

**A Short Course for the  
Oil & Gas  
Industry Professionals**

# OILFIELD DATA MINING

*There is often valuable information (gems) hidden in the volumes of data that is routinely collected in the oilfield.*

*Find out how these valuable gems can be harvested from data such as production/injection history, completion, well log, well test, seismic, etc., using state of the art data mining technologies adapted specifically to the exploration and production industry.*

**Course Description:**

This short course covers the fundamentals of Artificial Intelligence and Data Mining (AI&DM) and provides the theoretical background for its most used components such as artificial neural networks, genetic optimization and fuzzy logic.

The short course will provide insight on the type of problems that can be solved using AI&DM techniques. The larger part of the short course is devoted to field applications of these tools in production optimization and recovery enhancement of green (New) and brown (Mature) fields.



**INTELLIGENT SOLUTIONS, INC.**

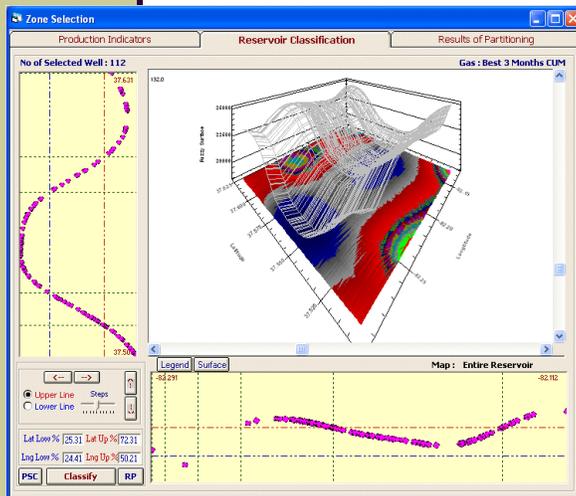




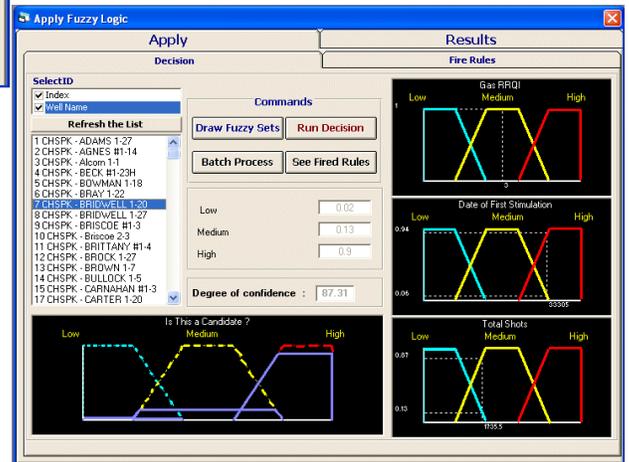
Artificial Intelligence is a collection of several analytical tools that attempts to mimic life. These tools (include but are not limited to, artificial neural networks, genetic optimization and fuzzy logic) are being used in many commercial products. They are an integrated part of many new cars such as Honda and Mitsubishi. They are used to detect explosive devices in the airport security systems, provide smooth rides in subway systems and prevent fraud in use of credit cards. They are extensively used in the financial market to predict chaotic stock market behavior, or optimize financial portfolios. Their application in the oil and gas industry is fairly new. A handful of researchers and practitioners have concentrated their efforts on providing intelligent tools for the petroleum industry. AI&DM tools have been used 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.

**Experience:**

This short course has been taught successfully, numerous times as in-house training to national oil companies and to audiences from many major oil companies.



Fuzzy pattern recognition applied to production data analysis in order to identify the remaining reserves in mature fields, application: Mid Continent U.S.



Fuzzy decision support system for restimulation candidate selection, application: Rockies, Green River Basin and Austin Chalk.



## Course Outline:

### Part One: Artificial Intelligence & Data Mining (AI&DM); Theoretical Background.

#### Introduction

State-of-the-art in Artificial Intelligence and Data Mining (AI&DM)

Fitness Function  
Genetic Operation  
Convergence

#### Artificial Neural Networks

General Overview  
Biological Background  
Learning algorithms  
Transfer Functions  
Training, Testing and Verification data sets  
Dos and Don'ts of Neural Network Practices

#### Fuzzy Logic

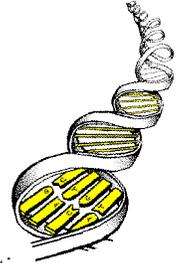
General Overview  
Fuzzy Set Theory  
Fuzzy Membership Function  
Fuzzy Decision Support Systems  
Fuzzy Rules  
Fuzzy Inference Engines  
Defuzzifications

#### Evolutionary Computing

General Overview  
Biological Background  
Genetic Algorithms

#### Hybrid Intelligent Systems

Integrating Neural Networks, Genetic Algorithms and Fuzzy Logic



### Part Two: AI&DM Upstream Applications & Hands On Exercises

#### SURROGATE RESERVOIR MODELS

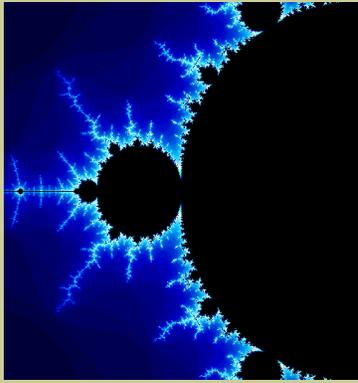
Surrogate Reservoir Models (SRM) are accurate replicas of full field simulation models that run in real-time. Using latest AI&DM tools, SRMs are built to mimic the behavior of complex and dynamic simulation models that are built in ECLIPSE™, CMG™, VIP™, ... and produce accurate results in fraction of a second. SRMs are used in the context of smart fields where real-time reservoir analysis and management is an absolute necessity. Furthermore, SRM are used in the context of reservoir analysis and management where full exploration of solutions space is required for identifying optimum (or near optimum) field development strategies.

Surrogate Reservoir Models are used for quantification of uncertainties associated with the geologic models used in the reservoir simulation. Given their fast (real-time) response to static and dynamic modifications of the parameters in the field, SRMs can provide probability distribution functions representing potential well responses to uncertain reservoir characteristics. By clearly identifying the Key Performance Indicators (KPI) SRM can serve as an effective computer assisted history matching tool, significantly reducing the time required for history matching.

#### SURFACE FACILITY SIMULATION & MODELING

Building surface facility models based on pressure, temperature and rate at key locations in the facility without the need for detail modeling of every pipe and small components present in the facility. Focusing on the major separation facilities and compression stations fully dynamic models are developed that can be used for:

- De-bottlenecking the surface facility.
- Optimize production from the subsurface by identifying the best settings at the surface facility.
- Calibration and validation of conventional surface facility modeling tools.



## Who Should Attend?

This course is designed for completion, production and reservoir engineers of operating companies as well as service company personnel involved with planning, completion and operating wells.

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## Part Two: AI&DM Upstream Applications & Hands On Exercises (Continue)

### TOP-DOWN, INTELLIGENT RESERVOIR MODELING

Conventional reservoir simulation is a bottom-up approach that starts with modeling the geology of the reservoir and is followed by adding petrophysical and geophysical information in order to reach at a relatively complete geological perception of the reservoir.

Top-Down, intelligent reservoir modeling approaches the reservoir simulation from different perspective by attempting to build a realization of the reservoir starting with well production behavior (history). The production history is augmented by core, log, well test and seismic data in order to increase the accuracy of the Top-Down modeling technique. This innovative and novel approach to reservoir simulation and modeling can substitute (at a fraction of the cost) conventional reservoir simulation and modeling in cases where performing conventional modeling is cost (and man-power) prohibitive. In cases where a conventional simulation and model of a reservoir (field) already exists, Top-Down modeling is considered as a complement to the conventional technique. It provides an independent look at the data coming from the reservoir/wells in order to identify optimum development strategy and recovery enhancement.

### RESERVOIR CHARACTERIZATION

Reservoir Characterization is essential to populate the geological and geo-cellular models that form the backbone of all reservoir simulation models. Building intelligent correlation models and workflows for:

- Rock-Typing Using SCAL data
- Correlating Well Logs with Core Analysis
- Correlating Well Logs to Seismic Attributes
- Generating Synthetic Well Logs from Existing Logs

### INTELLIGENT CANDIDATE SELECTION

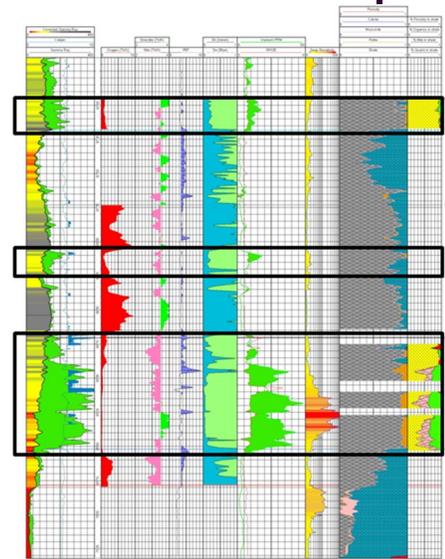
Model Building & Analysis  
Constrained Genetic Optimization  
Fuzzy Decision Support System & Ranking the Selected Candidates

### INTELLIGENT BEST PRACTICES ANALYSIS

Removing human bias from analysis to identify Data-Directed Best Practices. Descriptive Best Practices Analysis using the Existing Practices.

Predictive Best Practices Analysis,

- Full Field Analysis, Groups of Wells Analysis, Individual Well Analysis.
- Single Parameter Analysis, Combinatorial Analysis.





## ABOUT THE INSTRUCTOR

**Dr. Shahab D. Mohaghegh** is professor of Petroleum & Natural Gas Engineering at West Virginia University and founder and president of Intelligent Solutions, Inc., the leading company in providing the oil and gas industry with solutions based on artificial intelligence & data mining (AI & DM).

With more than 20 years of experience, Dr. Mohaghegh has pioneered the application of AI&DM in the exploration and production industry. He has successfully used Artificial Intelligence and Data Mining in applications related to the smart fields, formation evaluation, reservoir characterization, reservoir simulation, and reservoir management as well as drilling, completion and surface facilities. In 2011 Shahab D. Mohaghegh was the recipient of U.S. Secretary of Energy's Achievement Award for his technical contribution to DOE's efforts in addressing the Deepwater Horizon Oil Spill. He has been appointed by the U.S. Secretary of Energy, in two different administrations, to serve on the Unconventional Resources Technical Advisory Committee as a subject matter expert, a position he currently holds. This committee advises the Secretary of Energy directly and specifically on the Unconventional Resources research programs.

He has published more than 150 technical articles and has been granted and completed more than 50 research and development projects. He is the associate editor of various technical journals such as SPE Reservoir Evaluation and Engineering Journal, Journal of Natural Gas Science and Engineering, International Journal of Oil, Gas and Coal Technology, and technical editor and reviewer of several petroleum related journals such as Journal of Petroleum Science and Engineering, Computers & Geosciences, Geophysics, Applied Energy, and Energy & Fuels. His technical articles on the application of Artificial Intelligence & Data Mining (AI&DM) in the oil and gas industry and their recent developments have appeared in the *Distinguished Author Series of SPE's Journal of Petroleum Technology (JPT)* during September, October and November issues of 2000 as well as the April issue of 2005. As a *SPE Distinguished Lecturer* for 2007-2008 he was invited to 16 countries and delivered 26 lectures .

He is the program chair of SPE's newest technical section, "Petroleum Data-Driven Analytics—PD<sup>2</sup>A". He is the chair of SPE's Global Training standing Committee. He co-chaired the first SPE forum on Artificial Intelligence in 2009 and has also served as discussion leader and technical presenter in various SPE forums and has served as invited speaker and steering committee member in several SPE Applied Technical Workshops.

Shahab D. Mohaghegh holds B.S. and M.S. degrees in Natural Gas Engineering from Texas A&I University and Ph.D. in Petroleum & Natural Gas Engineering from The Pennsylvania State University.

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