

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

# RESERVOIR CHARACTERIZATION

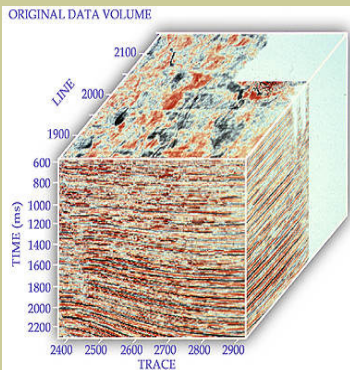
## Using State-of-the-Art in Artificial Intelligence & Data Mining (AI&DM)

**INSTRUCTOR:**

Shahab D. Mohaghegh, Ph. D.  
Intelligent Solution, Inc.  
Professor, Petroleum & Natural  
Gas Engineering  
West Virginia University  
Morgantown, West Virginia

*A Comprehensive Course Designed for Petroleum Professionals focusing on Hydrocarbon Reservoir Characterization using the latest techniques and algorithms in **Artificial Intelligence & Data Mining (AI&DM)**, offering an alternative approach to address complex static and dynamic problems in the E&P industry.*

*With Applications, examples and hands-on exercises in Surrogate Reservoir Models to adjust and quantify uncertainties associated with the geological models, Synthetic Conventional Well Logs, Synthetic MRI Logs, Core-Log correlations, Log-VSP correlations, VSP-3D Seismic Correlation, Rock Typing using dynamic SCAL data such as MICP & Relative Permeability data, ...*

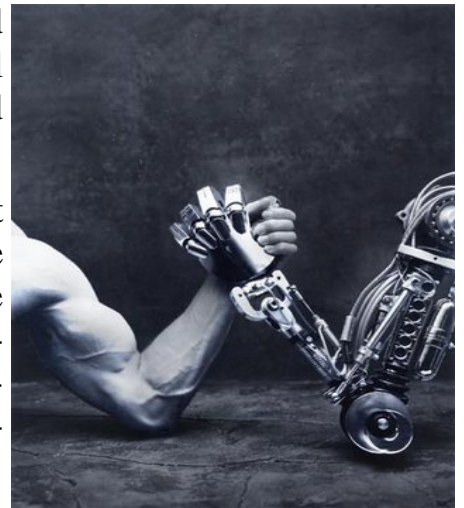


**Course Description:**

This short course will cover the fundamentals of Artificial Intelligence and Data Mining (AI&DM) and will provide the theo-

retical 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 analytical techniques and tools in Reservoir Characterization.



**INTELLIGENT SOLUTIONS, INC.**





### 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.

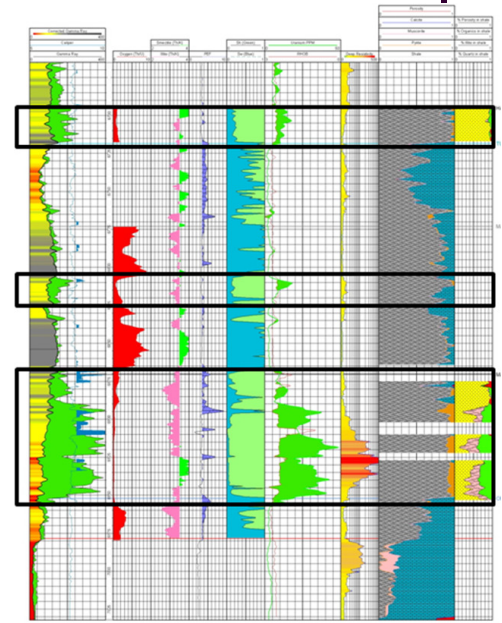
Artificial Intelligence is a collection of several analytical tools that attempts to mimic life. These tools (include but are not limited to, artificial neural networks, genetic optimization and fuzzy logic) are being used in many commercial products. They are an integrated part of many new cars such as Honda and Mitsubishi. They are used to 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. Artificial intelligence and data mining tools have been used to Optimize Hydraulic Fracture Designs, Characterize oil and gas reservoirs, Optimize drilling operations, Interpret well logs, Generate synthetic magnetic resonance logs, Optimize new well placement, Select candidate wells for treatments and Predict post fracture deliverability.

### *As a participants in the short course you are encouraged to bring:*

- Your laptop computer for hands-on practice of algorithms.
- Your own data. If you have data that you are currently working with, this is a great opportunity to bring your data to the class and practice with these algorithms on your own data instead of using data that is furnished as part of the course material. Please contact ISI for data format.

### *Every participant in the short course will receive:*

- A Course Manual including all the slides used during the presentation of the short course.
- An electronic copy of all the slides.
- Electronic copy of technical material as support for the topics covered in the short course. This technical material takes you beyond the summarized slides and help you review in detail all you have learned in the short course.
- A copy (full features with limited time license) of IDEA™ suite of software applications, the most comprehensive AI&DM tool for the Oil & Gas industry. During the short course you will learn how to work with IDEA™ suite of software applications.





Please do not forget to bring your laptop computer with you to the course. This short course includes several hands on exercises.

## 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

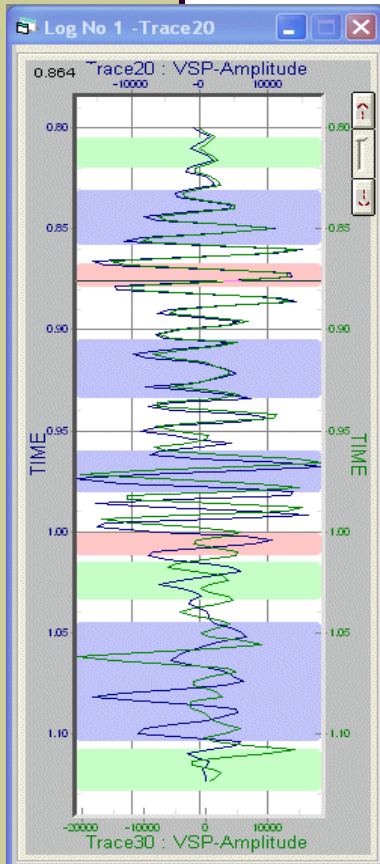
#### Evolutionary Computing

General Overview  
Biological Background  
Genetic Algorithms

#### Hybrid Intelligent Systems



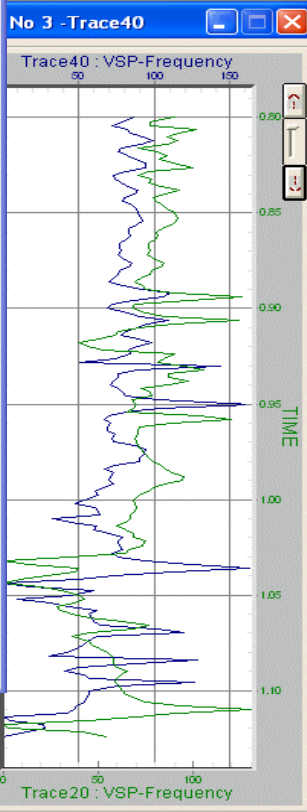
### Part Two: AI&DM for Reservoir Characterization & Hands On Exercises



#### SURROGATE RESERVOIR MODELS

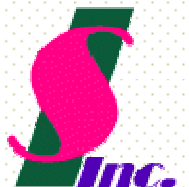
Surrogate Reservoir Models (SRM) are accurate replicas of full field simulation models that run in real-time. Using latest AI&DM tools, SRMs are built to mimic the behavior of complex and dynamic simulation models that are built using ECLIPSE™, CMG™, VIP™, ... and produce accurate results in fraction 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.

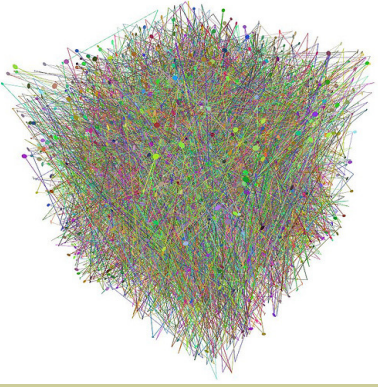
Surrogate Reservoir Models are used for quantification of uncertainties associated with the geologic models used in the reservoir simulation. Given their fast (real-time) response to static and dynamic modifications of the parameters in the field, SRMs can provide probability distribution functions representing 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.



INTELLI-

GENT





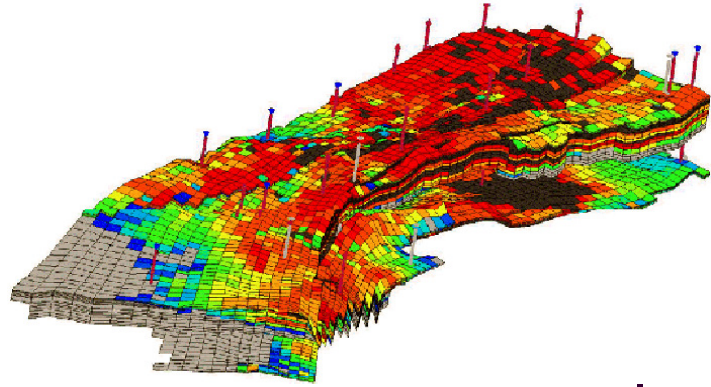
## Part Two: AI&DM for Reservoir Characterization & Hands On Exercises (Continue)

### COMPREHENSIVE WORKFLOW FOR POPULATING GEO-CELLULAR (GEOLOGICAL) MODELS

Development of geo-cellular models is an integral and crucial part of any reservoir simulation and modeling project. While almost all the wells are logged, the number of wells that have been cored are limited. Furthermore, while routine measurements such as porosity and permeability measurements are performed on all cores, Special Core Analysis (SCAL) are performed only on a smaller number of core samples.

Three dimensional seismic measurements are performed on many prolific reservoir. 3D seismic generates a wealth of information that represents the only direct measurements of rock properties between wells.

Populating the high resolution geo-cellular (geological) model requires accurate correlation of seismic measurements to well logs and well logs, to core measurements. In this



short course the most comprehensive work flow for populating the geo-cellular models are presented and covered in detail. The work flow includes the following components:

- **Rock-Typing using SCAL data**

This process includes using the dynamic rock-fluid characteristics such as Mercury Injection Capillary Pressure and Relative Permeability data in order to develop a series rock types or a series of flow units to assist reservoir engineers in modeling fluid flow in the reservoir.

- **Propagation into Cored Wells**

This process includes building intelligent models to correlate geology, depth, effective porosity and permeability to rock types and flow units.

- **Propagation into Logged Wells**

During this process intelligent models are built to correlate well logs to effective porosity and permeability.

- **Propagation into full field**

Building intelligent models to correlated VSP (Vertical Seismic Profiles) and 3D Seismic attributes to well logs such as gamma ray, density and SP is the final step in the process.



### Who Should Attend?

This course is designed for geologists, petro-physicists, geophysicists, and reservoir engineers that deal with Reservoir Characterization and reservoir simulation and modeling. Geo-scientists from operating companies as well as service company personnel involved with reservoir characterization and modeling are encouraged to attend.



### 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 17 years of experience, Dr. Mohaghegh has been a pioneer in the application of "AI&DM" in petroleum industry, applying hybrid forms of neural networks, genetic optimization and fuzzy logic to smart wells, smart completions, and smart fields as well as to drilling, completion, well stimulation, surface facility optimization, formation evaluation, seismic inversion, reservoir characterization, reservoir simulation and reservoir management.

He has published more than 100 technical papers during his career relating to application of AI&DM in the E&P and has been a technical editor/reviewer for various SPE journals as well as other petroleum-related publications such as Oil, Gas and Coal Technology, Journal of Petroleum Science and Engineering, Computers & Geosciences, Geophysics, and Energy & Fuels. His technical articles on the application of "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 during September, October and November of 2000 as well as the April 2005. He is a SPE Distinguished Lecturer for 2007-2008. He is an associate editor of SPE Reservoir Evaluation and Engineering Journal 97-99, & 2007- present. He has also served as discussion leader and technical presenter in SPE forums and has served as a steering committee member in SPE Applied Technical Workshops. He has been a panelist in several international conference discussing topics related to "AI&DM" and smart fields.

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.



### FOR MORE INFORMATION PLEASE CONTACT:

Shahab D. Mohaghegh  
Intelligent Solutions, Inc.  
P. O. Box 14  
Morgantown, WV 26507  
Tel: 713. 876. 7379  
Email: info@IntelligentSolutionsInc.com  
Shahab.Mohaghegh@gmail.com