GEOSTATISTICS

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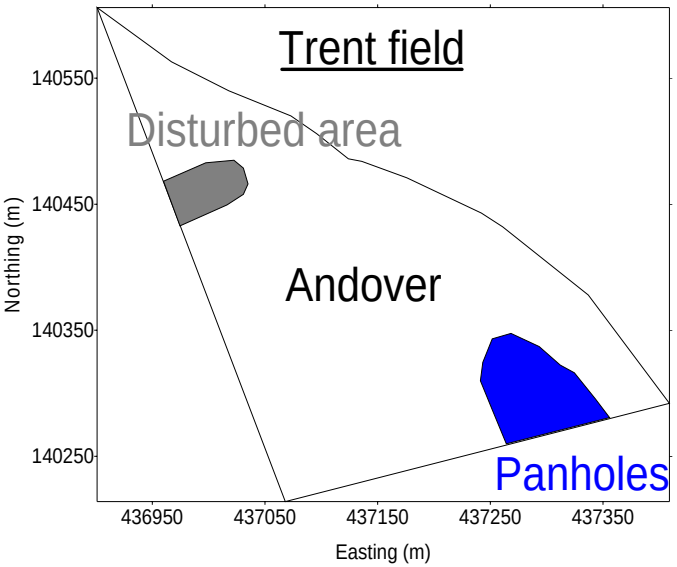


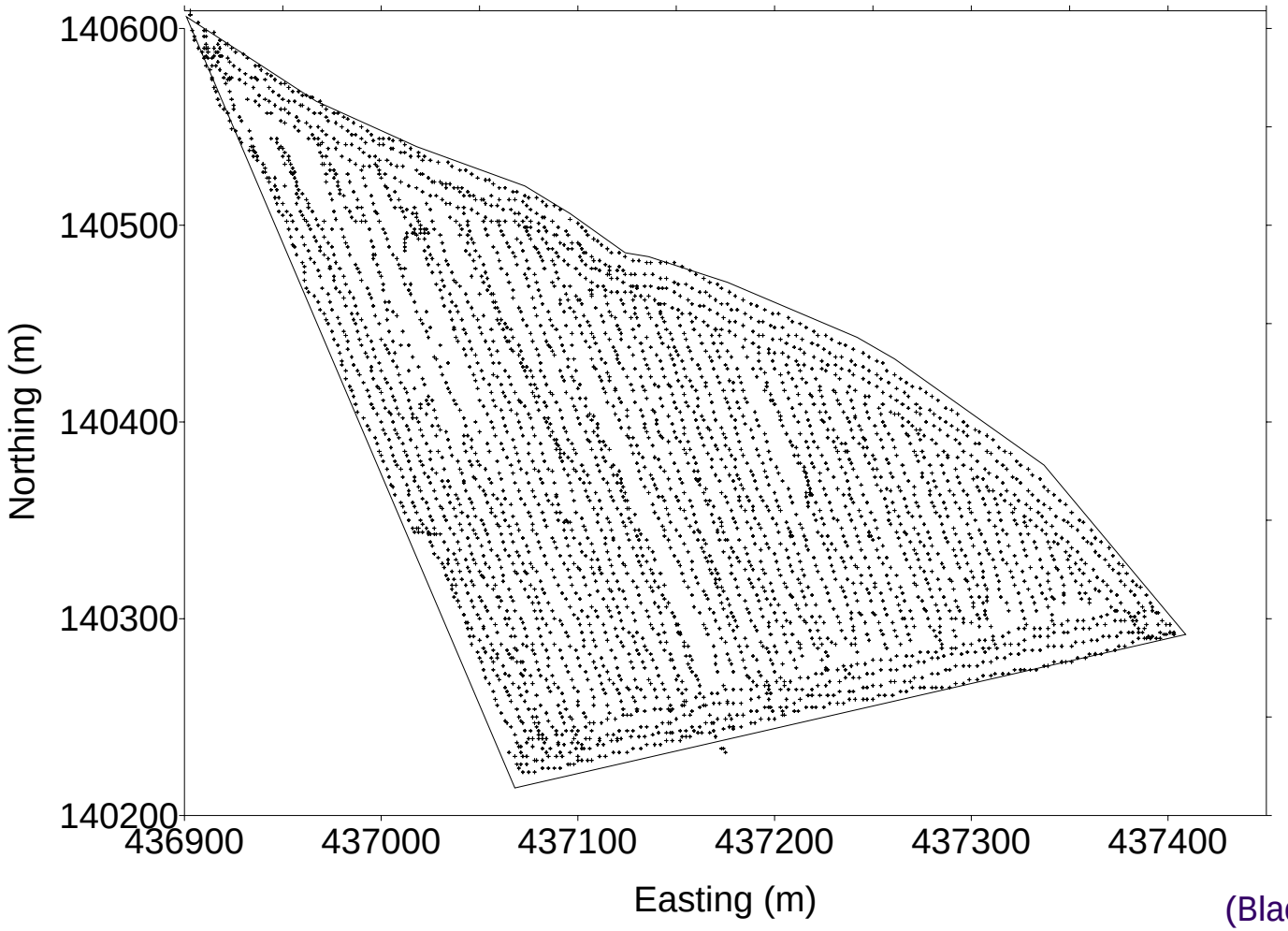
Trent Field
Westover Farm

(Blackmore, 2003)

Trent field, Westover Farm

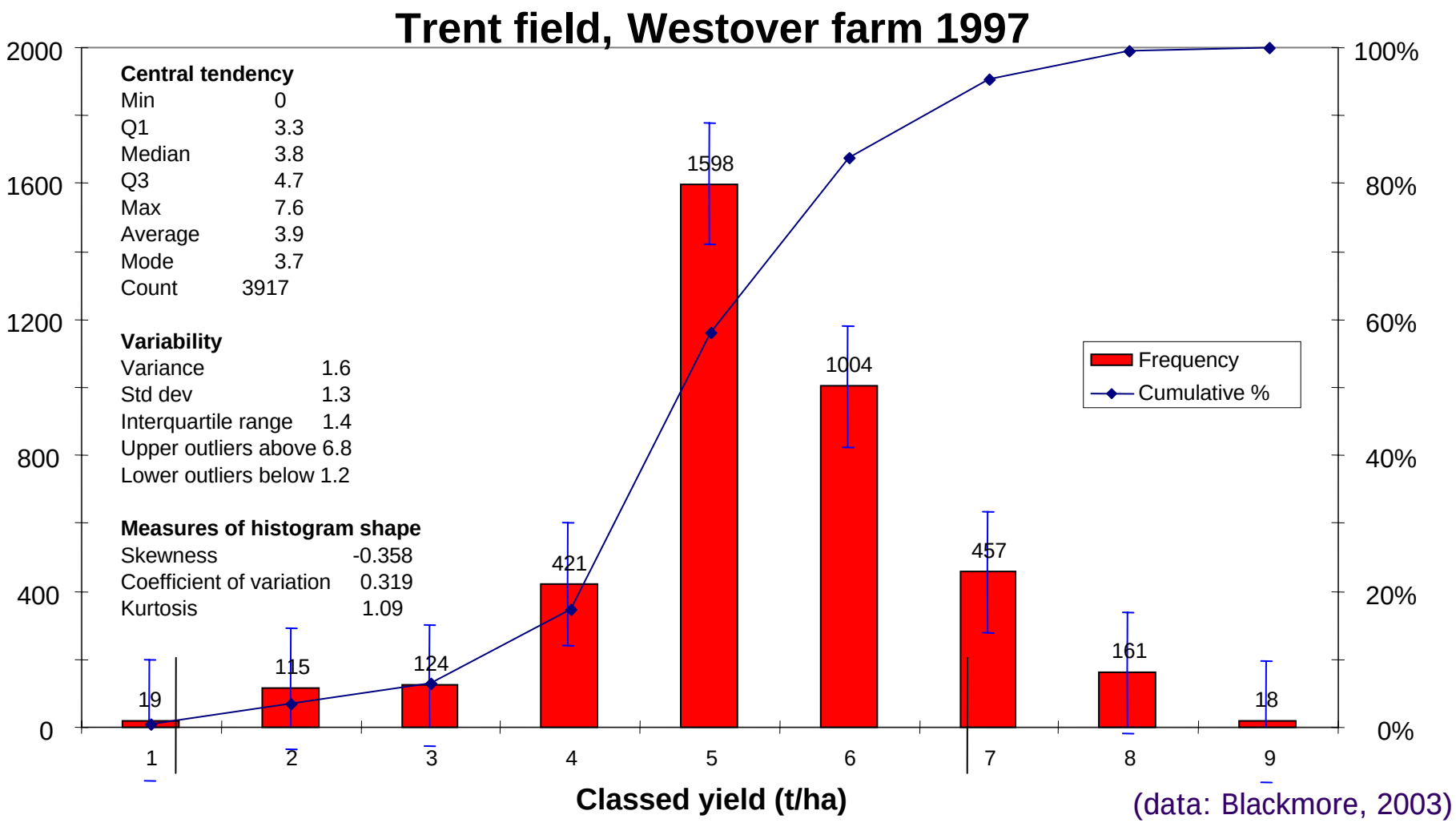
Yield mapping combine

Raw yield data points



(Blackmore, 2003)

Univariate summary statistics



(data: Blackmore, 2003)

Why Geostatistics ?

- We want to know the soil properties of some elements at each point to apply fertilizer where it needs and nowhere else
- Grid 20m x 20m

  e.g soil salinity

  pollution by heavy metals

  arsenic in ground water

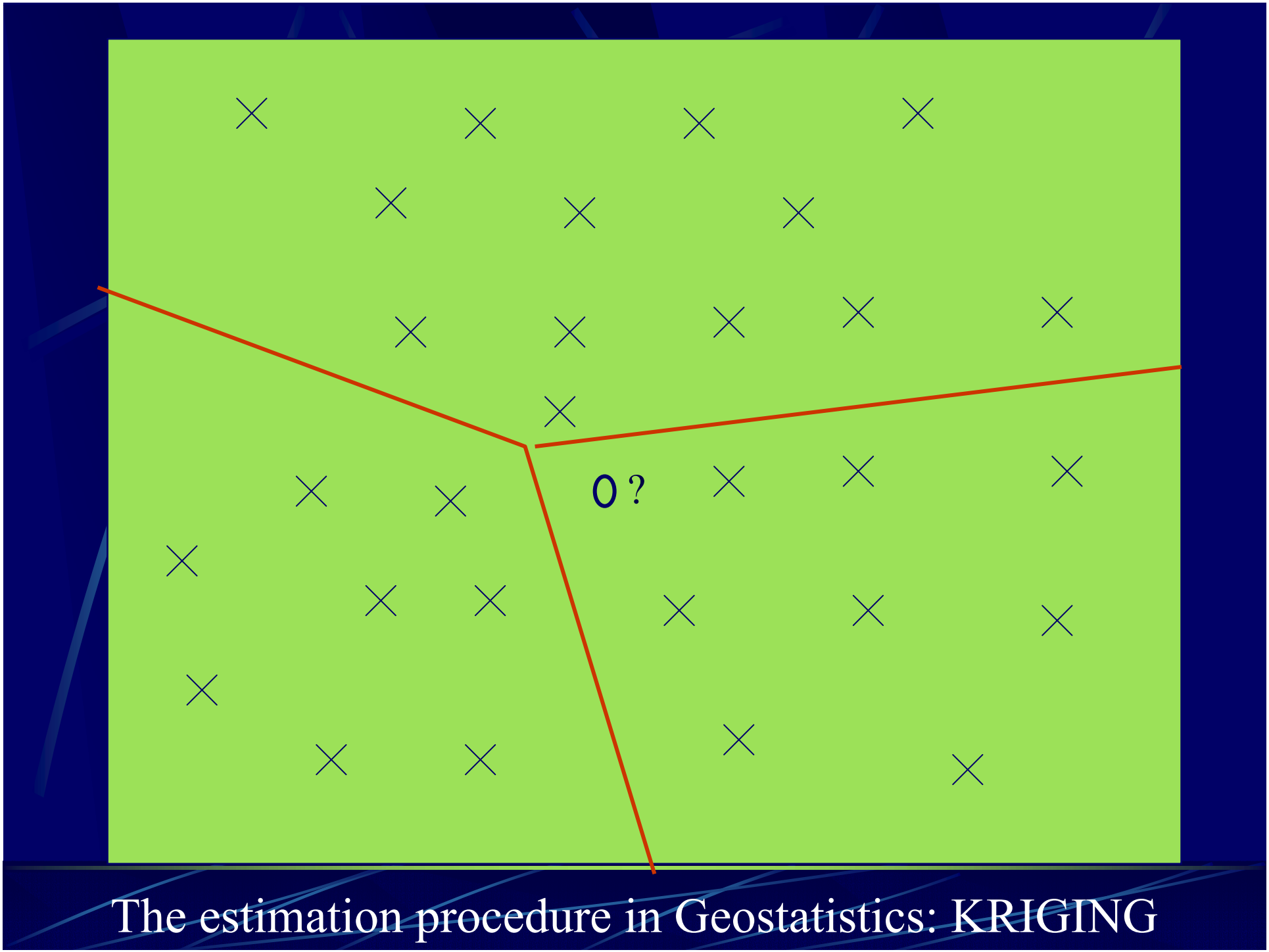
  rainfall

  barometric pressure

Why Geostatistics?

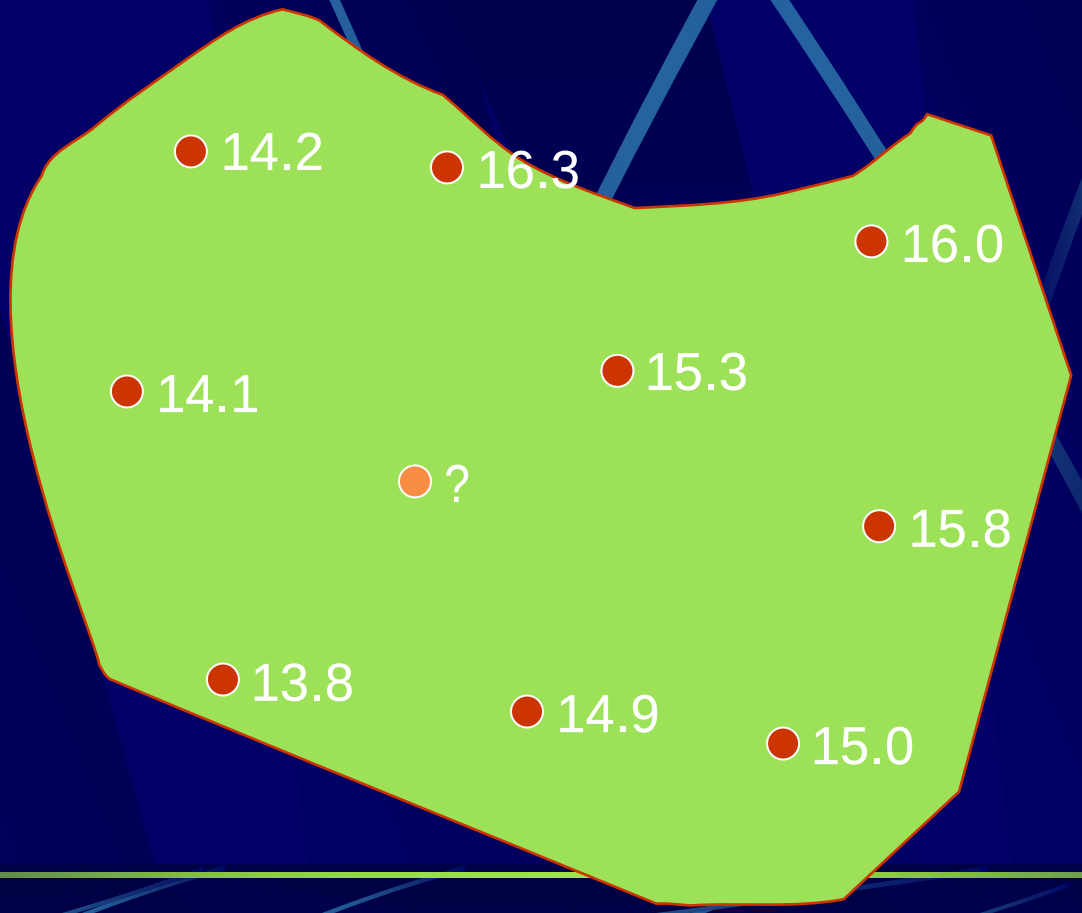
- COMMON: the environment is continuous, BUT
- We can afford to measure properties at only a finite number of places, OR
- The best we can do is to estimate, or predict, in spatial sense

This is the PRINCIPLE of Geostatistics

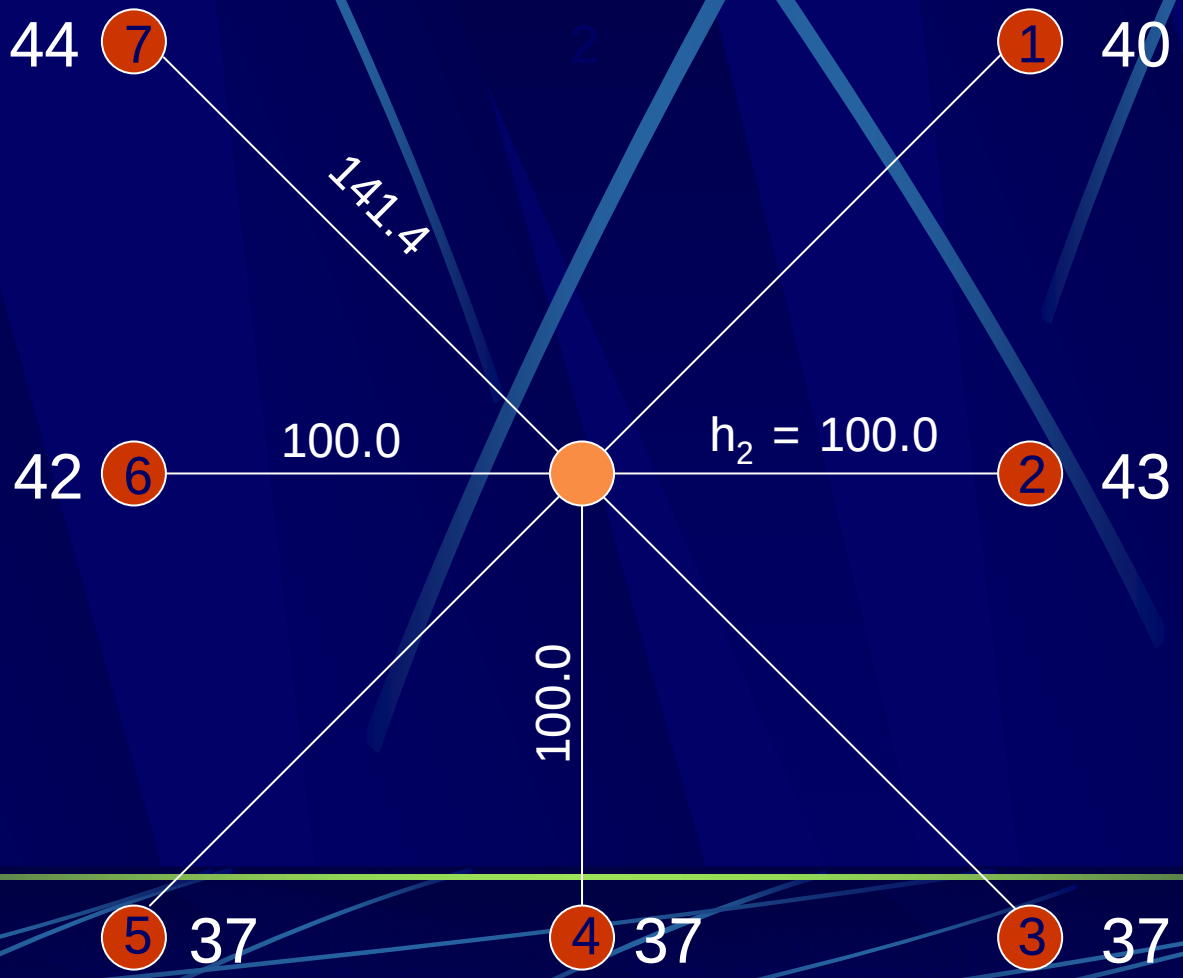


The estimation procedure in Geostatistics: KRIGING

Spatial prediction



Spatial relationships



Why Geostatistics?

- But, if there is an “ERROR”?
- If we underestimate and recommend less fertilizer when it is needed & the farmer loose yield & profit?
  - What are you going to say to the farmer?
- Geostatistics gives the answer!

  It can never provide complete information, of course, but given the data, it can enable you to estimate the probabilities that true values exceed specified threshold

Spatial data

- Spatial statistics refers to environment for soil, water, air
- Result of the actions & interactions of many different processes & factors
- Each process might itself operate on several scales simultaneously, in a non-linear way, and with local positive feedback.

Spatial data

- The spatial changes in the environment are obvious, when we see them on aerial photographs and satellites or are more subtle e.g. temperature or chemical
- Measurements are taken in a few cm, or meters, which we call point samples.
- Point samples are positively related “auto-correlated”. Places close to one another tend to have similar values, while further apart differ more. Environmentalists know that intuitively.

Geostatisticians can quantify the spatial autocorrelations and minimize the errors

Geo vs Classical Statistics

1. Classical Stats are based on random sampling, linear sum of data, all of whom carry the same weight

   If there is spatial correlations, then by stratifying we can estimate more precisely or sample more effectively. If the strata are of different sizes, then we can vary the weights attributable to their data in proportion

Geo vs Classical Stats

2. Geostatistics rely on spatial models, while classical don't.

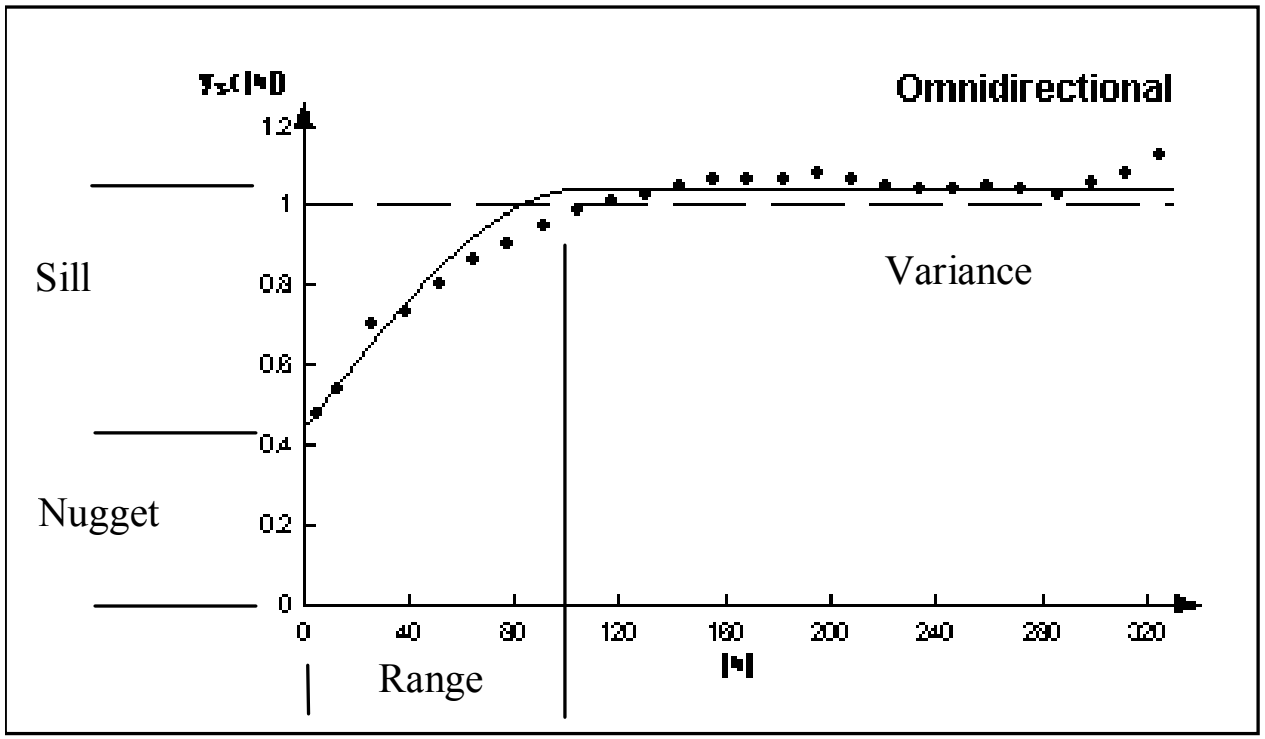
   Classical are based on sampling design, which implies unbiasedness & provides estimates of error if the choice of sampling design is suitable. It requires no assumptions about the nature of the variable itself.

   In Geostatistics, assumes that the variable is random & is the outcome of one or more random processes. The models of which predictions are based, are of these random processes.

Semi-variogram used for Kriging

Spatial relationship

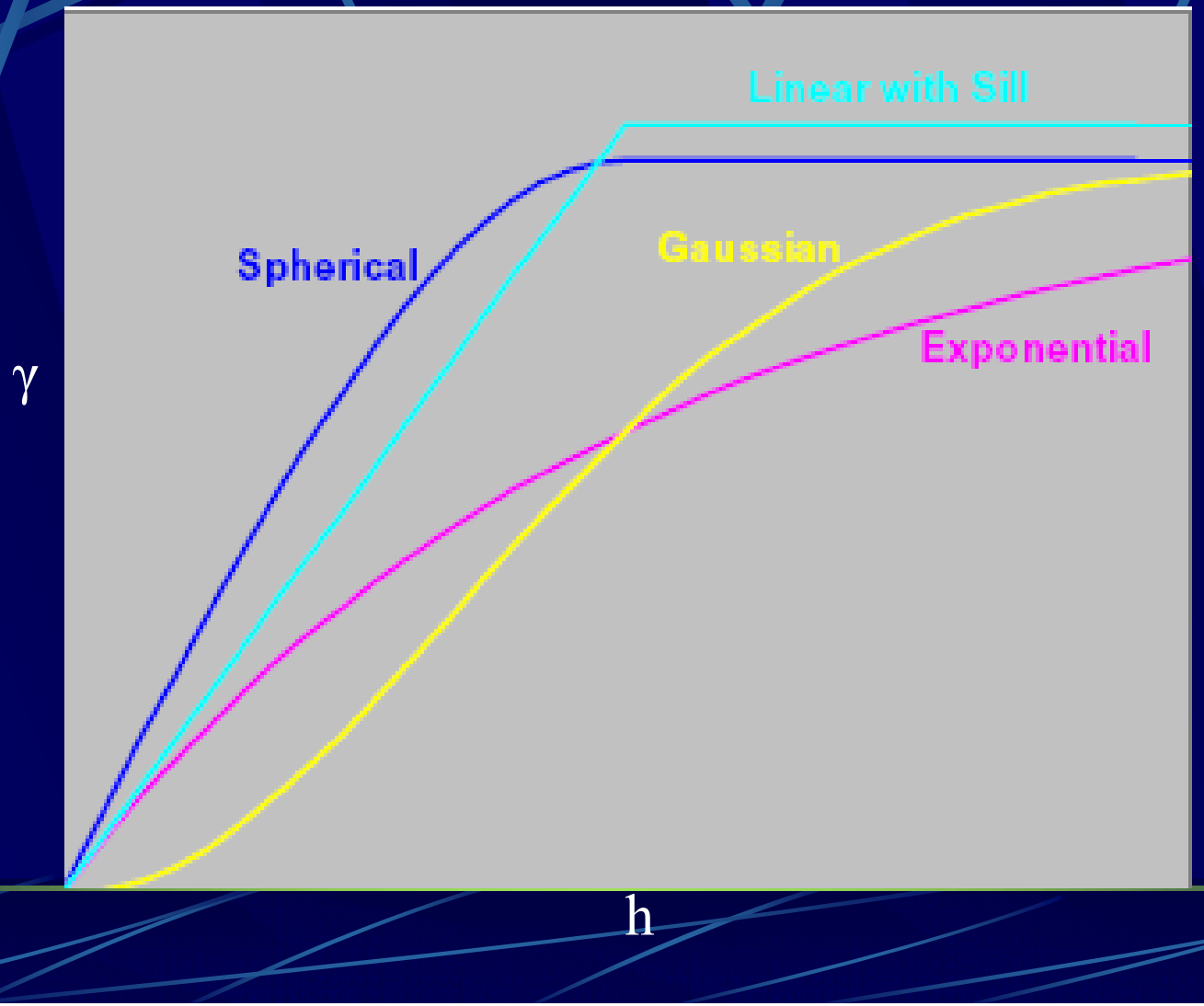
Micro error
or
Sampling error



Distance of influence

$$\hat{\gamma}(h) = \frac{1}{N(h)} \sum_{i=1}^{N(h)} \left[z(x_i) - z(x_i + h) \right]^2$$

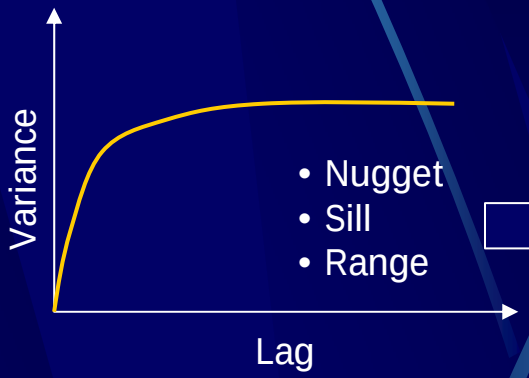
Spatial models



Simulation

Sample data

Variogram model



Convert parameters to a covariance model

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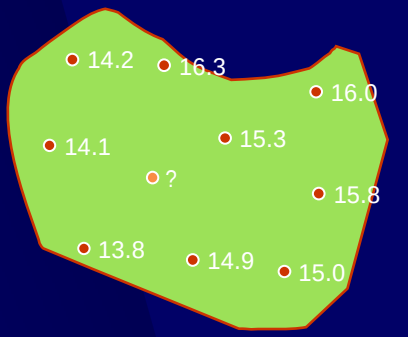
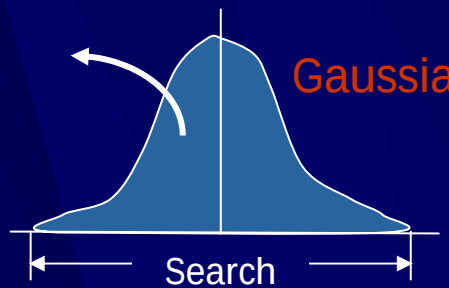


• Mean
• Lag

Using the lag, find covariance from covariance model

Local mean



Randomly select value from distribution

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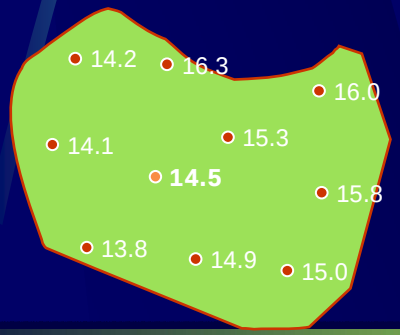

• Simulated value = 14.5

(Adapted from Chainey and Stuart, 1998)