Esri International User Conference | San Diego, CA

Technical Workshops | July 2011

Geostatistical Analyst - An Introduction

Steve Lynch and Eric Krause

Presentations of interest…

- **Geostatistical Simulations**
  - Tuesday 5:00pm – 6:00pm Demo Theater
- **Surface Interpolation in ArcGIS**
  - Wednesday 9:00am – 10:00am Demo Theater
- **Creating Surfaces**
  - Wednesday 1:30pm – 2:45pm 1A/B
- **Concepts and Applications of Kriging**
  - Thursday 10:15am – 11:30am 14A

Outline

- What is
  - geostatistics?
  - Geostatistical Analyst?
- Interpolation workflow
- Demonstrations
- Supplementary information
- Post 10
- Questions / Answers

Please fill out the questionnaire

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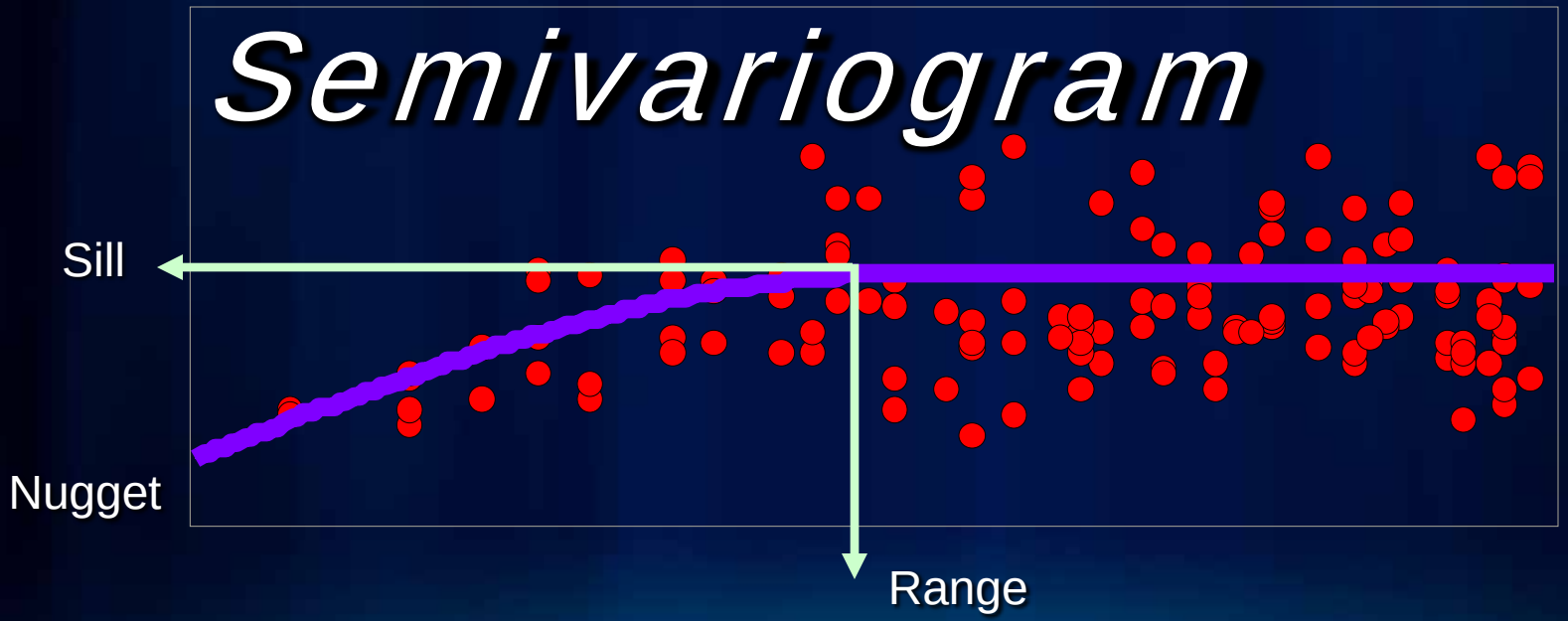
What is geostatistics ?

The statistics of spatially correlated data



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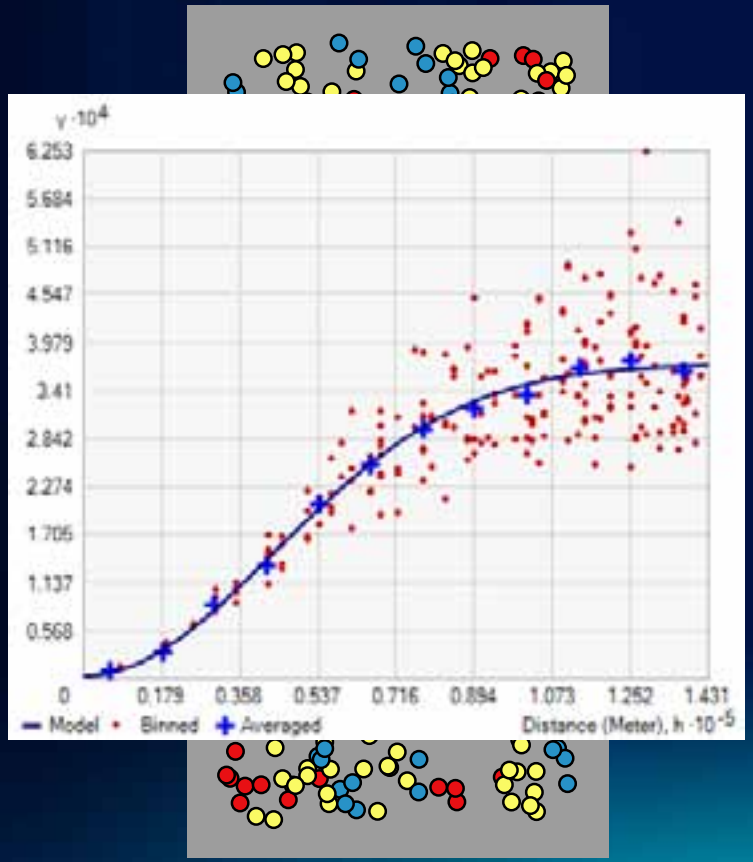
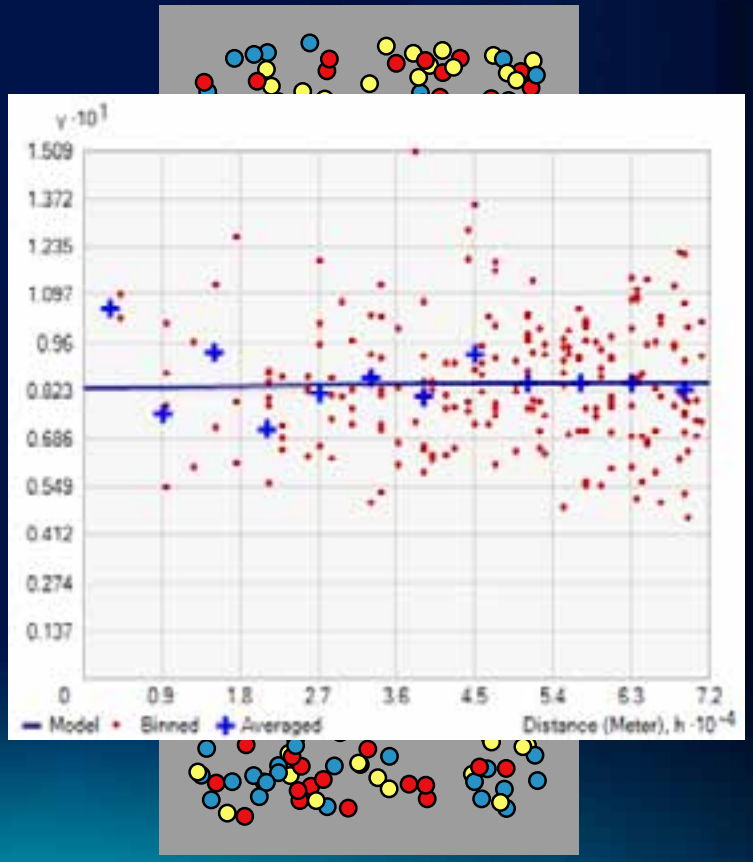
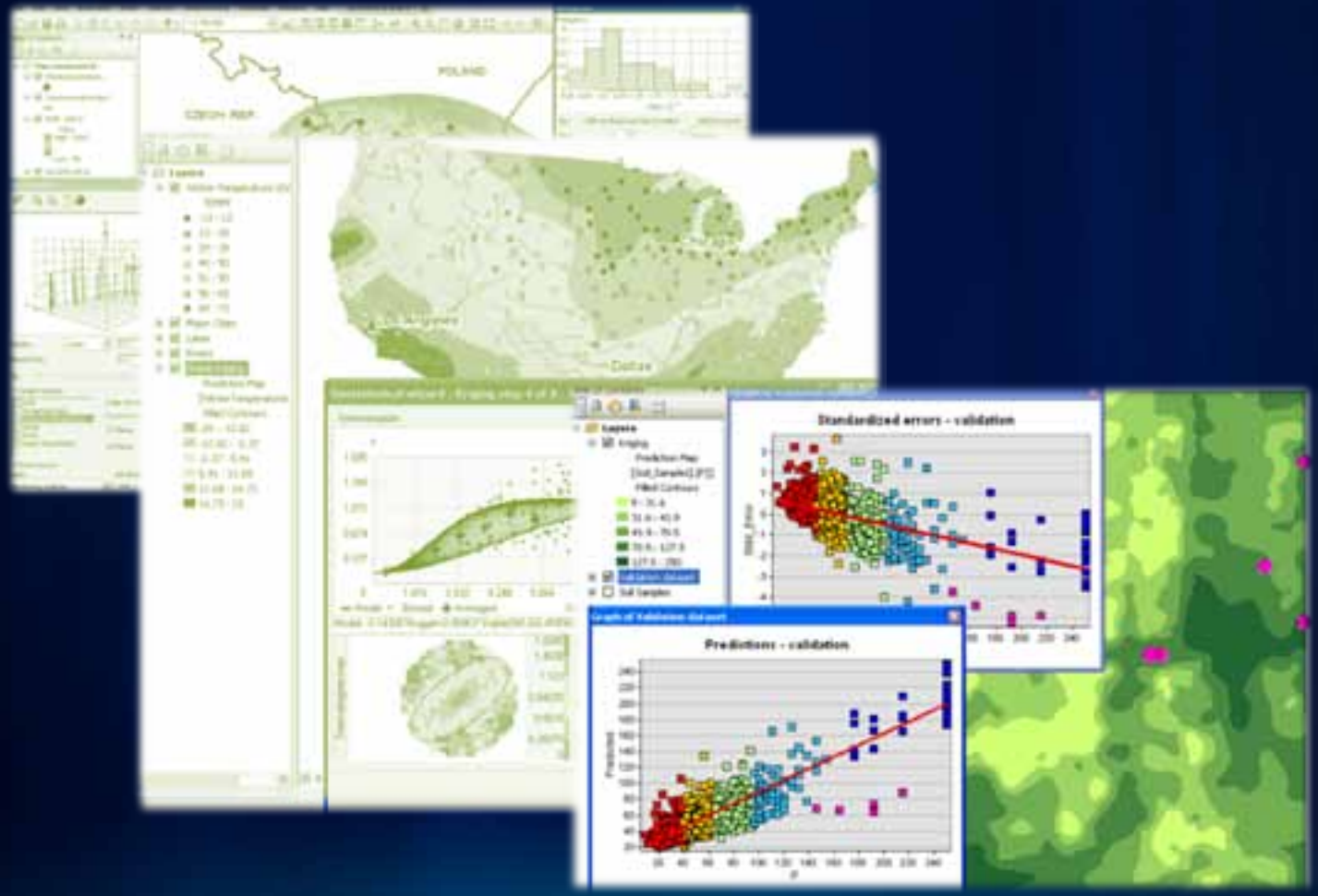




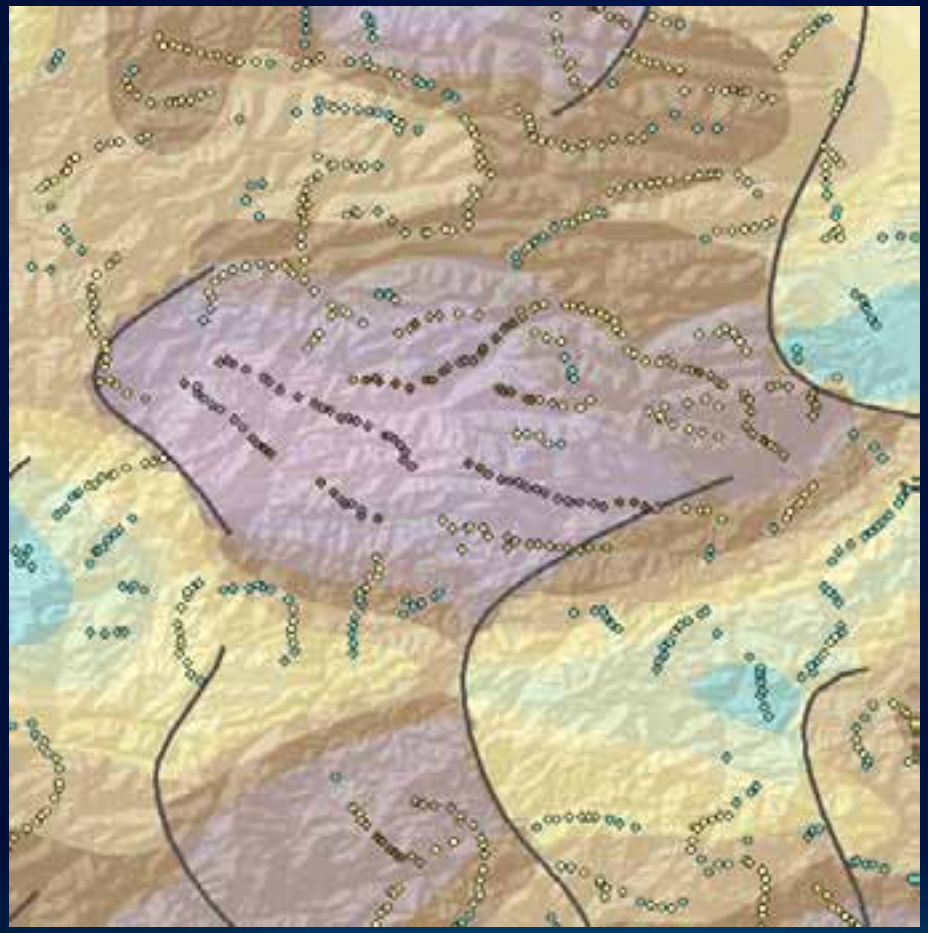
Geostatistical Analyst - Overview

- Interactive
  - Exploratory Spatial Data Analysis tools
  - Variography
  - Kriging
  - Other interpolation methods
  - Cross validation
- Geoprocessing toolbox
  - Interpolation
  - Sampling Network Design
  - Simulation
  - Utilities
  - Conversion

Where is Geostatistical Analyst used?



Where is Geostatistical Analyst used?

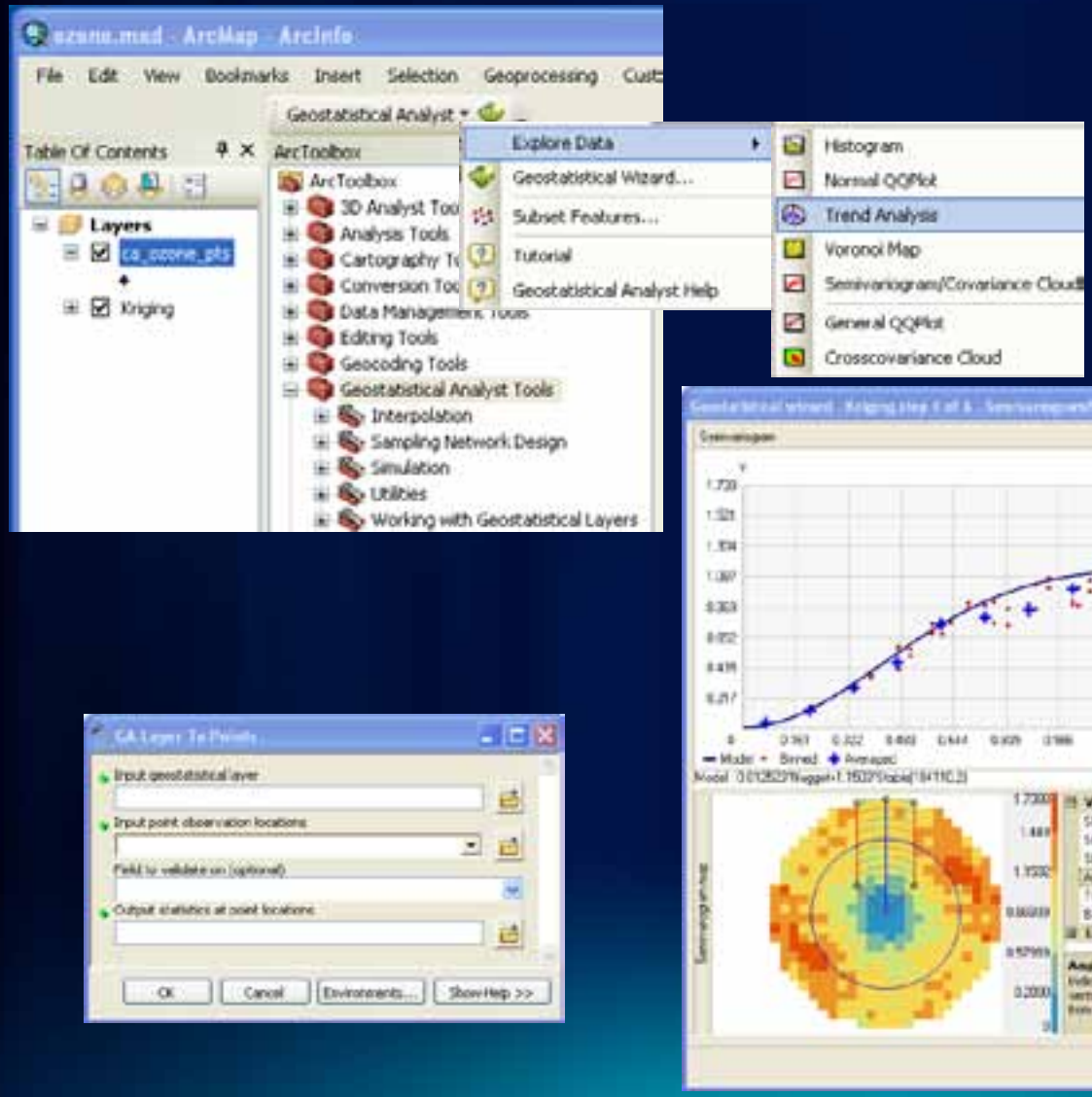


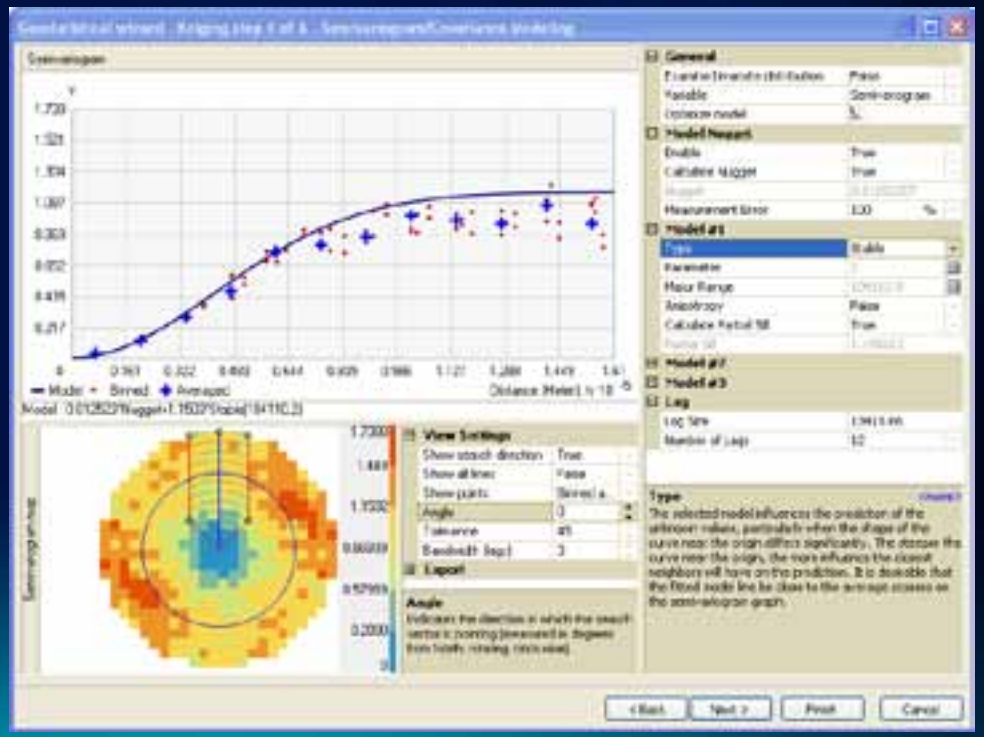
Experiment conducted by the US EPA 20 years ago

- 12 independent reputable geostatisticians
- Given the same data
- Asked to perform the same straightforward estimation
- Results were widely different
- Different
  - data analysis conclusions
  - variogram models and choice of kriging type
  - searching neighborhoods.

Isaaks & Srivastava, 1989. An Introduction to Applied Geostatistics.

Geostatistical Analyst – Toolbar and Toolbox





Wizard demonstration

Demonstration

What’s new in 10 – Geoprocessing tools

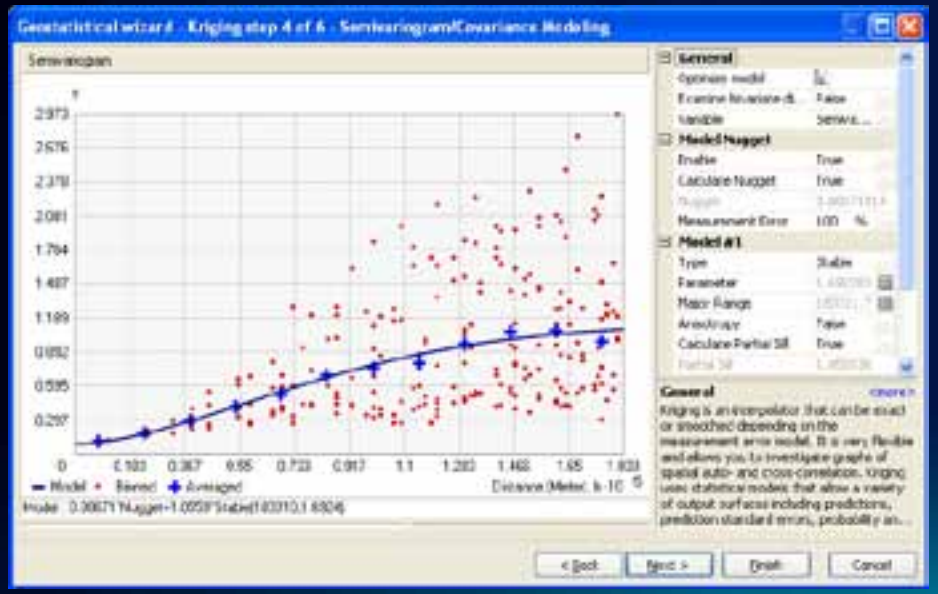
- Global Polynomial Interpolation
- Local Polynomial Interpolation
- IDW
- Radial Basis Functions
- Cross Validation
- Subset Features

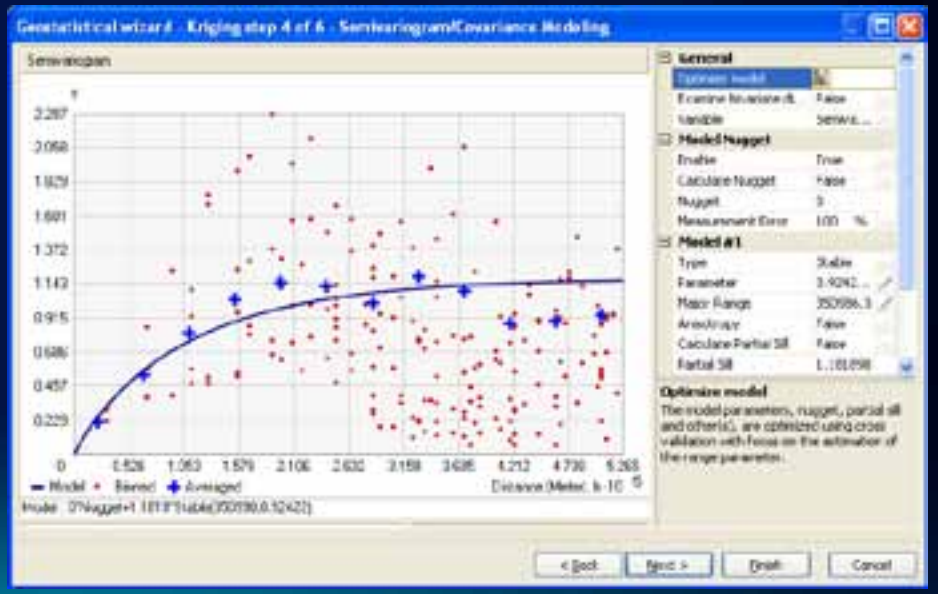
What’s new in 10 - functionality

- Interpolation with barriers
  - Diffusion Interpolation
  - Kernel Interpolation
- Sampling network design
  - From scratch
  - Existing network

What's new in 10 – Optimize buttons

- **Local Polynomial Interpolation**
- **Kriging**
  - **Nugget, partial sill and other(s), are optimized using cross validation with focus on the estimation of the range parameter.**





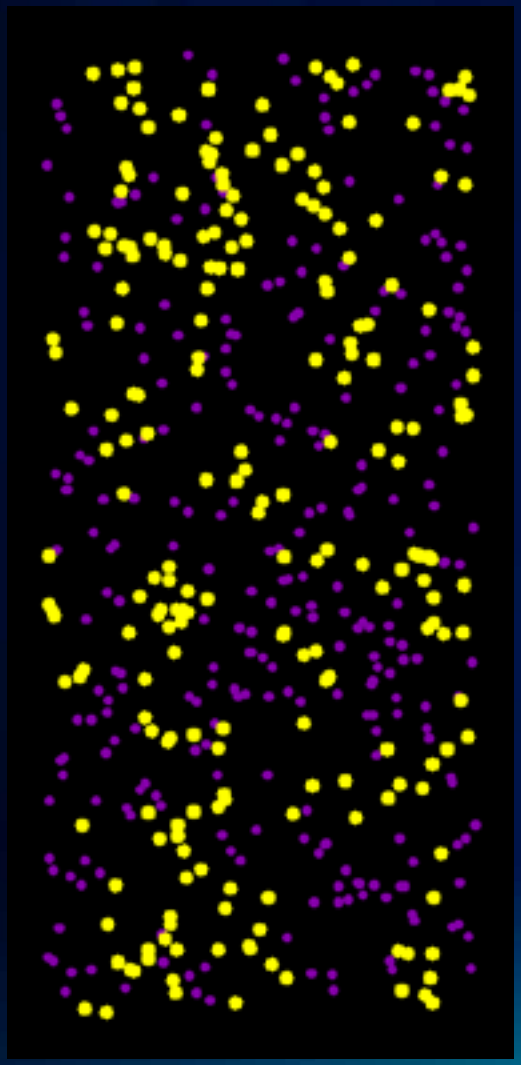
Interpolation workflow

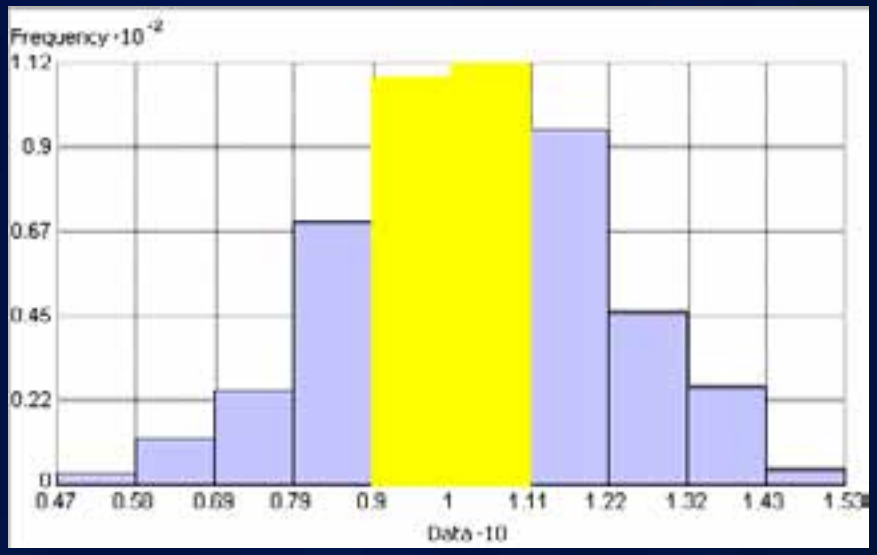
- Exploratory Spatial Data Analysis (ESDA)
- Interpolation
- Goodness of fit

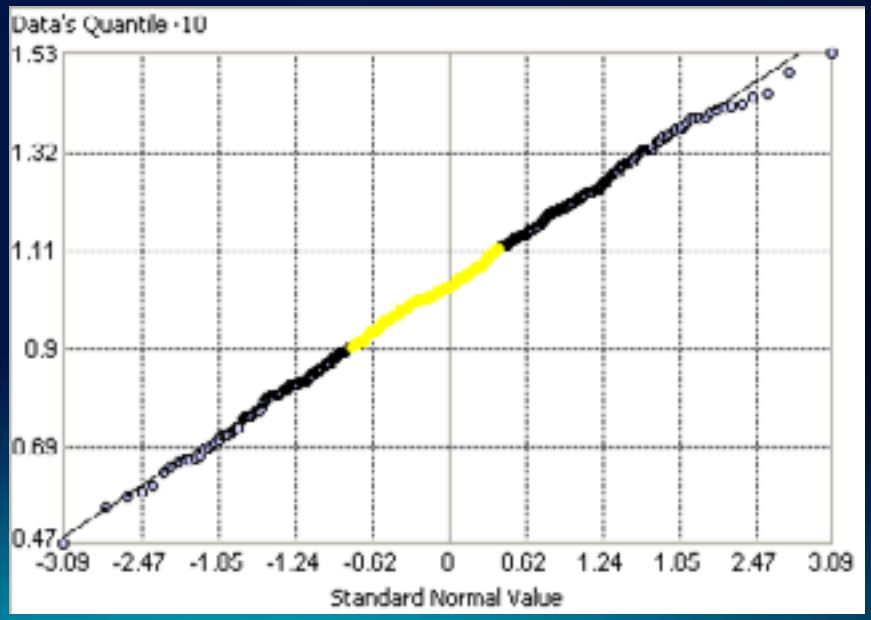
Exploratory Spatial Data Analysis

- Where is the data located?
- What are the values at the data points?
- How does the location of a point relate to its value?

Exploratory Spatial Data Analysis (ESDA)







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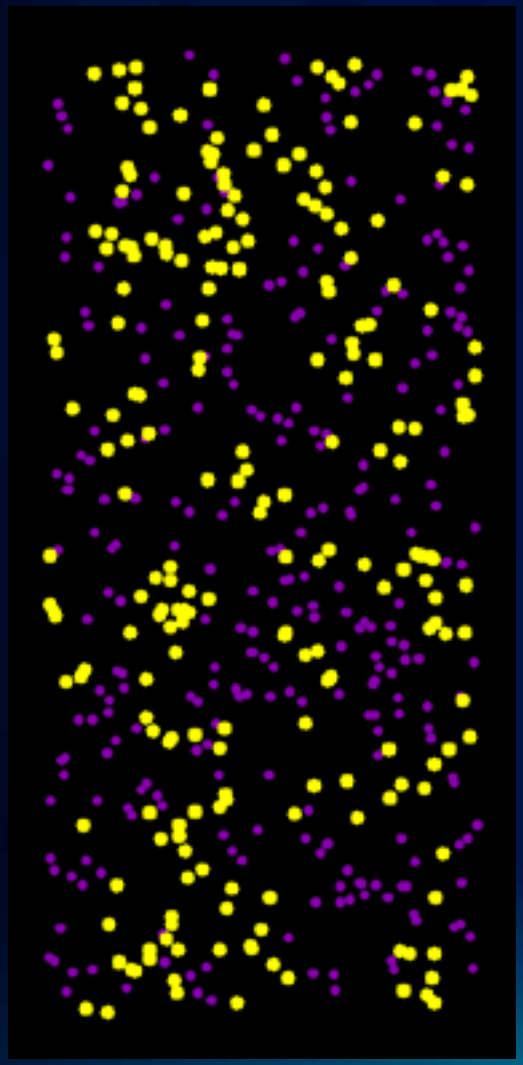

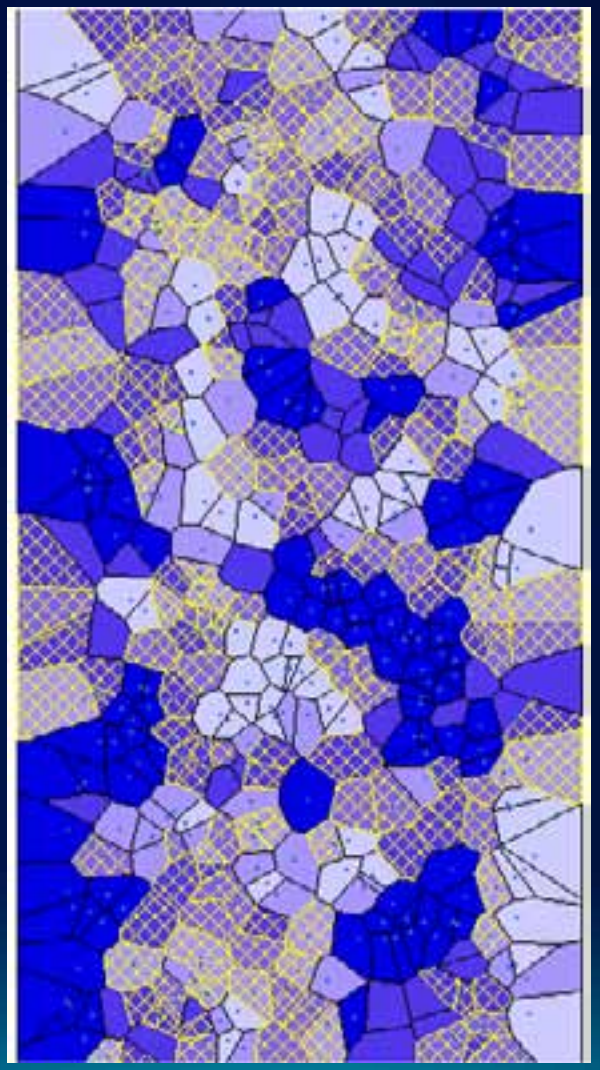

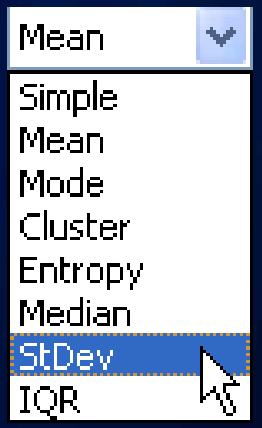

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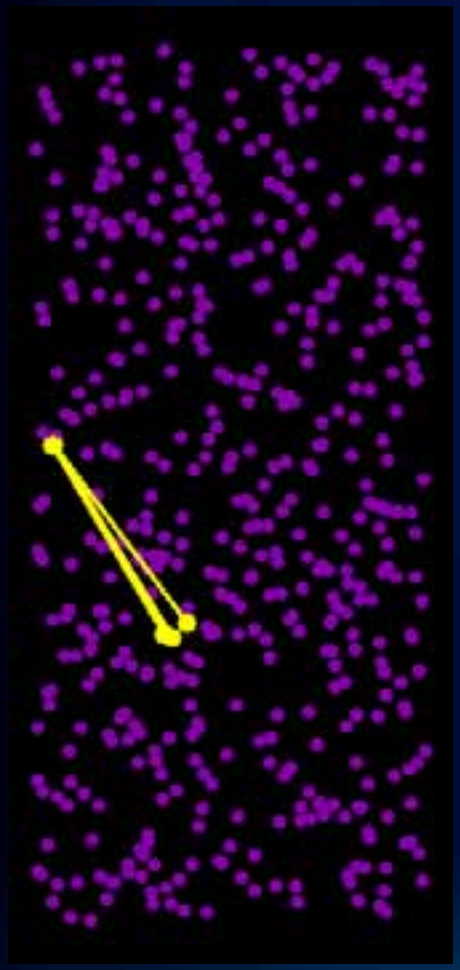
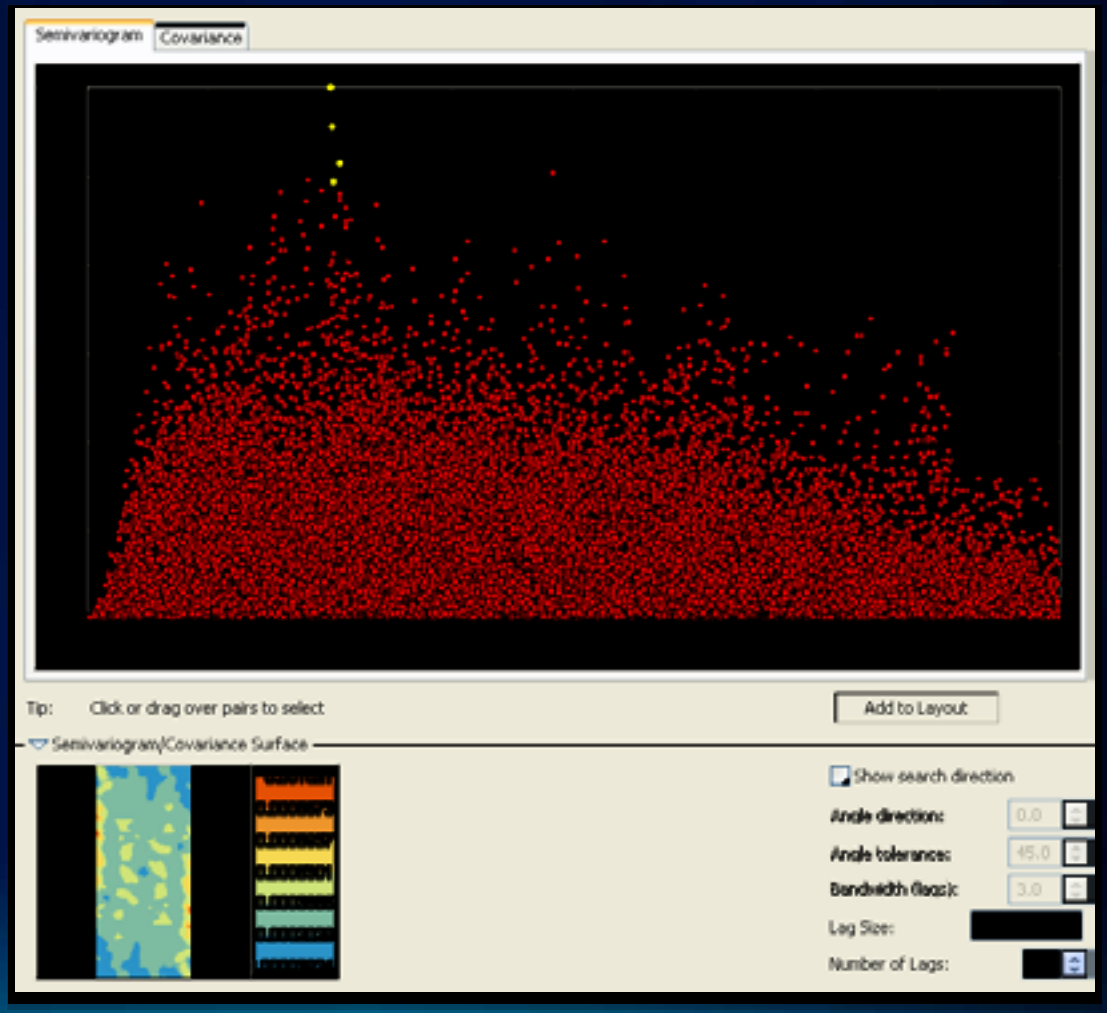
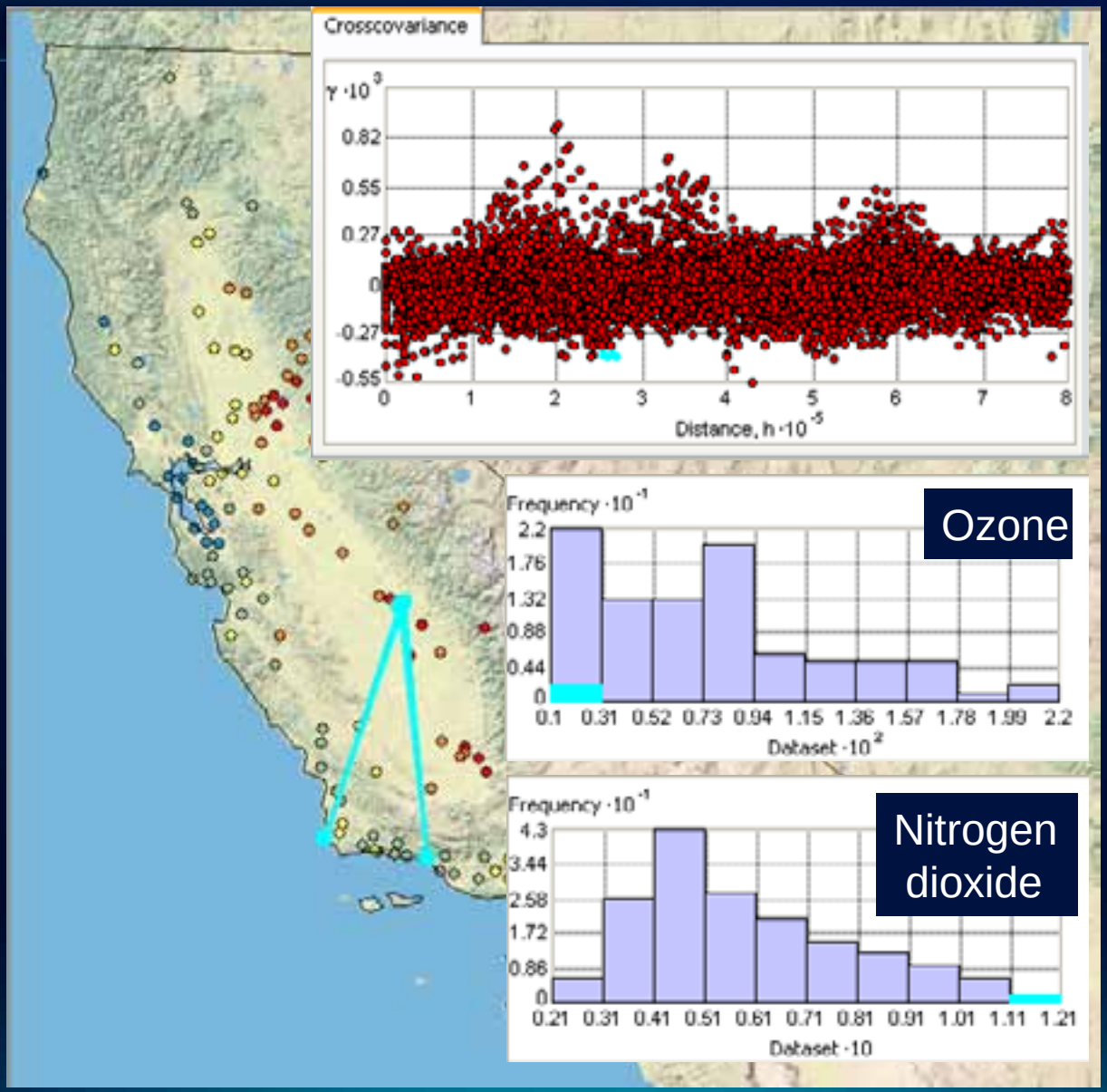




Crosscovariance



Kriging

- **Concepts and Applications of Kriging**
- **Thursday 10:15am – 11:30am 14A**

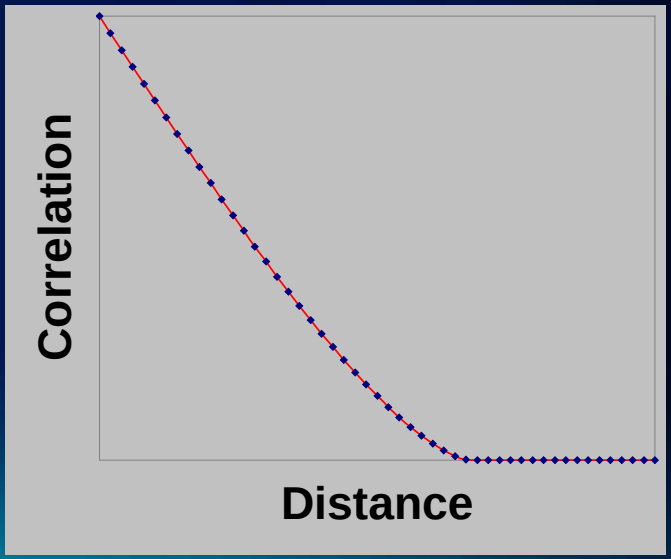
Outline

- Introduction to kriging
- Best practices
- Fitting a proper model
- Variography, transformations, isotropy, stationarity
- Comparing models using cross validation
- Interpreting results

What is kriging?

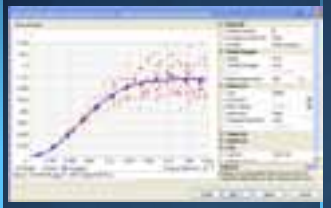
- It is a geostatistical interpolation technique
- that models the spatial correlation of point measurements
- to estimate values at unmeasured locations.

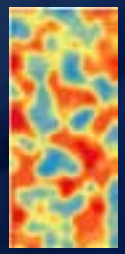
- Associates uncertainty with the predictions



Kriging

Demonstration



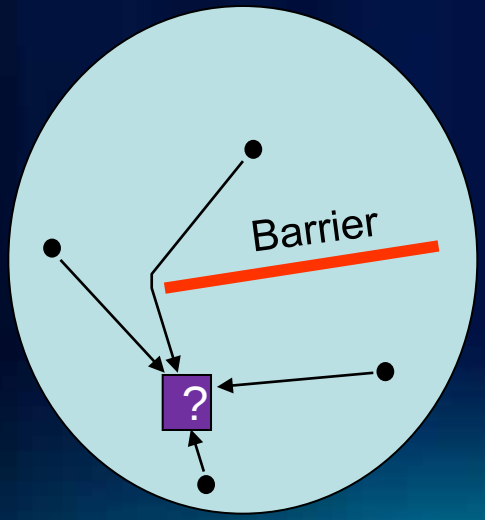


Kriging as a geoprocessing tool!

- Requires interactive variography
- Spatial Analyst
- Empirical Bayesian Kriging

Interpolation with Barriers

- Kernel interpolation
- Diffusion interpolation



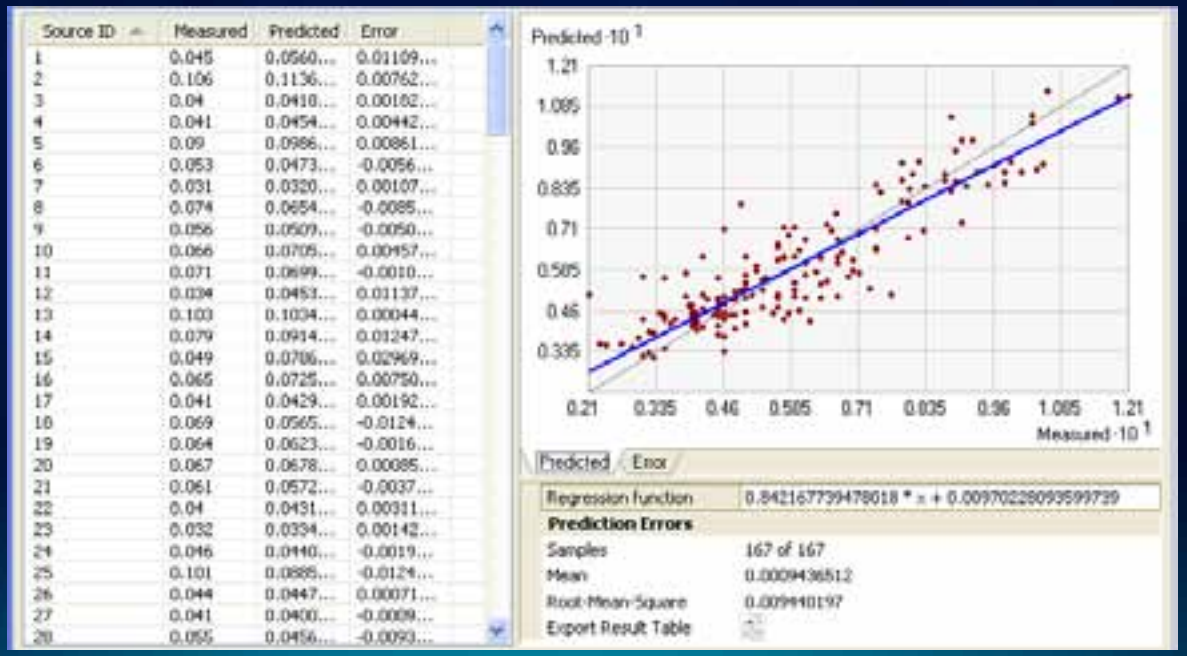
Cost Raster

Kernel Interpolation with Barriers

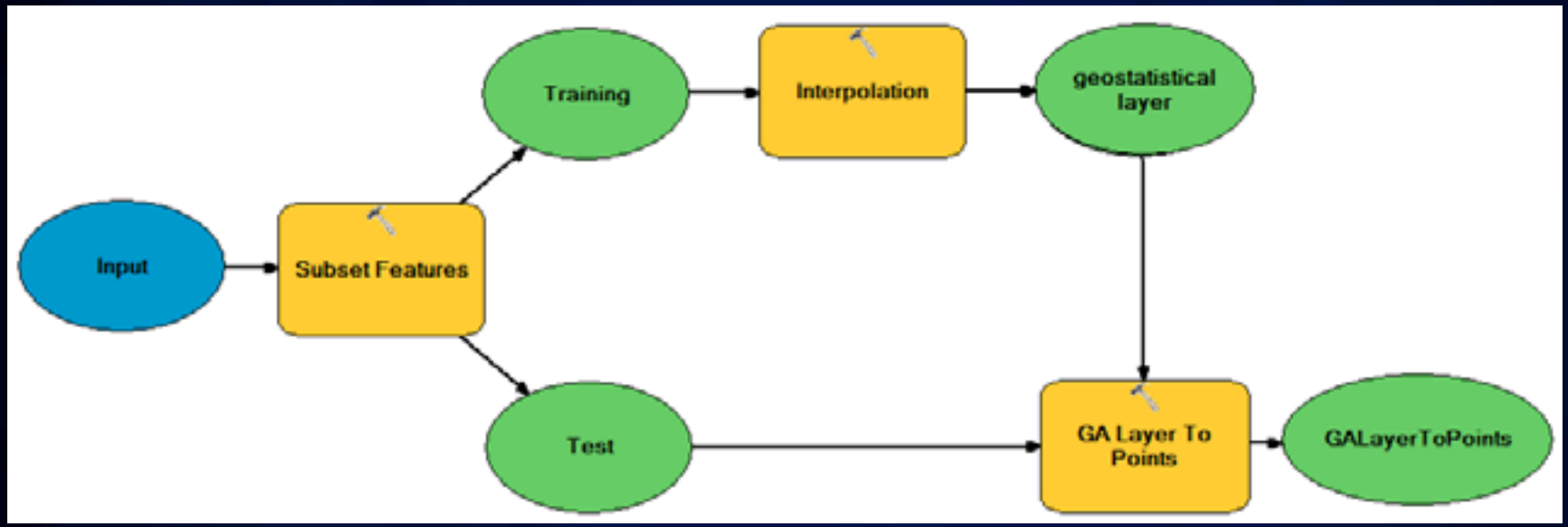
Demonstration

Goodness of fit / Model acceptance

- **Subset Features**
- **Cross Validation**



Subset Features



	ELEVATION	Predicted	Error
	99	196.216111	97.216111
	-32	47.910613	79.910613
	194	256.709823	62.709823
	545	605.799907	60.799907
	91	149.811753	58.811753
	65	116.717815	51.717815
	98	148.111075	50.111075

Cross validation – Modelbuilder + Python

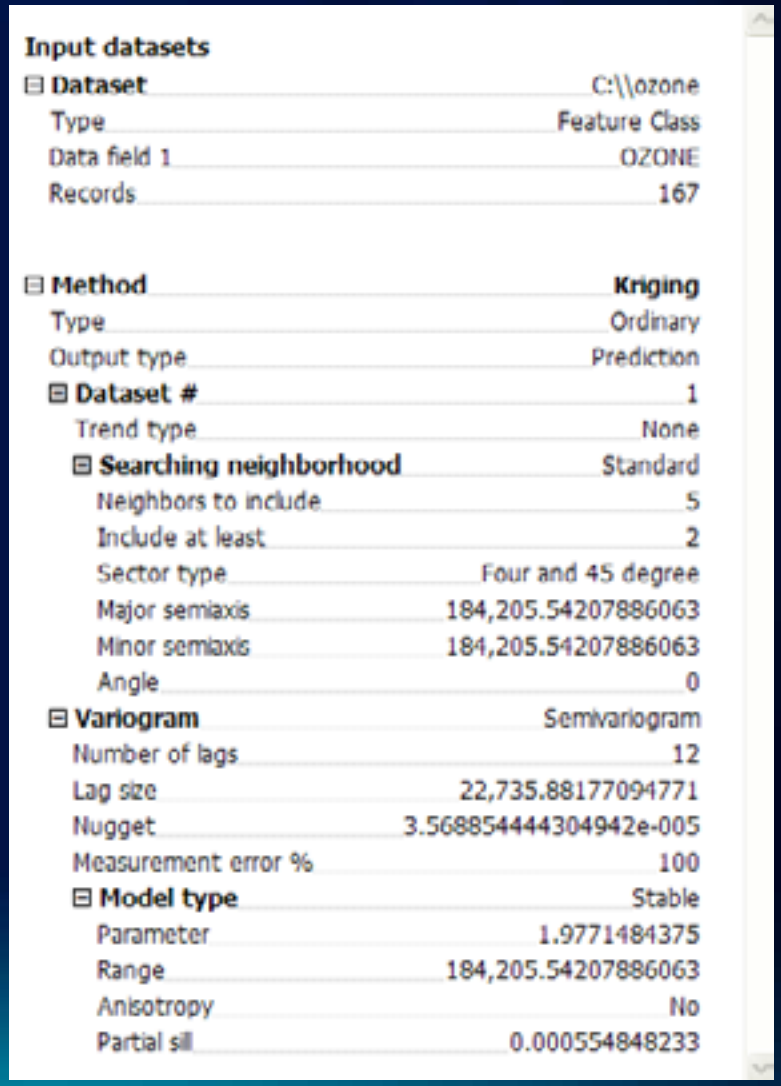
Demonstration

Cressie, 1990

- Cross validation does not prove that the model is correct,
- merely that it is not grossly incorrect.

Geostatistical layer

- Method and parameters
- Pointer to the data
- Dynamic

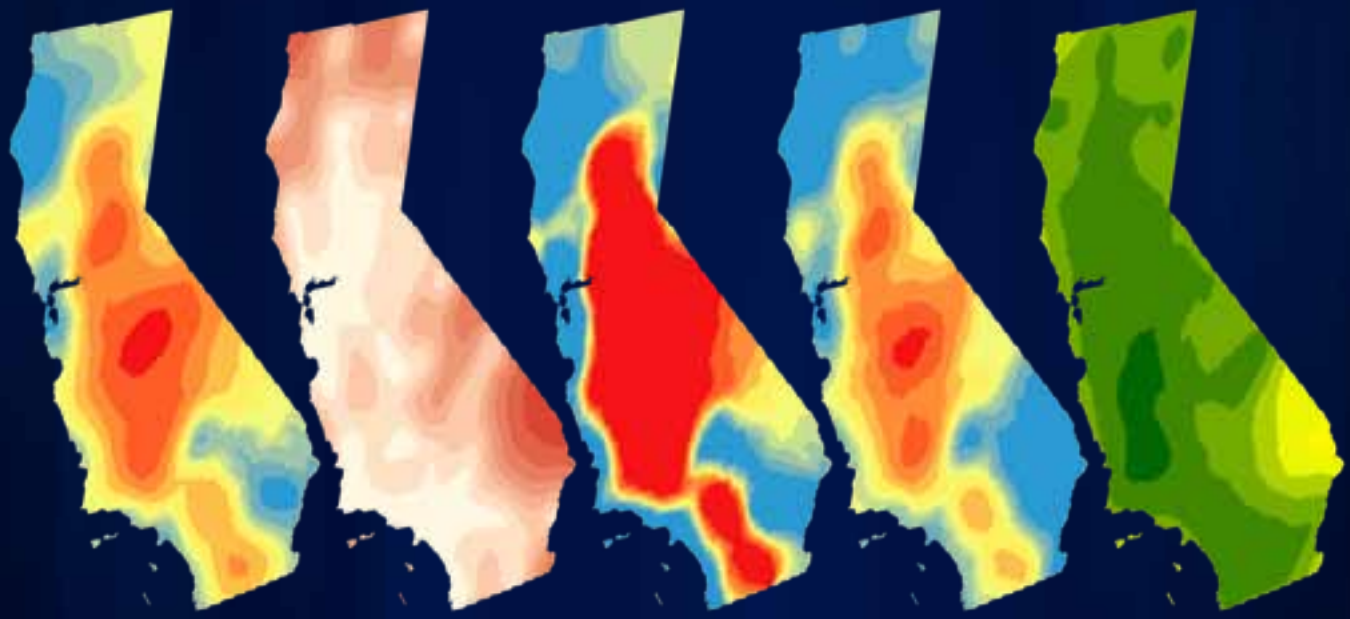


Input datasets	
Dataset	C:\\ozone
Type	Feature Class
Data field 1	OZONE
Records	167
Method	**Kriging**
Type	Ordinary
Output type	Prediction
Dataset #	1
Trend type	None
Searching neighborhood	Standard
Neighbors to include	5
Include at least	2
Sector type	Four and 45 degree
Major semiaxis	184,205.54207886063
Minor semiaxis	184,205.54207886063
Angle	0
Variogram	Semivariogram
Number of lags	12
Lag size	22,735.88177094771
Nugget	3.568854444304942e-005
Measurement error %	100
Model type	Stable
Parameter	1.9771484375
Range	184,205.54207886063
Anisotropy	No
Partial sill	0.000554848233

Geostatistical layer

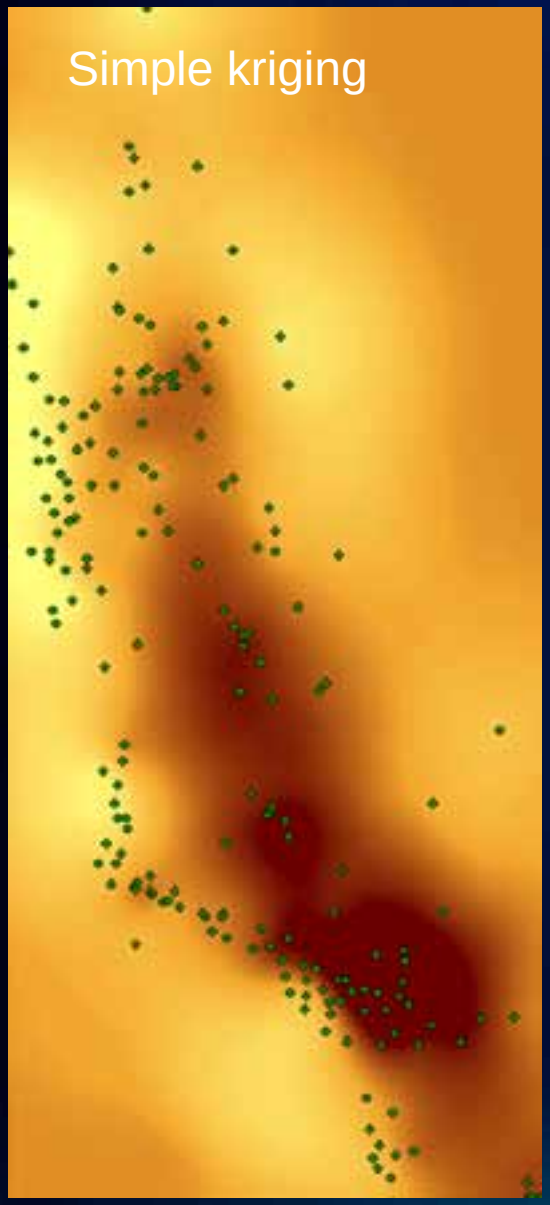
Demonstration

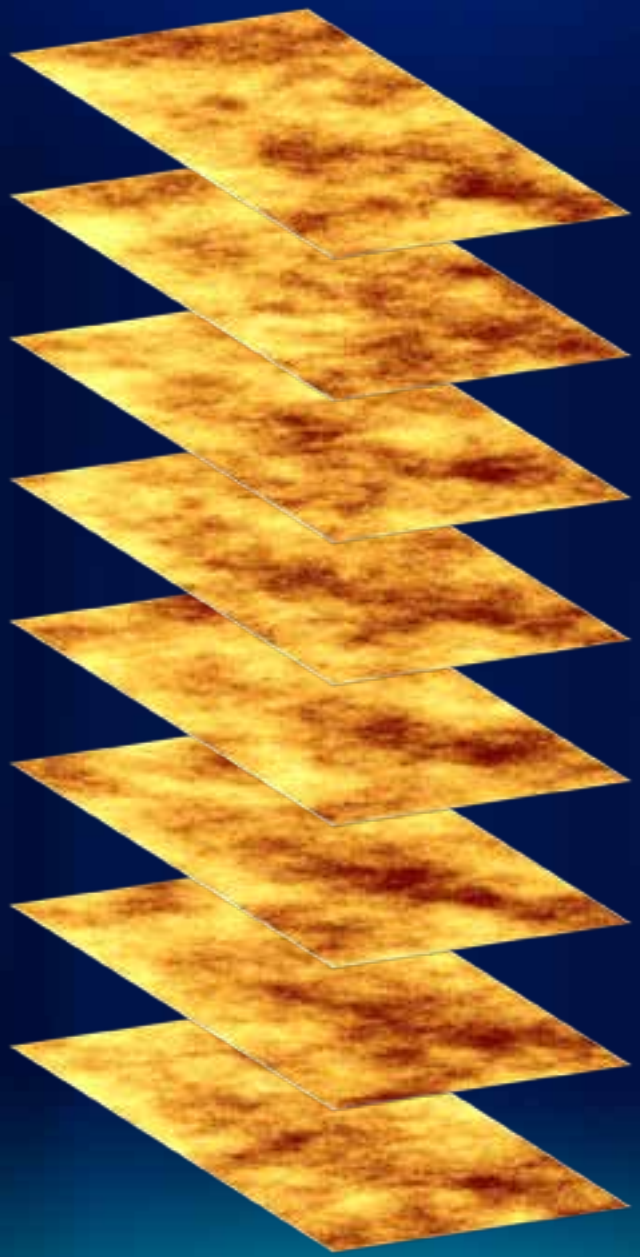
Output = Prediction, Prediction SE, Probability, Quantile, Condition number



Gaussian Geostatistical Simulations

- Geostatistical Simulations
- Tuesday 5:00pm – 6:00pm Demo Theater


Simple kriging

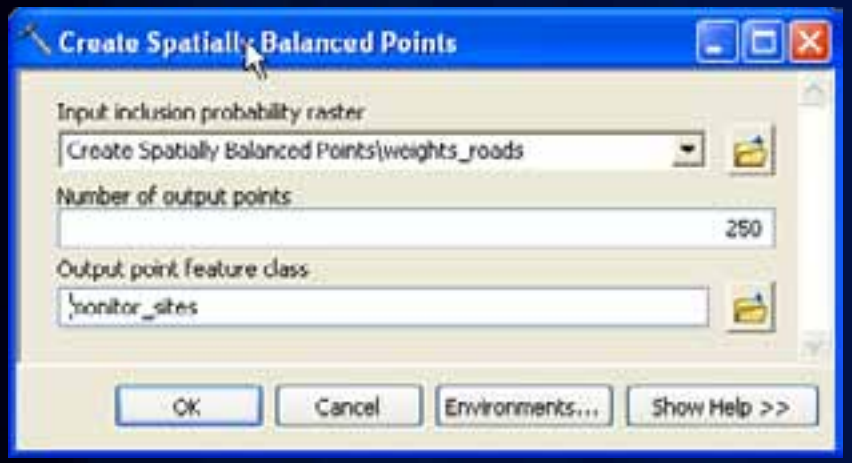



N = 500

Create Spatially Balanced Points

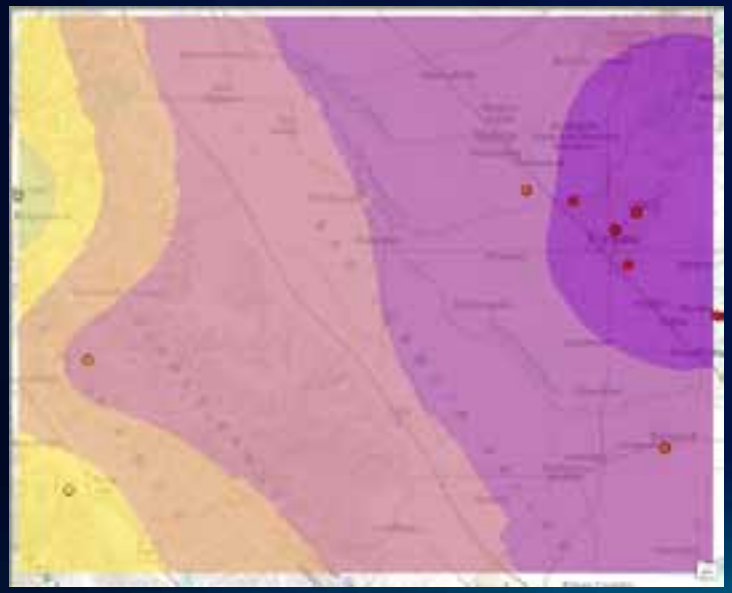
- Monitor road pollution
- Convert roads to raster
- High value = busy road
- Low value = quite road

Create Spatially Balanced Points (cont.)

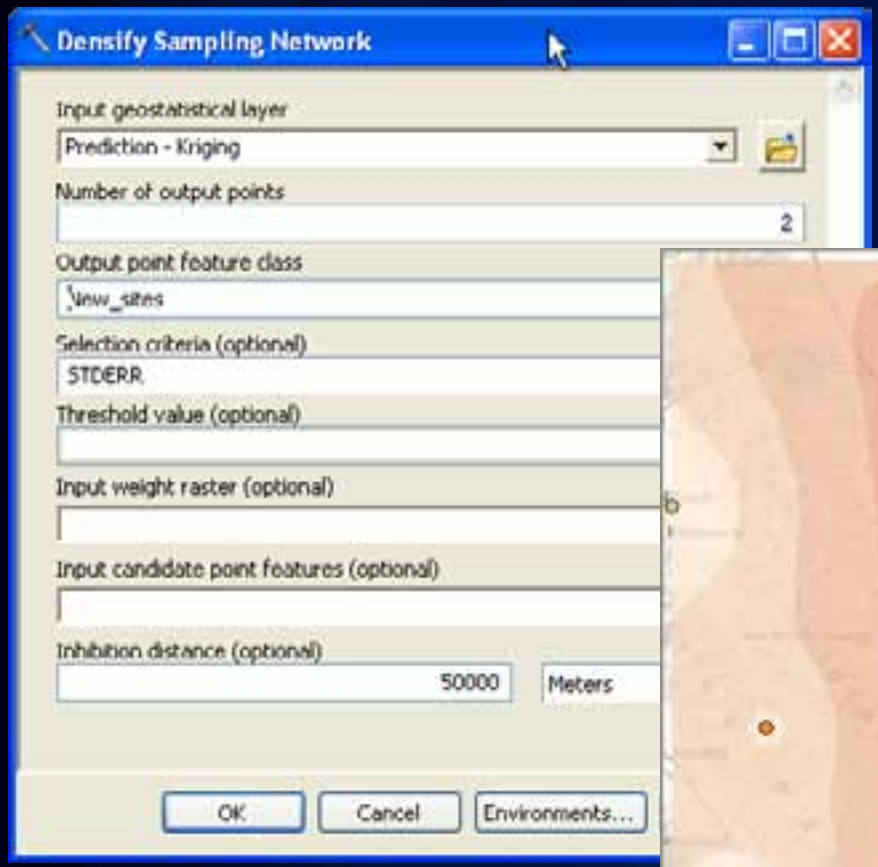


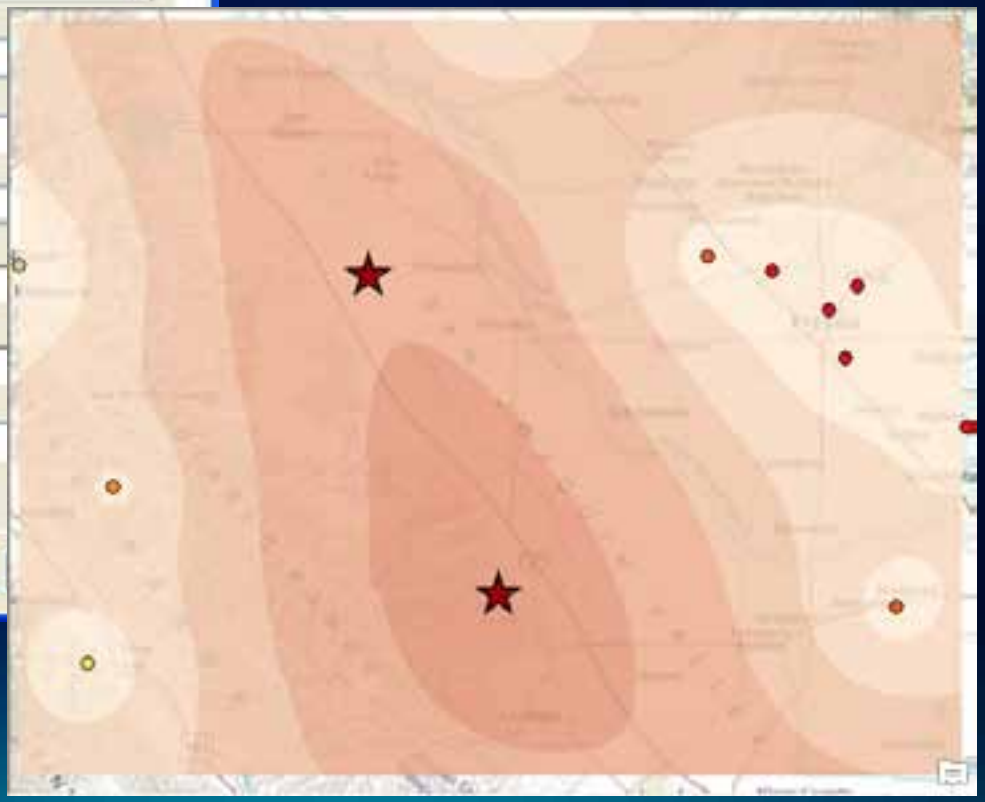
Densify Sampling Network

- Used kriging to create:
  - Prediction surface
  - Standard error of prediction
- Want to add 2 new sites



Densify Sampling Network (Cont.)





Sampling Network Design

Please fill out the questionnaire

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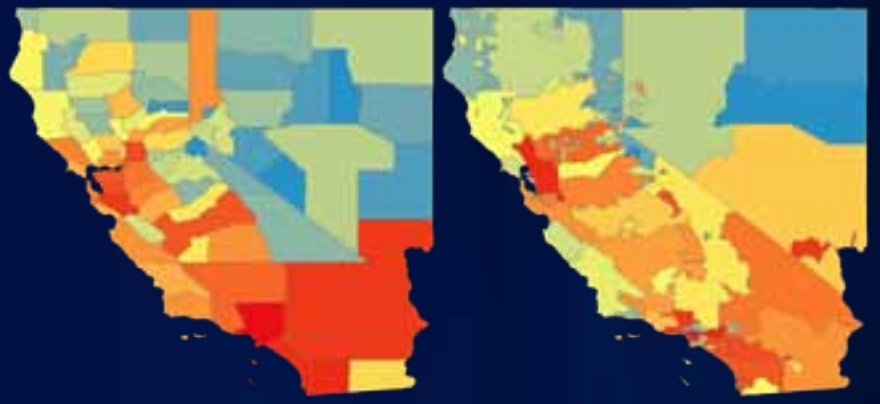
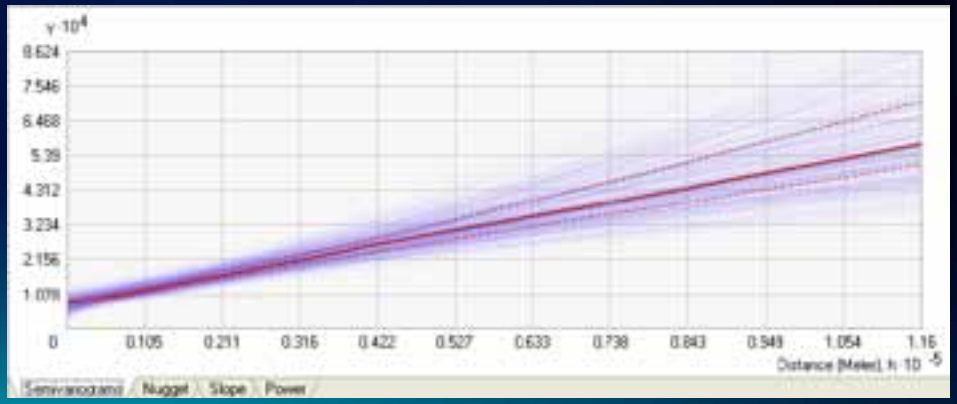
Post 10

Areal Interpolation



Empirical Bayesian Kriging



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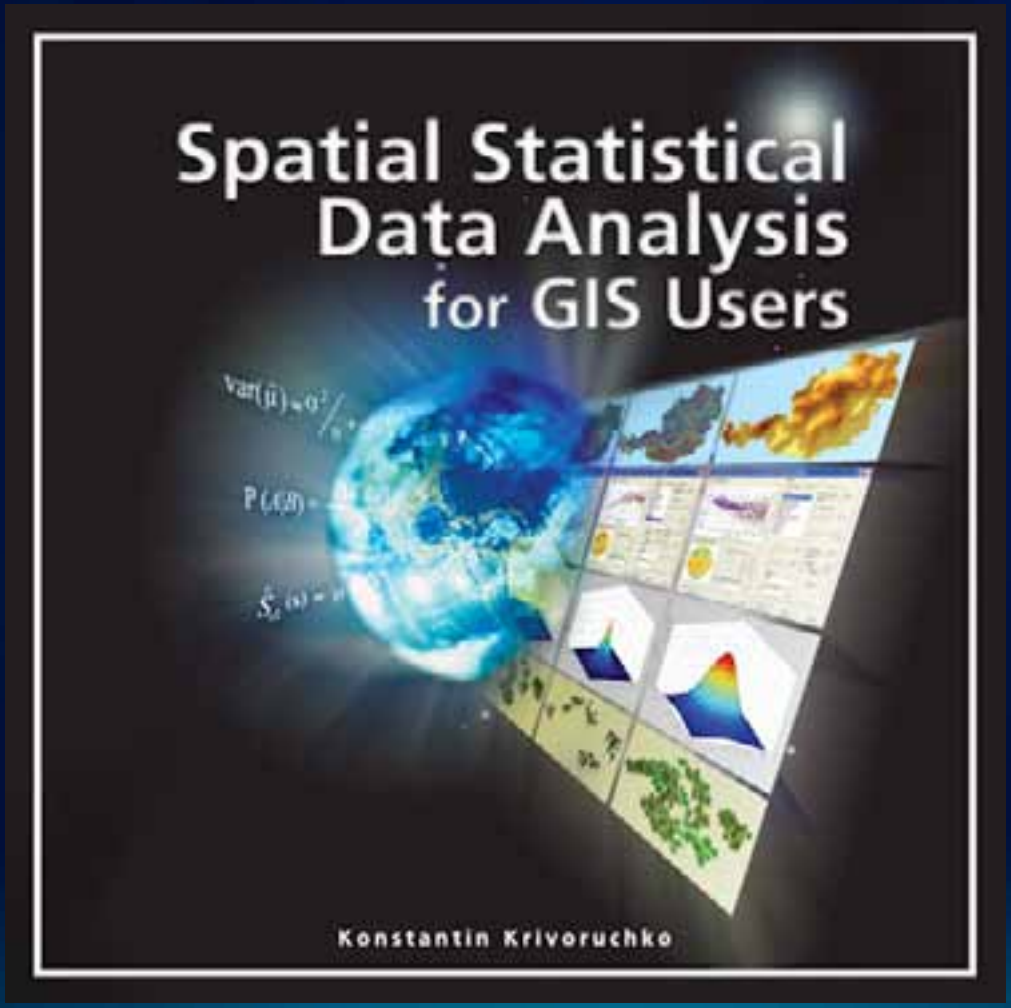

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