INTELLIGENT SOLUTIONS, INC. PRESENTS:

ISI's Short Course Series; AI&DM in the Exploration & Production Industry

COURSE TITLE:

RESERVOIR CHARACTERIZATION USING ARTIFICIAL INTELLIGENCE AND DATA MINING (AI&DM).

INSTRUCTOR:
SHAHAB MOHAGHEGH, PH. D.
INTELLIGENT SOLUTION, INC.
PROFESSOR OF PETROLEUM & NATURAL GAS ENGINEERING
WEST VIRGINIA UNIVERSITY
MORGANTOWN, WEST VIRGINIA, USA
EMAIL: SHAHAB@INTELLIGENTSOLUTIONSINC.COM
EMAIL: SHAHAB.MOHAGHEGH@MAIL.WVU.EDU
TEL: 304.293.3984
MOBILE: 713.86.7379
URL: HTTP://WWW.INTELLIGENTSOLUTIONSINC.COM
URL: HTTP://SHAHAB.PE.WVU.EDU

INTENDED AUDIENCE:
GEOLOGISTS, PETRO-PHYSICIST, GEO-PHYSICISTS, RESERVOIR ENGINEERS AND ASSET MANAGERS. THIS COURSE IS BENEFICIAL FOR THOSE WHO ARE INVOLVED IN DATA ANALYSIS, MODELING AND DECISION MAKING IN THE OIL AND GAS INDUSTRY.

COURSE DESCRIPTION:

THIS SHORT COURSE IS DIVIDED INTO PARTS. THE FIRST PART OF THE SHORT COURSE IS DEDICATED TO THE FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE AND WILL PROVIDE THE THEORETICAL BACKGROUND FOR ITS MOST USED COMPONENTS SUCH AS ARTIFICIAL NEURAL NETWORKS, EVOLUTIONARY COMPUTING, AND FUZZY LOGIC. THE SHORT COURSE WILL THEN PROVIDE SOME INSIGHT ON THE TYPE OF PROBLEMS THAT CAN BE SOLVED USING THE ARTIFICIAL INTELLIGENCE AND DATA MINING TECHNIQUES AND THE TYPES OF PROBLEMS THAT ARE NOT SUITED FOR AI&DM. THE SECOND PART OF THE SHORT COURSE IS DEVOTED TO ACTUAL APPLICATION OF THESE ANALYTICAL TOOLS AND TECHNIQUES IN HYDROCARBON RESERVOIR CHARACTERIZATION. THESE APPLICATIONS WILL COVER AREAS SUCH AS:

- QUANTIFICATION OF UNCERTAINTIES ASSOCIATED WITH GEOLOGICAL MODELS.
- CLASSIFICATION OF RESERVOIR INTO ROCK TYPES AND FLOW UNITES USING STATIC AND DYNAMIC PROPERTIES.
- DEVELOPING INTELLIGENT MODELS TO CORRELATE SEISMIC ATTRIBUTES TO WELL LOGS, WELL LOGS TO CORE MEASUREMENTS, …
- DEVELOPING SYNTHETIC CONVENTIONAL WELL LOGS AND SYNTHETIC MAGNETIC RESONANCE IMAGING LOGS.
- ETC. …

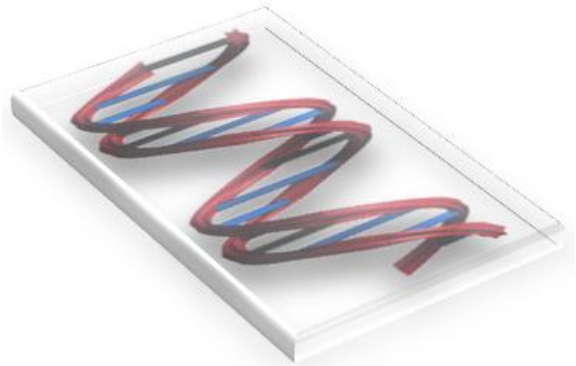
ARTIFICIAL INTELLIGENCE IS A COLLECTION OF SEVERAL ANALYTICAL TOOLS THAT ATTEMPTS TO MIMIC LIFE. THESE TOOLS (INCLUDE BUT ARE NOT LIMITED TO, ARTIFICIAL NEURAL NETWORKS, EVOLUTIONARY COMPUTING, AND FUZZY LOGIC) ARE BEING USED IN MANY COMMERCIAL PRODUCTS. THEY ARE AN INTEGRATED PART OF MANY NEW CARS SUCH 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 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 TOOLS HAVE BEEN USED TO OPTIMIZE HYDRAULIC FRACTURE DESIGNS, CHARACTERIZE OIL AND GAS RESERVOIRS, OPTIMIZE DRILLING OPERATIONS, INTERPRET WELL LOGS, GENERATE VIRTUAL MAGNETIC RESONANCE LOGS, OPTIMIZE NEW WELL PLACEMENT, SELECT CANDIDATE WELLS FOR TREATMENTS AND PREDICT POST FRACTURE DELIVERABILITY.

A DETAIL OUTLINE OF THE COURSE MATERIAL FOLLOWS.

Course Outline:

- **Part One: Virtual intelligence; an over view**
  - Introduction
  - State-of-the-art

- **Part Two: Artificial Neural Networks**
  - General Overview
  - Biological Background
  - Learning algorithms
    - Supervised
      - Backpropagation Networks
      - Conjugate Gradient Networks
      - Radial Basis Function Networks
      - Auto Associative Networks
    - Unsupervised (Self Organizing Maps)
      - Kohonen networks
    - Reinforced
  - Transfer Functions
  - Training, Testing and Verification data sets
  - Training a Network
  - Dos and Don'ts of Neural Network Practices



Part Three: Evolutionary Computing

- General Overview
- Biological Background
- Genetic Algorithms
  - An Optimization Solution
  - Initial Population
  - Fitness Function
  - Genetic Operation
  - Convergence
- Digital and Analog Coding of the Population

- **Part Four: Fuzzy Logic**
  - General Overview
  - Fuzzy Set Theory
    - Fuzzy Sets
    - Fuzzy Membership Function
  - Fuzzy Decision Support Systems
    - Fuzzy Rules
    - Fuzzy Inference Engines
    - Defuzzifications
  - Fuzzy Pattern Recognition
    - Fuzzy C-mean Clustering

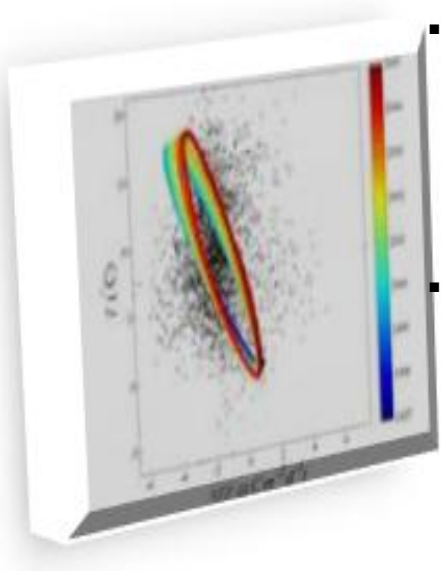
- **Part Five: Hybrid Intelligent Systems**
  - General Overview
  - Integrating Neural Networks, Genetic Algorithms and Fuzzy Logic

- **Part Six: Field Applications**

  - ***Surrogate Reservoir Models (SRM)***

    - Building replicas of full field models
    - Using SRM to quantify uncertainties associated with the geological model
    - SRM-assisted history matching and its role in fine tuning the geological model.

  - ***Generating Synthetic Well Logs***



    - Synthetic conventional well logs.
      - Completing missing portions of the well logs
      - Data preparation preprocessing
      - Data partitioning
      - Fuzzy cluster analysis
      - Data driven modeling, calibration and validation
    - Synthetic MRI logs.
      - Completing missing portions of the well logs
      - Data preparation preprocessing
      - Data partitioning
      - Fuzzy cluster analysis
      - Data driven modeling, calibration and validation

  - ***Building Intelligent Models for Generating Rock Types***

    - Detail Analysis and understanding of SCAL results.
    - Curve representation using AI&DM techniques
      - Mercury Injection Capillary Pressure Curves
      - Relative Permeability Curves
    - Data preparation preprocessing
    - Unsupervised, Reinforced and Supervised Fuzzy Cluster Analysis
    - Data driven modeling, calibration and validation

  - ***Building Intelligent Models to Correlate Well Logs to Core Measurements***

    - Understanding the problem
      - Clastic versus Carbonate formations
    - Data preparation preprocessing
    - Data partitioning

- Fuzzy cluster analysis
- Data driven modeling, calibration and validation

- ***Building Intelligent Models to Seismic Attributes to Correlate Well***

  - Seismic attributes analysis and understanding
  - Well log analysis and understanding
  - Are VSPs available? Role of VSP in the analysis.
  - Data preparation preprocessing
  - Data partitioning
  - Fuzzy cluster analysis
  - Data driven modeling, calibration and validation

- **Part Seven: Getting Familiarity with Software Implementations**

  - **INTELLIGENT DATA EVALUATION & ANALYSIS, IDEA™**

    - **Data Preparation**
      - Getting to know your data
      - Frequency Distribution
      - Conventional Regression Analysis
      - Dealing with Missing Data
      - Dealing with Outliers
      - Advance Statistical Analysis

    - **Key Performance Indicators**
      - Ranking the Performance Indicators
      - Behavior of the Performance Indicator

    - **Cluster Analysis**
      - Conventional K-Mean Clustering
      - Fuzzy C-Mean Clustering
      - Automatic Cluster Analysis

    - **Neural Network Model Building**
      - Data partitioning
        - Intelligent Data Partitioning
        - Cluster Analysis-Based Partitioning
        - Random Partitioning
        - Pre-Determined Partitioning

      - Neural Model Architecture
        - Number of Layers
        - Number of Neurons
        - Activation Functions
        - Learning Rates
        - Momentum

      - Training Algorithms
        - Back Propagation
        - Generalized Regression
        - Recurrent
        - Radial Basis Functions
        - Self-Organizing Maps

      - Training Process
        - Avoiding Overtraining
        - Real-time Monitoring of the Training Process

- Neural Model Analysis
  - Parameters Inter-Dependency
    - Tables
    - Functions
    - Neural Models
  - Sensitivity Analysis
    - Single Parameter Analysis
    - Combinatorial Analysis
    - Monte Carlo Simulation
  - General Model Behavior

- Neural Model Application
  - Import New Data
  - Apply Neural Model