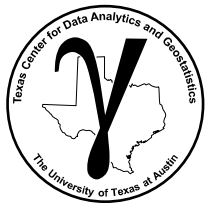

Open Source Spatial Data Analytics in Python with GeostatsPy II

Spatial Uncertainty Modeling with GeostatsPy

Lecture outline . . .

- **Spatial Simulation**
- **Interactive Demo with GeostatsPy**
- **Workflow with GeostatsPy**

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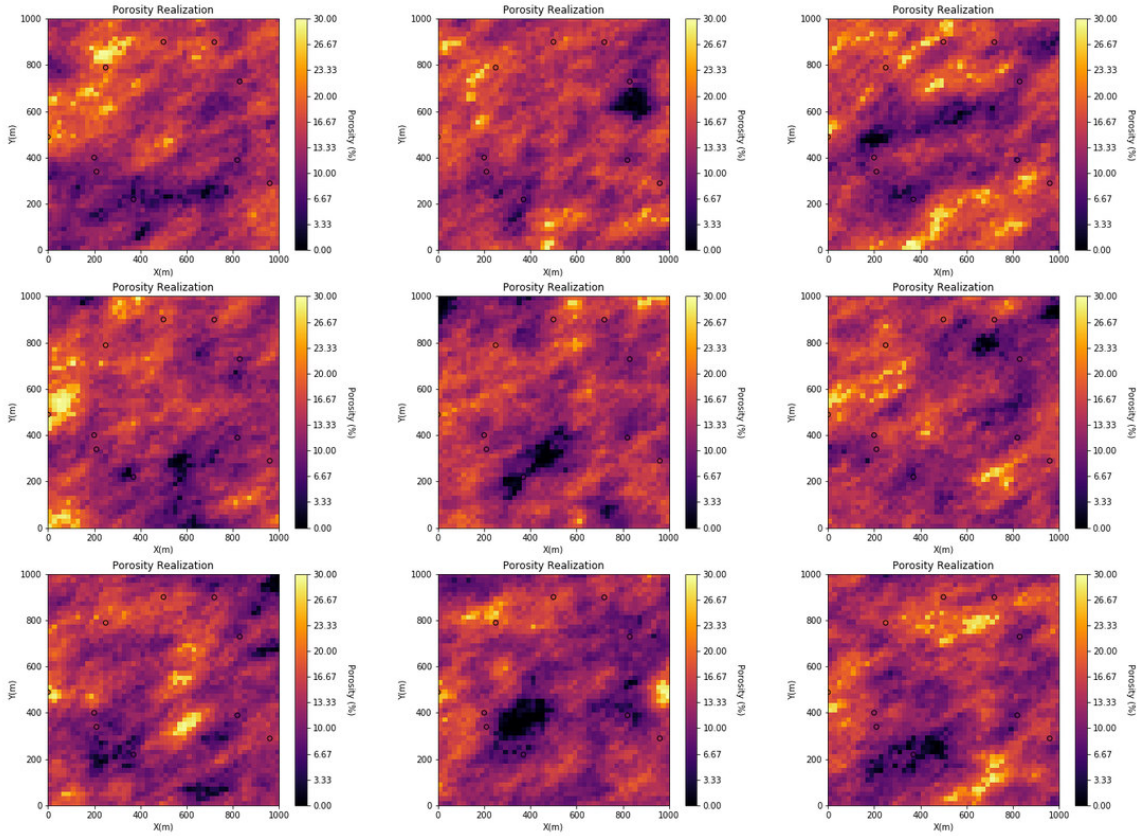
Motivation

Spatial simulation to calculate an ensemble realizations is the building block for modeling spatial, subsurface uncertainty.



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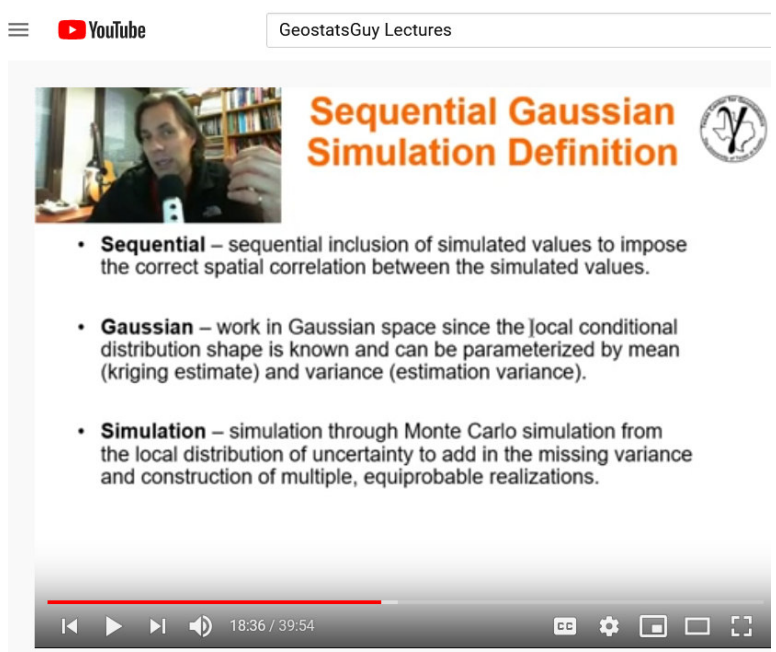
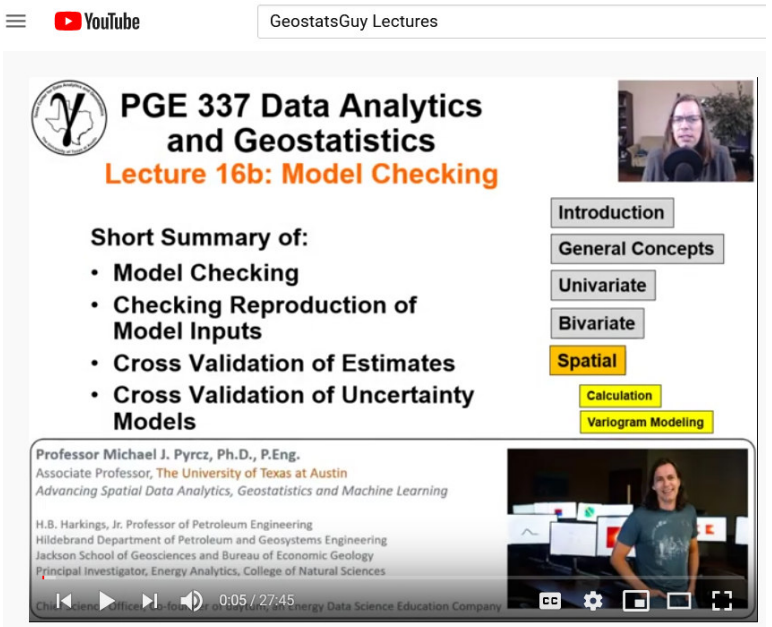
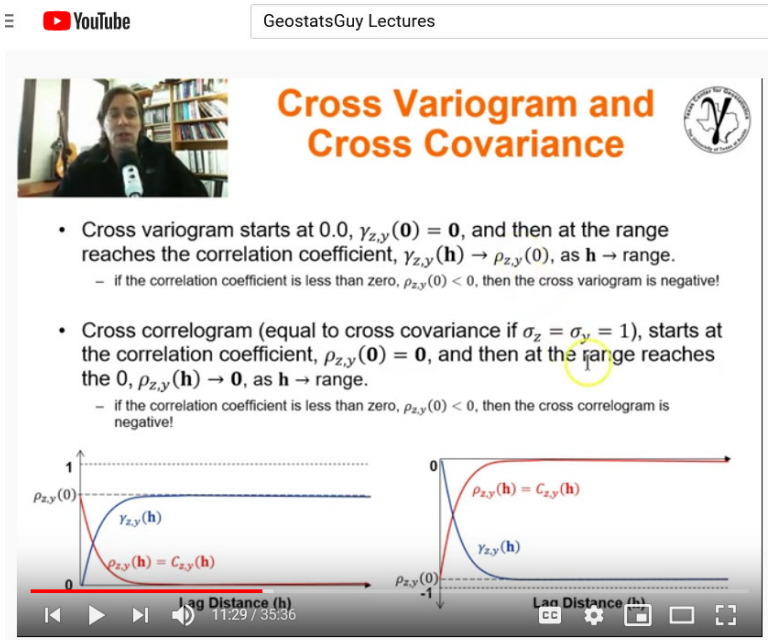
Recorded Lectures



13 Data Analytics: Simulation



16b Data Analytics: Model Checking



16 Data Analytics: Cosimulation

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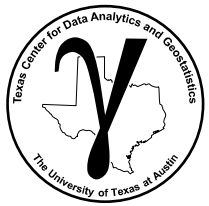

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Lecture outline . . .

- **Spatial Simulation**

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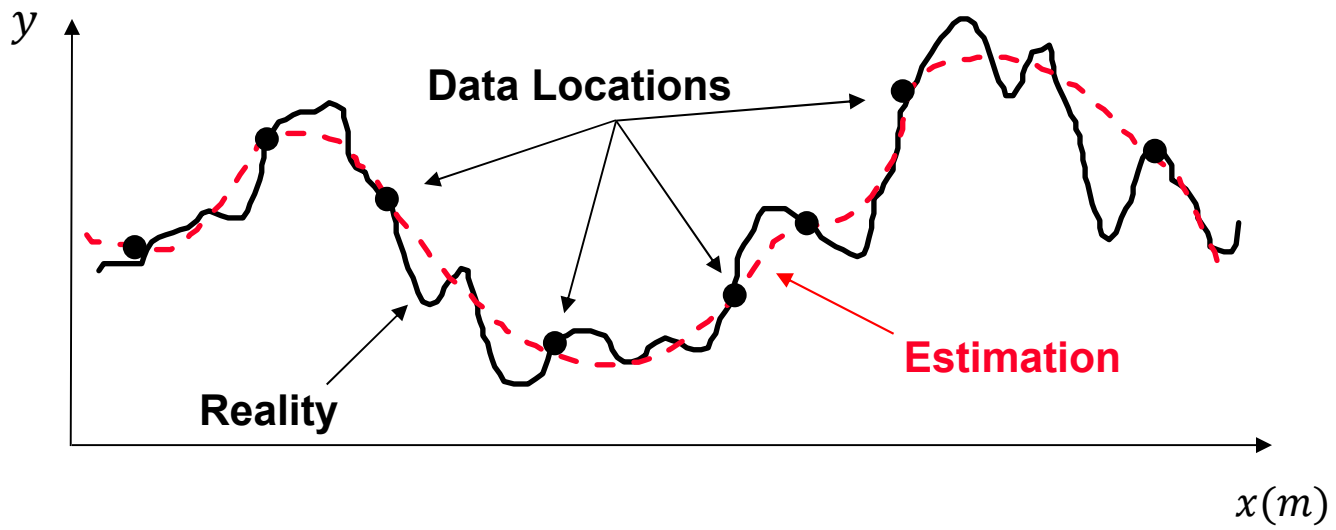
Motivation for Simulation

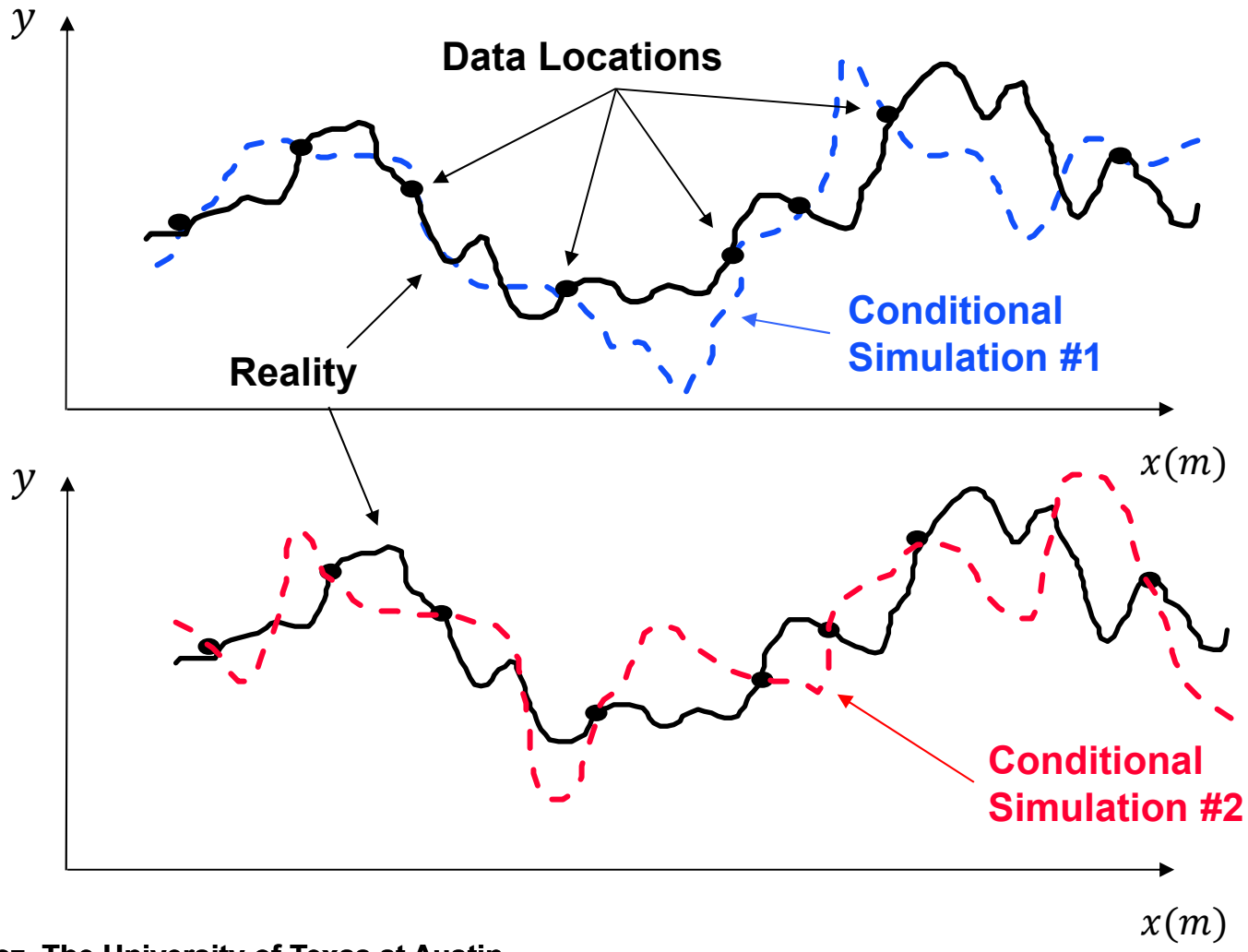
- Recall estimation: assign the most accurate value at each location.



- This would not be appropriate for flow simulation!
  - Permeability variance is too low, Dykstra-Parsons is underestimated

Motivation for Simulation

- What do we accomplish with simulation?



Motivation for Simulation

- What do we accomplish with simulation?

What does a simulated dill pickle potato chip taste like?

What does a simulated reservoir model look like?

What does a simulated reservoir flow like?

Estimation vs. Simulation

	Estimation	Simulation
Local Data Conditioning (Exactitude)	honors local data	honors local data
Local Accuracy (Best Value, Minimize Estimation Variance)	locally accurate, primary goal of estimation is 1 estimate!	sacrifices local accuracy, reproduces histogram
Spatial Continuity	too smooth, appropriate for visualizing trends	honors spatial variability, appropriate for flow simulation
Uncertainty Model	one model with local uncertainty, no assessment of global uncertainty	many models (realizations), assessment of global uncertainty

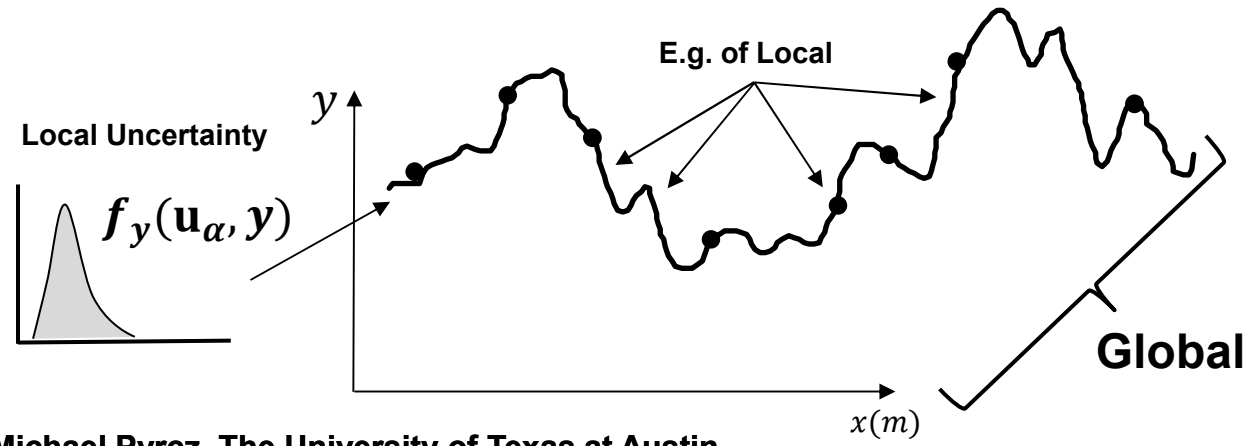
Global and Local Definition

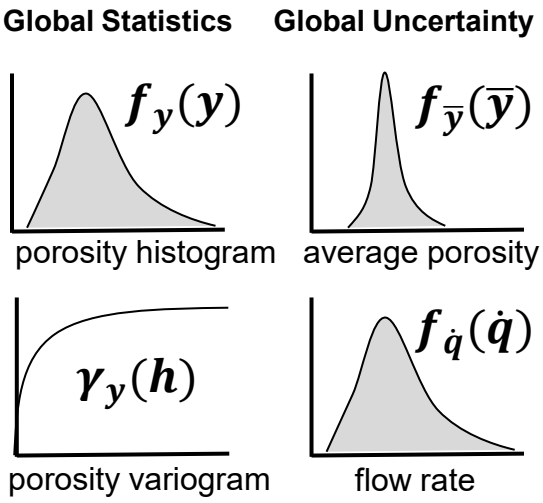
Global vs. Local Measures

- Local Measure – a feature value at a single location
- Global Measure – a statistical summary over the volume of interest

Global vs. Local Accuracy

- Global Accuracy – we honor a statistic calculated over the volume of interest (variogram / distribution)
- Local Accuracy – we have an estimate the minimized the estimation variance / most likely value





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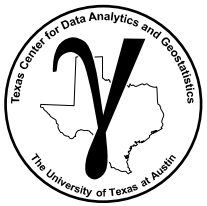
Sequential Gaussian Simulation Definition

- **Sequential** – sequential inclusion of simulated values to impose the correct spatial correlation between the simulated values.

- **Gaussian** – work in Gaussian space since the local conditional distribution shape is known and can be parameterized by mean (kriging estimate) and variance (estimation variance). Due to the central limit theorem the global distribution is correct (Gaussian), so we can back transform after simulation original data space.

- **Simulation** – simulation through Monte Carlo simulation from the local distribution of uncertainty to add in the missing variance and construction of multiple, equiprobable realizations.



Open Source Spatial Data Analytics in Python with GeostatsPy II

Spatial Uncertainty Modeling with GeostatsPy

Lecture outline . . .

- **Interactive Demo with GeostatsPy**

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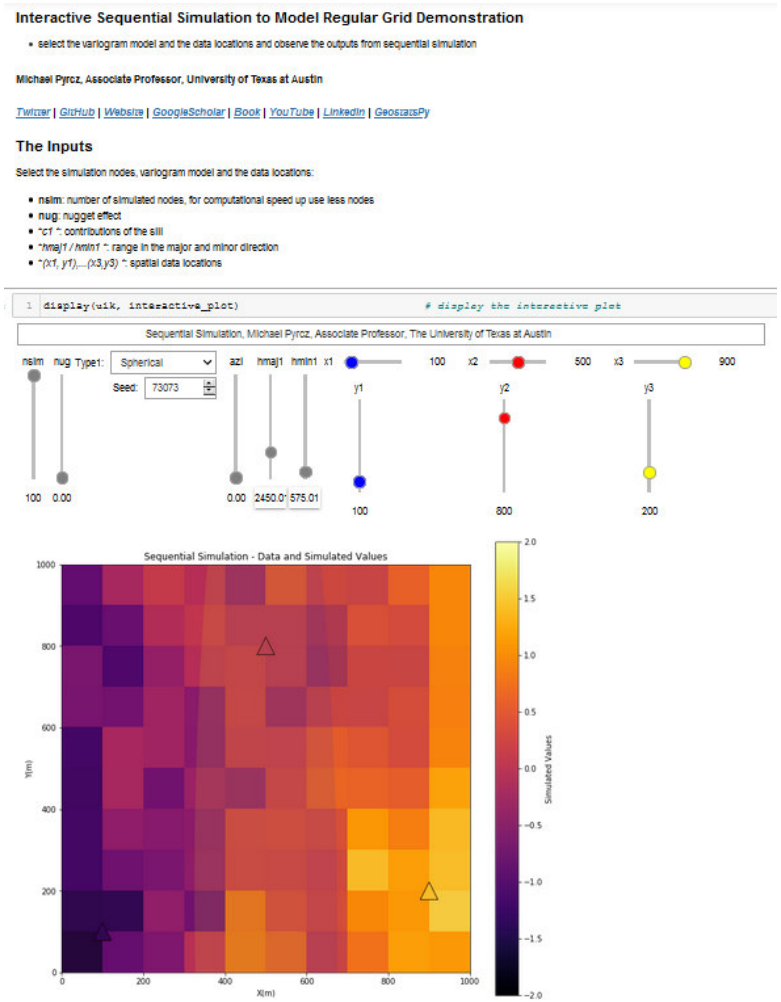
Interactive Spatial Simulation Demonstration with GeostatsPy

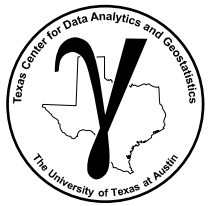
Let's calculate spatial simulations:

Some Hints:

- start with short range and few grid cells, nsim is small
- add anisotropy
- rotate the anisotropy
- increase the number of grid cells, WARNING: increase the number of grid cells



Interactive Python Jupyter simulation calculator (Interactive_Simulation.ipynb).



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Spatial Uncertainty Modeling with GeostatsPy

Lecture outline . . .

- **Workflow with GeostatsPy**

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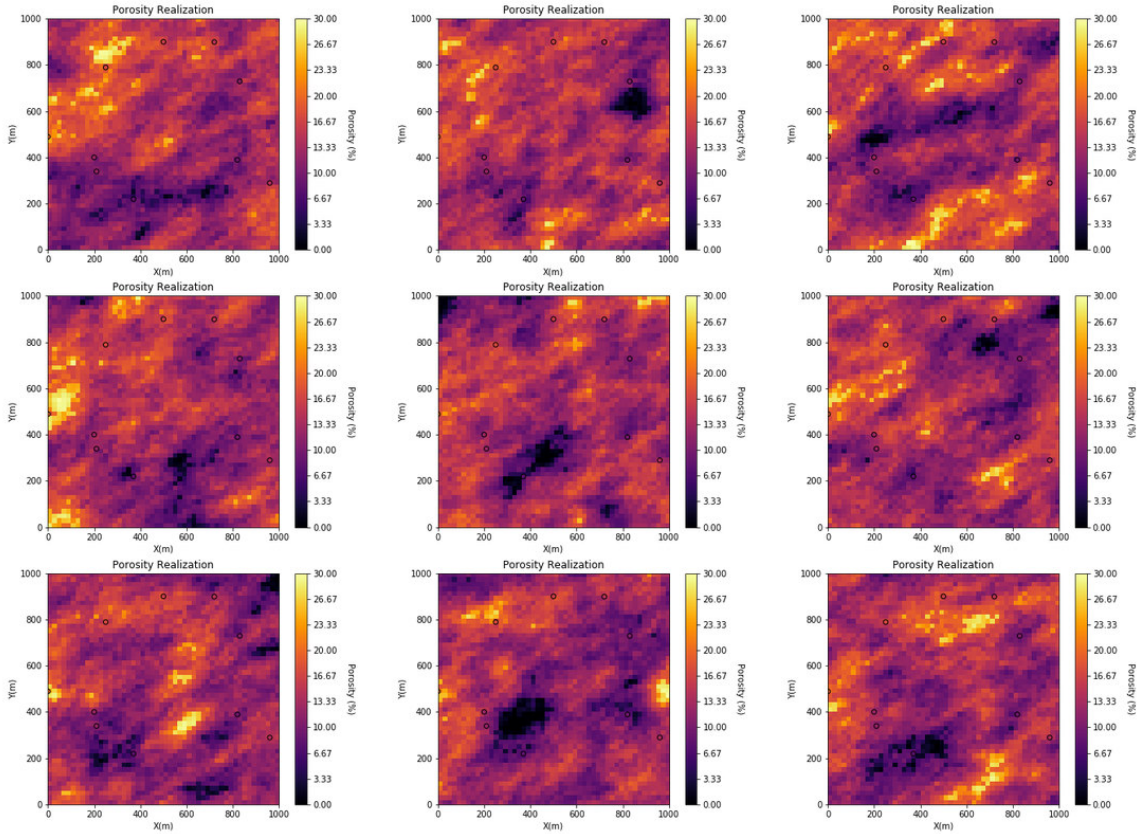
Spatial Simulation Workflow with GeostatsPy

Let's walkthrough a more thorough spatial simulation workflow:

- specify model parameters
- calculate and visualize realizations



Python Jupyter variogram calculation (GeostatsPy_simulation_wPostSim.ipynb).

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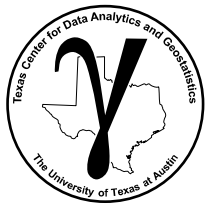

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Spatial Uncertainty Modeling with GeostatsPy

Lecture outline . . .

- **Spatial Simulation**
- **Interactive Demo with GeostatsPy**
- **Workflow with GeostatsPy**

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