COA 616 Geostatistics in Environmental Sciences

# Lecture 8 – Ordinary Kriging II

Wei Wu

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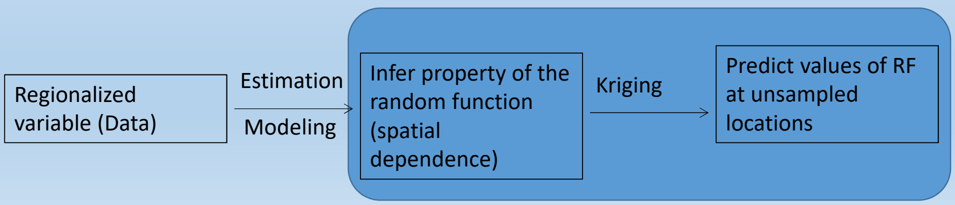


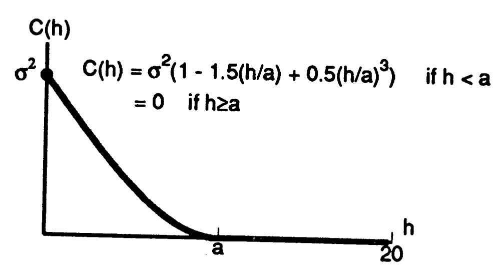
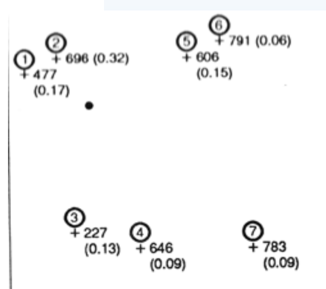




**Figure 12.4** The spherical model of a covariance function.




Similar to inverse distance weighting, OK gives far away samples less weights, sample 2 vs. 7

# Variogram Model Parameters

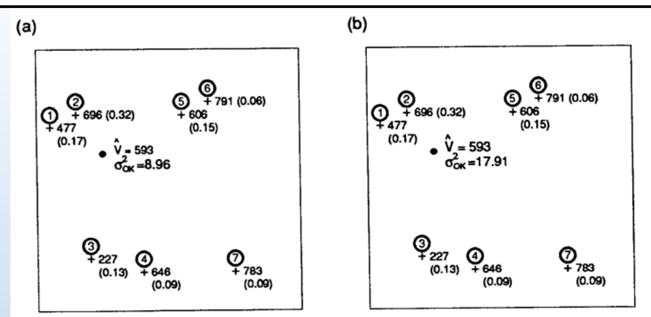
- We now look at how parameters of a variogram (covariance) model affect the OK weights
- Scale, shape, nugget, range, and anisotropy

# Scale

$$\gamma_1(h) = 10(1 - e^{-.3|h|})$$

$$\gamma_2(h) = 20(1 - e^{-.3|h|})$$

Sill of10 vs. 20




Sill = 10 Sill = 20

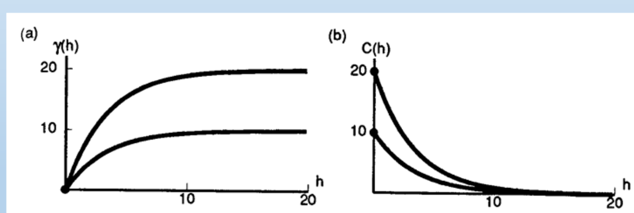



**Figure 12.5** Two variograms and their corresponding covariance functions that differ only by their scale.

# The Effect of Scale

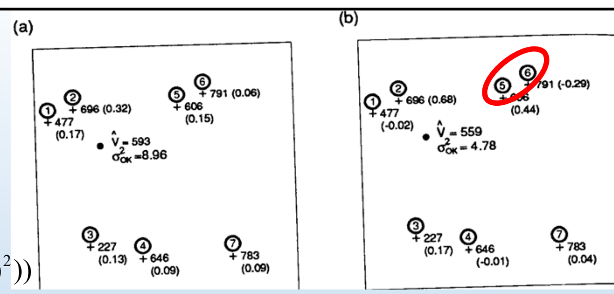
- With any rescaling of the variogram, neither the Kriging weights nor the estimate are changed while the variance increases by the same factor used to scale the variogram

# Shape

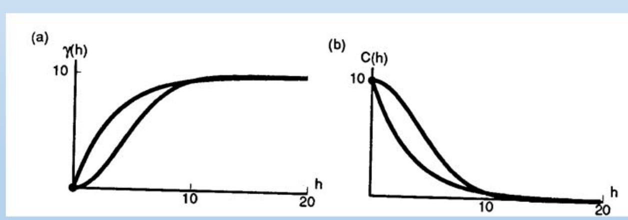
$$\gamma_1(h) = 10(1 - \exp(-3\frac{|h|}{10}))$$

$$\gamma_2(h) = 10(1 - \exp(-3(\frac{|h|}{10})^2))$$

Exponential vs. Gaussian model




Exponential Gaussian



## The Effect of Shape

- Exponential (Eq1) vs. Gaussian (Eq2) variogram model
- The Gaussian variogram model assigns more weight to the closer samples

## The Effect of Shape

- Screen effect - a sample falls behind another sample that is closer to the unknown. It receives less (or negative) weights, sample 5 vs. 6
- The Gaussian models has a stronger screen effect than the exponential model

## The Effect of Shape

- Weights that are less than 0 or greater than 1 can produce estimates larger than the largest sample value or smaller than the smallest. Weights within [0,1] produce estimates only within the min and max of sample values
- Negative weights may produce negative estimates, although in most science applications values should be positive

## Nugget

$$\gamma_1(h) = 10(1 - e^{-.3|h|})$$

$$\gamma_2(h) = \begin{cases} 0 & \text{if } h = 0 \\ 5 + 5(1 - e^{-.3|h|}) & \text{if } h > 0 \end{cases}$$

Nugget = 0 vs. =1/2 sill

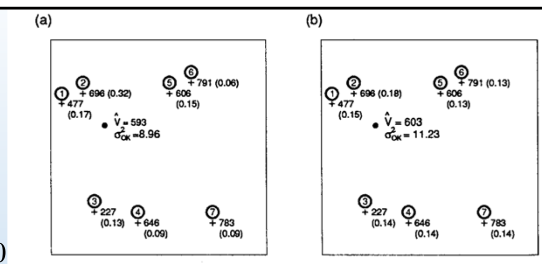
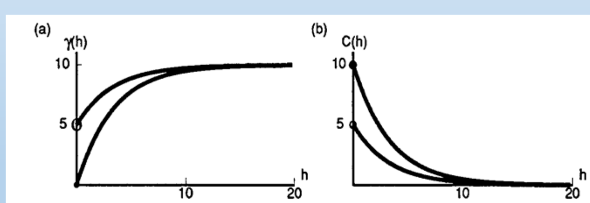



**Figure 12.10** Ordinary kriging results using two different covariance functions that differ only in their nugget effect. (a) shows the kriging weights for no nugget effect while (b) shows the weights for a relative nugget of one-half. The two covariance functions are given in Figure 12.9.



# The Nugget Effect

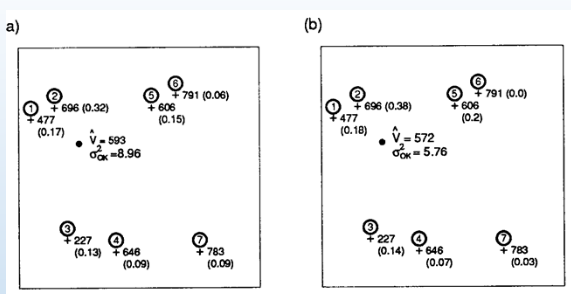
- The nugget effect makes weights become more similar to each other and results in higher kriging variance
- A pure nugget effect model entails a complete lack of spatial correlation

# Range

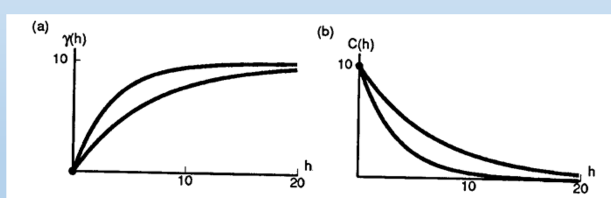
$$\gamma_1(h) = 10(1 - e^{-.3|h|})$$

$$\gamma_2(h) = 10(1 - e^{-.15|h|}) = \gamma_1(\frac{1}{2}h)$$

Range of *h* vs. 1/2*h*



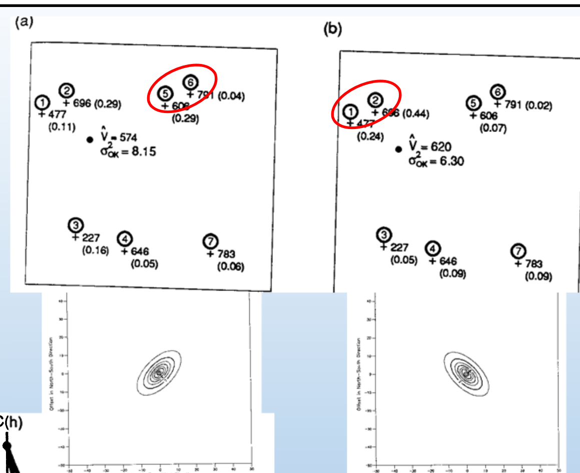

Range = 10 Range = 20

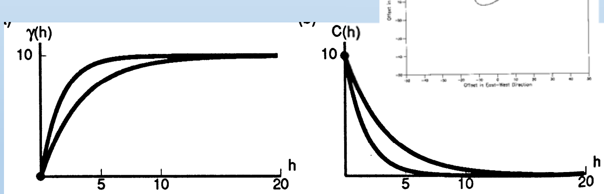


# The Effect of Range

- A decrease in the range raises the kriging variance
- If the range becomes too small, then all samples appear to be equally far away from the point being estimated. Then the estimation becomes similar to the simple average of the samples with same weight, 1/n

# Anisotropy




Directional variograms and covariance functions

# Effect of Anisotropy

- More weights are given to samples lie in the direction of maximum continuity
- Weights given to the samples in the maximum spatial continuity would increase as the anisotropy ratio becomes smaller

# Anisotropy Ratio