N345: Next Generation Earth Modeling; Integrating Geostatistics, Geoscience, Engineering, and Data Science

Instructor(s): Jeffrey Yarus

Format and Duration

Classroom - 4 Days
Virtual - 8 Sessions

Summary

This class addresses the application and integration of data analytics to subsurface geomodeling for unconventional resources, including oil, gas, and geothermal. Deterministic and stochastic methods used to create static models and uncertainty assessment will be reviewed to establish a common knowledge baseline. This is followed by skill development in data analysis methods such as multivariate statistics and machine learning. Topics include kriging, conditional simulation, principal components, cluster analysis, regression, recursive portioning, neural networks, and other practical methods. The class focus is to go beyond traditional static modeling through the integration of geostatistics and data science to produce reliable models for reservoir and completion engineers.Participants will learn how to create mappable quality indices to optimize successful well placement and formation stimulation strategies. This course pulls together geoscience, engineering, and data science to build synergistic teams, optimize successful drilling programs, reduce uncertainty, and drive down cost per barrel of oil equivalent.

Business Impact: In order to increase production and drive down the cost per barrel of oil equivalent (BOE), this course will enable participants to build reliable earth models of unconventional reservoirs using analytics for data insight and geostatistics for assessing uncertainty.

Learning Outcomes

Participants will learn to:

1. How to apply data analytics and machine learning for data QC.
2. Assess critical relationships between petrophysical, geochemical, geothermal, and mechanical data using multivariate analysis.
3. Evaluate workflows for geocellular modeling of unconventional reservoirs.
4. Tell the difference between interpolation, simulation, imputation, and prediction.
5. How to properly integrate data science and geostatistical static modeling.
6. Develop spatial models using quality indices from integrated geomechanical, geochemical, geothermal, and petrophysical properties.
7. Assess the uncertainty of geomodels of unconventional reservoirs.
8. Post process static geomodels al reservoirs for dynamic flow simulation.
9. Provide valuable model information to well completion and stimulation engineers.
10. Understand the value of C.I.P. languages (e.g. R and Python) in geomodeling.

Training Method

This is a classroom or virtual classroom course comprising a mixture of lectures, discussion, case studies, and practical exercises.

Who Should Attend

This course has been designed for mid to senior level geoscientists (specifically geomodelers), and data scientists who are working with geomodelers. Familiarity with geostatistics and practical geocellular modeling is assumed. Managers and others who have previous experience in building geomodels and wish to develop a better understanding of how to apply geomodeling and data science techniques to unconventional reservoirs could also benefit from this course.

Course Content

This course will address questions about using geocellular models for unconventional reservoirs such as:

- The difference between Conventional and Unconventional Reservoirs
- Are common modeling tools such as kriging and conditional simulation appropriate?
- Can Machine Learning be used to create geomodels?
- I'm not a developer, how can I use R and Python to help me build models?
- Is it necessary to model "shale facies" or "geothermal facies" and if so, how do we define them?
- What if my data are sparse and there is no seismic?
- How do I deal with missing values when I am building a geomodel?
- Geocellular grids or meshes; what dimensions, layering types, and granularity are required?
- How to integrate natural fractures - key considerations
- What is the role of micro-seismic data and how can it be used in a geocellular model?
- How can geocellular models be used to improve geosteering and real-time drilling?
- What are the limitations to geocellular grids and stratigraphic layering styles?
- How do geocellular grids of unconventional reservoirs respond in dynamic simulators?
- How can Completion Engineers benefit from geomodels?

The specific topics to be addressed are:

Topic 1

- Introduction
  - Role of 3D geocellular models for unconventional resources
  - Considerations for constructing geocellular grids or meshes for unconventional resources
- Exploratory data analytics for unconventional resources
  - Types of variables
  - Univariate and bivariate statistics for data quality assessment
- Review of principles of spatial modeling

Topic 2

- Review of Kriging and Conditional Simulation
- Review of geomodeling steps and the importance of frameworks and stratigraphy

- Workflows for shale plays and how they differ from conventional plays
- Understanding multivariate analysis techniques and machine learning
- Applications in R and Python
- Post processing - Building probability maps to identify “Sweet Spots” and improve well placement

Topic 3 - Modeling Workshop

This workshop uses simple exercises on a variety of multivariate techniques in order for participants to better understand the underlying principles. Some of the examples are from unconventional shale reservoirs and some are not. Those that are not, are classic data sets used in texts, classrooms, seminars, and online short courses and are not necessarily geologic in nature, but clearly illustrate the methods.

Practical computer-based exercises demonstrating Multivariate Data Analytics that form the basis of the workshop include the following:

- A brief introduction to R and R Studio
- Exploratory Data Analytics
- Spatial Modeling, Kriging and Conditional Simulation
- Analytics for data reduction and data redundancy
    - Principal Component Analysis and Factor Analysis
- Classification Systems and Regression Systems
    - Discriminant Analysis
    - CART

The actual number of exercises and methods will vary depending on available time.