N440: Shale Analytics: Asset Management with Data-Driven Analytics and Modeling

Instructor(s): Shahab Mohaghegh

2 Days	Competence Level: Skilled
Classroom Course	

Summary

This course covers the fundamentals of data-driven analytics and predictive modeling. It explains the technology and provides details on how it can be used to analyze and model the complex behavior of production from shale assets that are completed with massive, multi-stage, multi-cluster hydraulic fracs. Using field measurements as building blocks, predictive models can be trained, calibrated and validated to use to optimize frac design.

Learning Outcomes

Participants will learn to:

1. Determine the benefits of applying data-driven analytic techniques.
2. Identify, quantify and prepare suitable data sets for data mining.
3. Develop, train, calibrate and validate predictive models.
4. Analyze the results of a predictive model and assess the impact of various parameters.
5. Incorporate modeling results into future plans, such as hydraulic fracture optimization.

Duration and Training Method

This is a two-day classroom course comprised of lectures with case studies and discussion.

Who Should Attend

The course is designed for reservoir engineers, completion engineers and geoscientists involved in designing hydraulic fracs as well as for anyone seeking to understand how data analytics may be used to optimize well completions.

Prerequisites and Linking Courses

A basic familiarity with resource plays and multi-stage hydraulic fracture completions, such as presented in N313 (Evaluating Resource Plays), is recommended but not required. No previous knowledge of data analytics is assumed.

The course links to two other courses on data analytics (N436 and N441) as well as engineering courses on unconventional reservoirs (N973, N989), shale completions (N944) and hydraulic fracturing (N959).

Course Content

The main idea behind data-driven solutions is that “data” can provide the foundation of new solutions. Using “data” as the main building block of models is the new paradigm in science and technology. Data-driven analytics and predictive modeling incorporate pattern recognition capabilities of artificial intelligence and data mining and use machine learning to solve complex and non-linear engineering problems.

N440: Shale Analytics: Asset Management with Data-Driven Analytics and Modeling

Instructor(s): Shahab Mohaghegh

2 Days	Competence Level: Skilled
Classroom Course	

These advanced techniques are integral to many new technologies, such as smart automatic transmission in many cars, detecting explosives in the airport security systems, providing smooth rides in subway systems and preventing fraud in use of credit cards. They are extensively used in the financial market to predict chaotic stock market behavior, or optimize financial portfolios.

Application of data-driven analytics and predictive modeling in the oil and gas industry is fairly new. Tools have been developed to model reservoir behavior, optimize hydraulic fracture designs, characterize oil and gas reservoirs, optimize drilling operations, interpret well logs, generate synthetic magnetic resonance logs, optimize infill placement, select candidate wells for treatments and predict post-fracture deliverability.

Hard Data vs. Soft Data

In the context of oil and gas production from shale assets, "Hard Data" refers to field data that can readily be measured during operations. Examples in hydraulic fracturing are fluid type and amount, proppant type and amount, injection, breakdown and closure pressure and the corresponding injection rates.

"Soft Data" refers to variables that are interpreted, estimated or guessed, such as hydraulic fracture half length, height, width and conductivity. Even when software modeling is used to estimate these parameters, the gross limiting and simplifying assumptions that are made, such as well-behaved penny-like double wing fractures, renders the utilization of "Soft Data" in design and optimization of frac jobs irrelevant.

Another variable that is commonly used in the modeling of hydraulic fractures in shale is Stimulated Reservoir Volume (SRV). SRV is also "Soft Data" since its value cannot be directly measured. SRV is mainly used as a set of tweaking parameters to assist reservoir modelers in the history matching process. The utility of micro-seismic events to estimate SRV is at best inconclusive. While it has been shown that micro-seismic may provide some valuable information regarding the effectiveness of multi-stage hydraulic fractures in some shale assets, lack of correlation between recorded and interpreted micro-seismic data and the results of production logs has been documented on other shale assets.

This course will demonstrate through actual case studies (real field data from hundreds of shale wells) how to build data-driven predictive model and how to use them in order to perform analysis.

Part One: Overview and Theoretical Background of Data-Driven Analytics

- Introduction
  - Data-driven analytics & predictive modeling (a paradigm shift)
  - Artificial intelligence and data mining (AI&DM)
- Artificial Neural Networks
  - Biological background
  - Learning algorithms
  - Training, testing and verification data sets
  - Best neural network practices
- Evolutionary Computing

- General overview
- Biological background
- Genetic algorithms

- Fuzzy Logic
  - General overview
  - Fuzzy set theory
  - Fuzzy membership function

Part Two: Analysis, Modeling and Optimization of Hydraulic Fracturing in Shale Assets; Cases Studies

- Pre-Modeling Data Mining
  - Get to know your data
  - Conventional statistics
  - Cluster analysis
  - Fuzzy pattern recognition—Key Performance Indicators (KPI)
  - Well quality analysis—step analysis
- Predictive Modeling
  - Data set partitioning
  - Model topology
  - Training and calibration of the predictive model
  - Validation of the predictive modelPost-Modeling Analysis
  - Look-back analysis (how good are the existing hydraulic fractures)
  - Impact of reservoir characteristics on the well productivity
  - Impact of design parameters (completion & hydraulic fractures) on well productivity
  - Evaluation of service company’s performance
  - Placing the next pad (horizontal wells)
  - Design of new hydraulic fractures