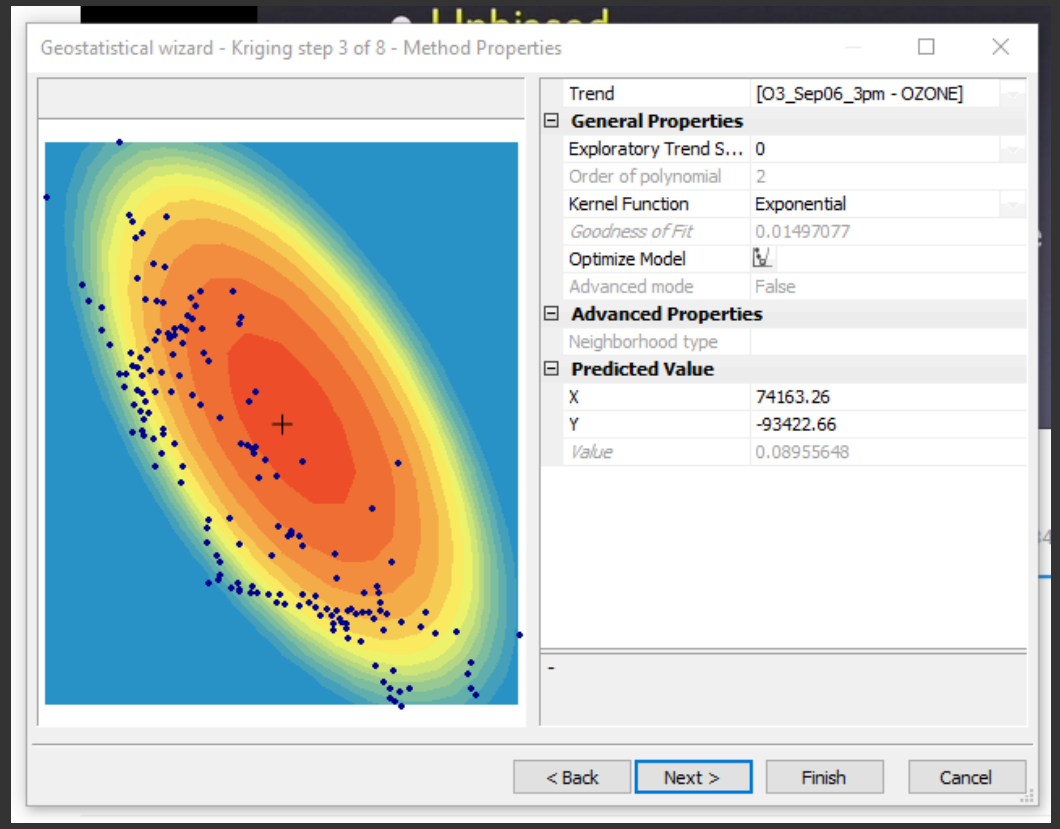
- Global geographic trend approximated with a mathematical model



Ozone in California

Improving upon the estimate made by the global trend

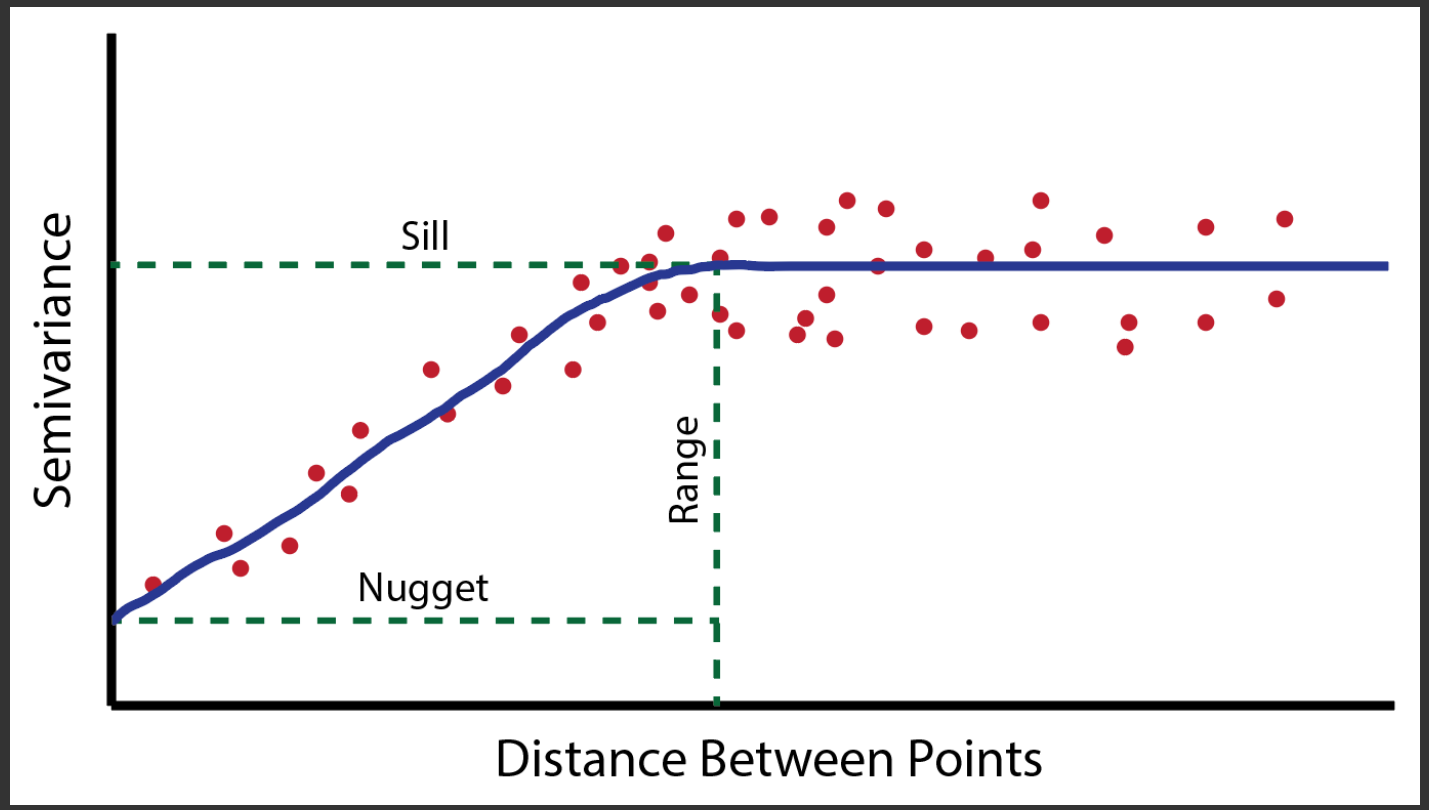
- Reduce the residual by modeling a local trend
- Explore the spatial dependency of the residuals
- Model spatial autocorrelation using a semivariogram



Ozone in California

Review of Semivariogram

- Semivariance = measure of the spatial dependence between two observations as a function of the distance between them
- = squared difference of the two values
- Semivariogram = a graph of how semivariance changes as the distance between observations changes



Review of Semivariogram

Range: distance where model first flattens out

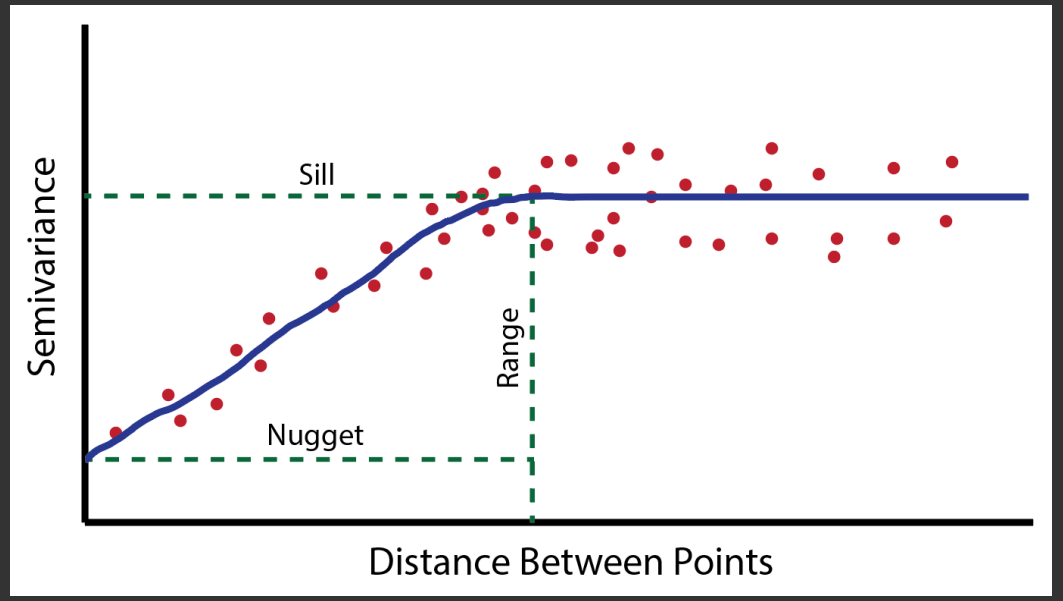
Sill: value of semi-variance at range

Nugget: semi-variance at distance = zero

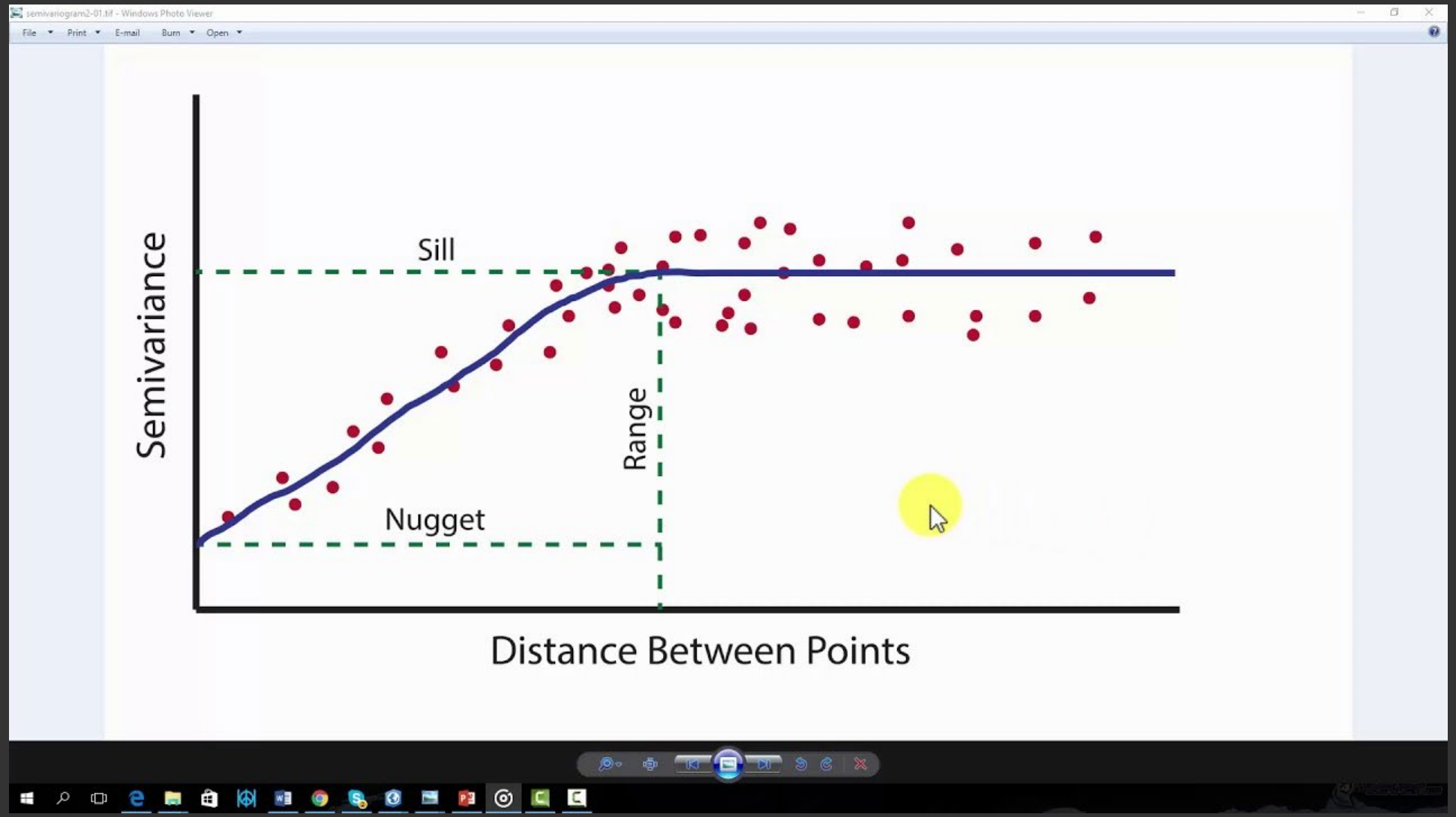
Partial Sill: Sill minus nugget

*Theoretically, at zero separation distance (lag = 0), the semivariogram value is 0. However, at an infinitesimally small separation distance, the semivariogram often exhibits a nugget effect, which is some value greater than 0.

*The nugget effect can be attributed to measurement errors or spatial sources of variation at distances smaller than the sampling interval or both. Measurement error occurs because of the error inherent in measuring devices. Natural phenomena can vary spatially over a range of scales. Variation at microscales smaller than the sampling distances will appear as part of the nugget effect. Before collecting data, it is important to gain some understanding of the scales of spatial variation.

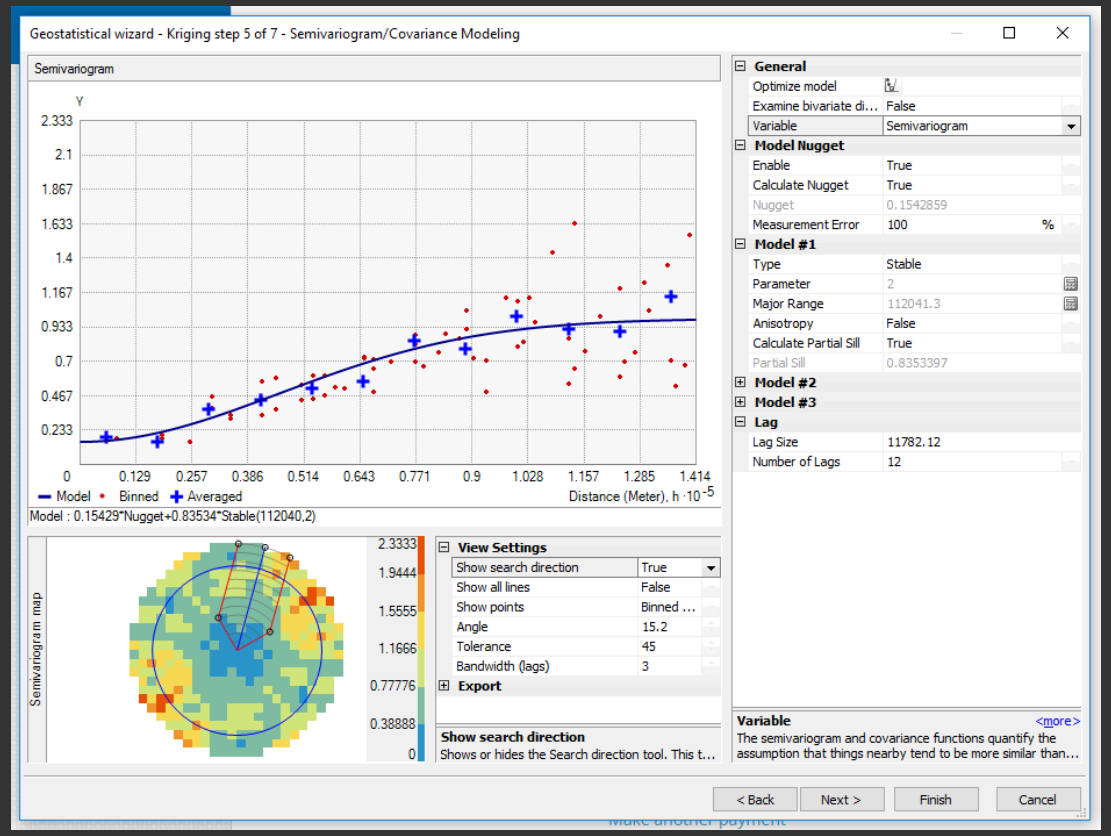


Video: Semivariograms



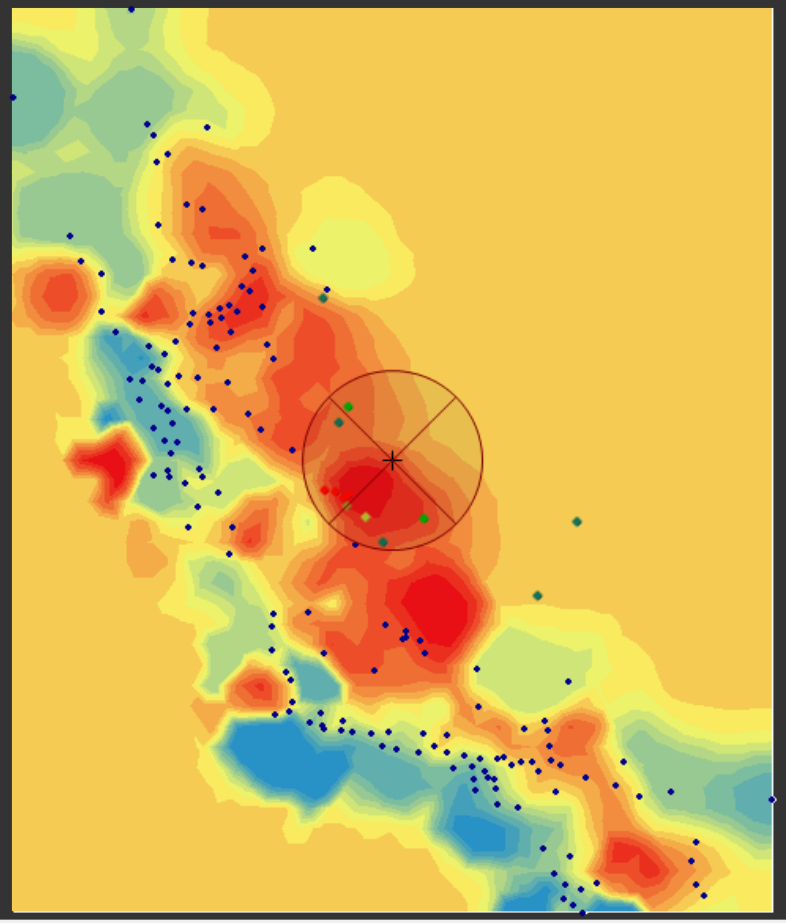
Anisotropy

- Directional differences in spatial dependence
- Can incorporate this into the kriging model by exploring the semivariogram



Ozone in California

Kriging Steps



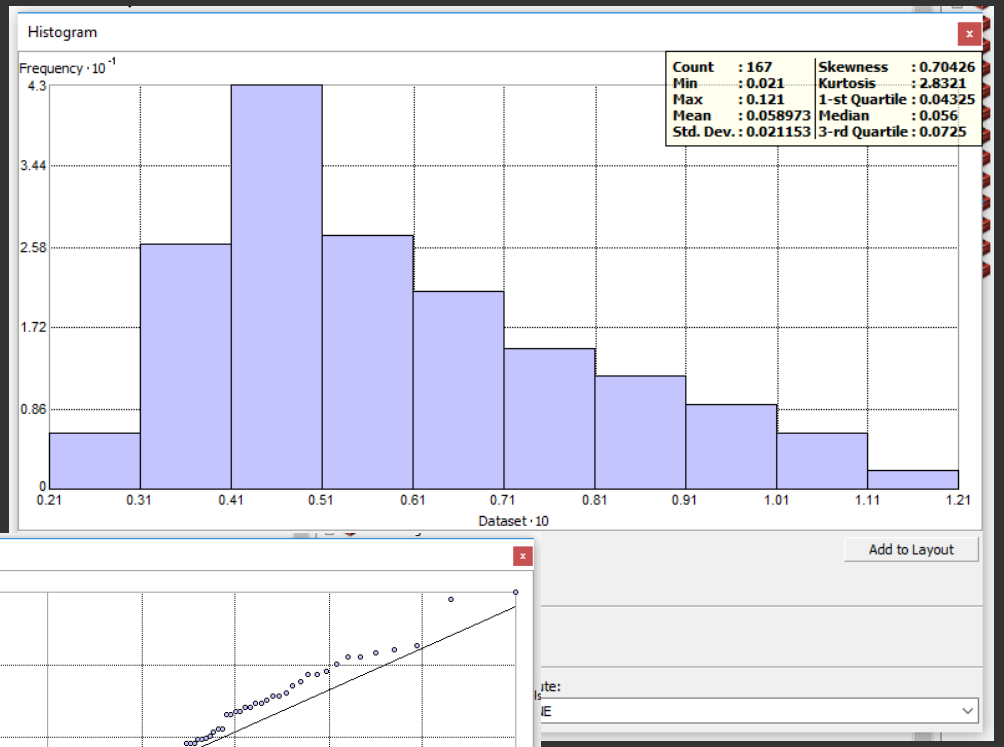
Ozone in California

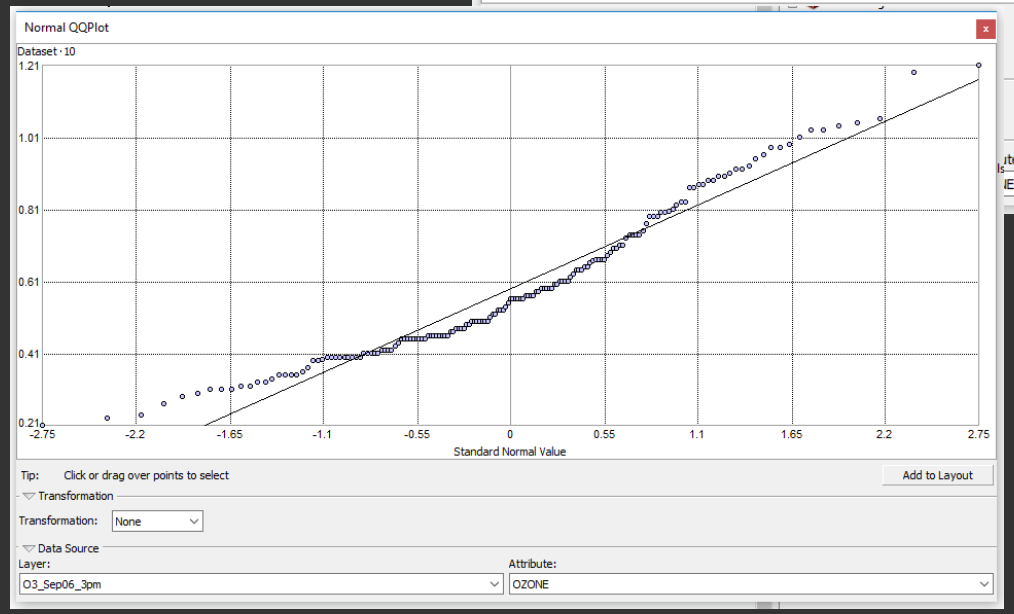
1. Exploratory statistical analysis of the data
2. Semivariogram modeling
3. Creating the surface
4. Exploring a variance surface (optional)

❖ Kriging is most appropriate when you know there is a spatially correlated distance or directional bias in the data

Things to Consider

1. Is the data normally distributed?
2. Is there skewness?
3. Is there kurtosis?
4. Does the QQ Plot suggest normality?

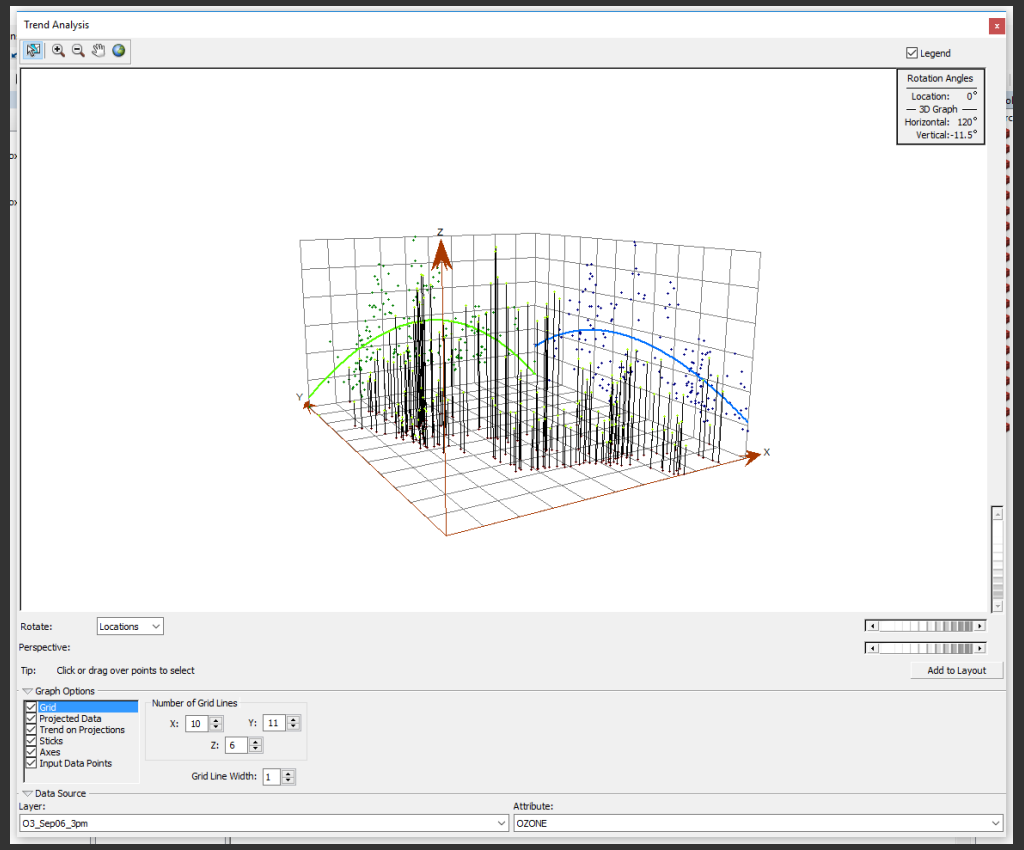




Ozone in California

Things to Consider

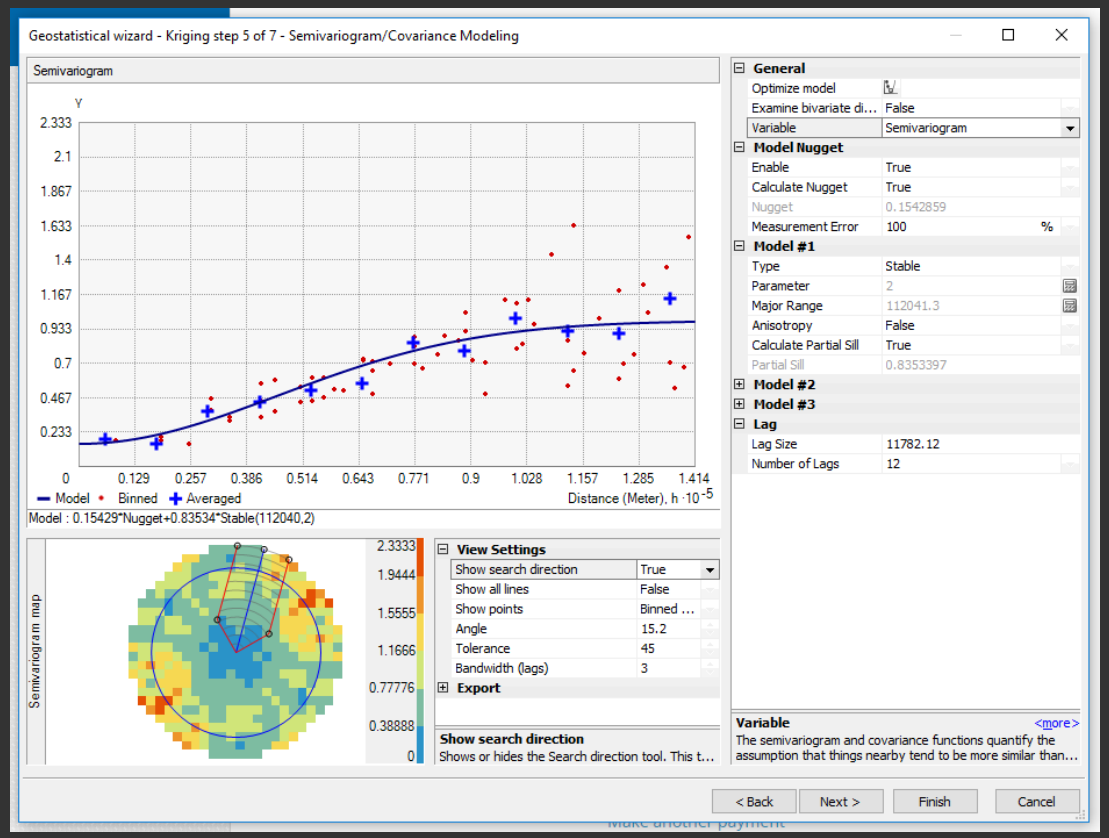
5. What is the global trend?



Ozone in California

Things to Consider

6. What does the semivariogram tell you about spatial autocorrelation?
7. Should you consider anisotropy?



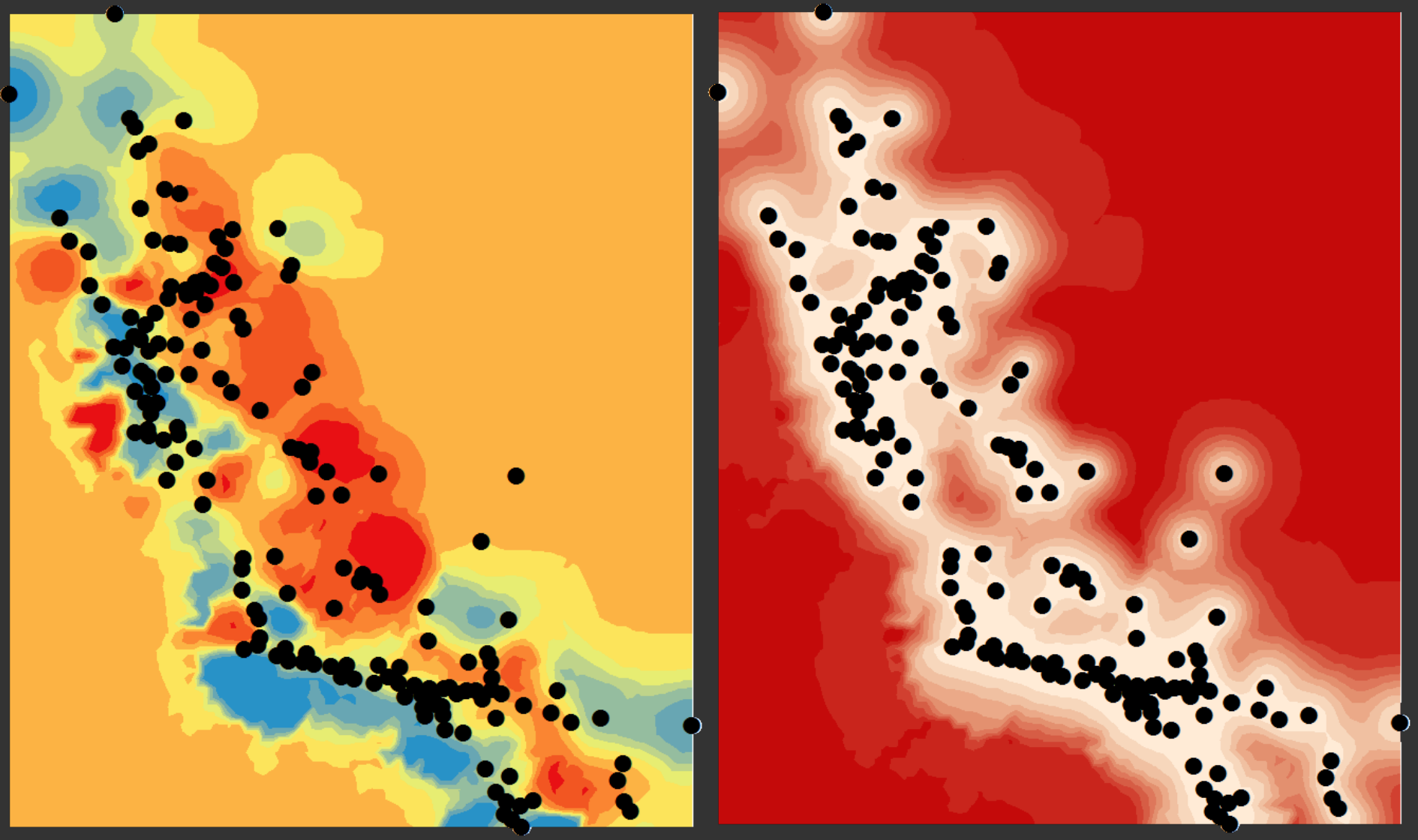
Ozone in California

Things to Consider

An analysis of your data will allow you to make decisions relating to:

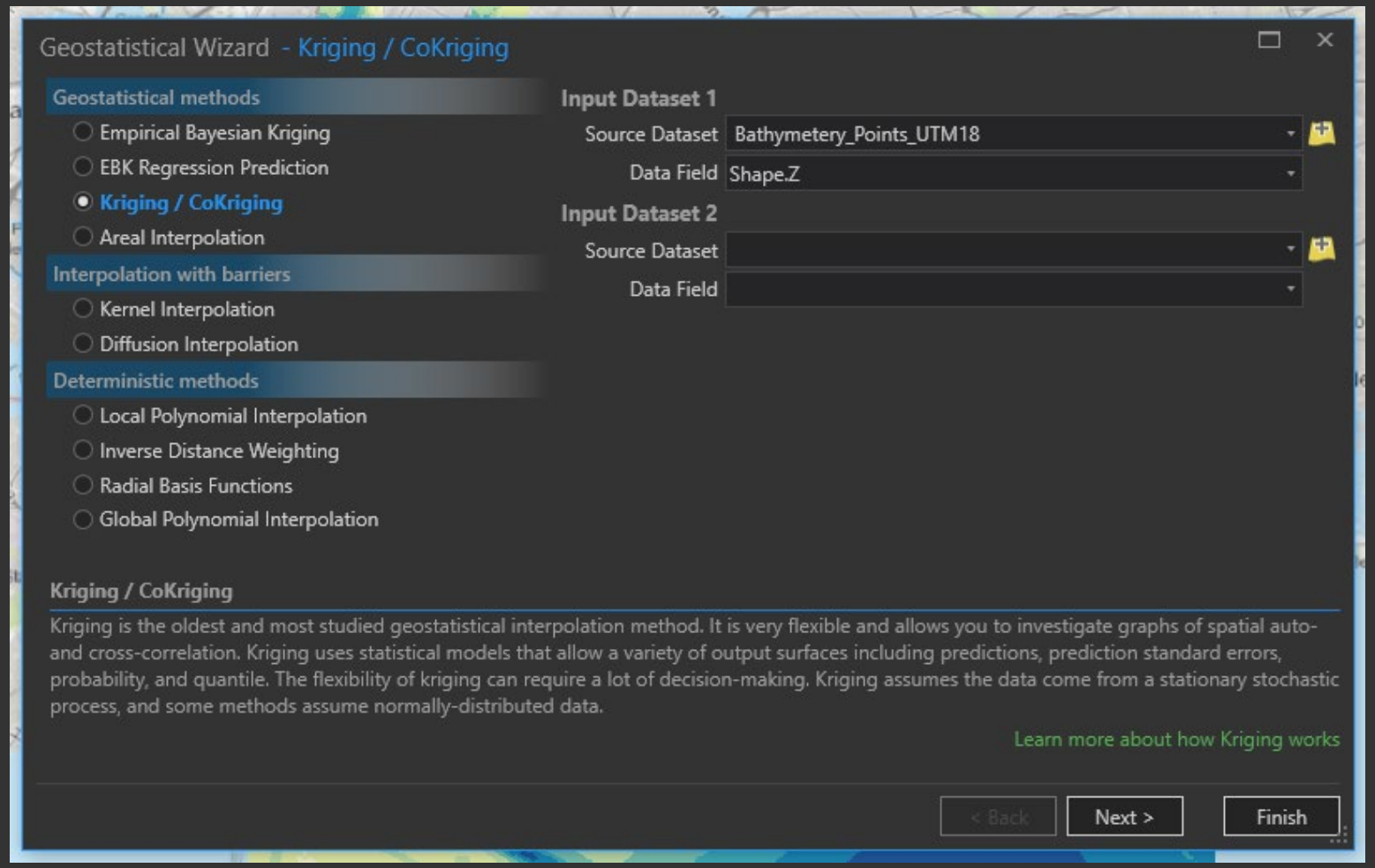
1. If data transformations should be applied
2. Best function to fit
3. Sill, range, and nugget settings
4. Directional considerations (anisotropic)
5. Best search direction and width

Kriging and Estimating Error



Ozone in California

Geostatistical Analyst



Co-Kriging

- Adds a covariant that may help improve the prediction
- For Example: temperature predictions may be improved by incorporating elevation

This is the end of this lecture module.

Please return to the West Virginia View Webpage for additional content.