AGENDA

- Data Mining: What is it?
- Data Mining Virtuous Cycle
- Data Mining: O&G Input Space
- Data-Driven Analytics:
  - Artificial Intelligence & Deep Learning
- Case Studies:
  - Seismic Attribute Analysis
  - Seismic Image Analysis
DATA MINING: WHAT IS IT?

- Data Mining Styles
  - Hypothesis Testing
  - Directed Data Mining
  - Undirected Data Mining

**DO WE HAVE ANY ACTIONABLE ANALYTICS FROM OUR BIG DATA IN THE CLOUD?**

**YES, THE DATA SHOWS THAT MY PRODUCTIVITY PLUNGES WHENEVER YOU LEARN NEW JARGON.**

**MAYBE IN-MEMORY COMPUTING WILL ACCELERATE YOUR APPLICATIONS.**

**WHAT I COULD BE DOING**

**WHAT PEOPLE THINK I DO**

**WHAT I ACTUALLY DO**
"Those who do not learn from the past are condemned to repeat it."

George Santayana
DATA MINING: O&G INPUT SPACE

- Geomechanics
  - Young's Modulus
  - Poisson's ratio

- Geochemistry
  - TOC
  - Kerogen% (Kerogen percentage)

- Acoustic Impedance Inversion

- Faults

- Fractures

- Velocity Anisotropy

- Reservoir Dimensions

- Multivariate Multidimensional Multivariate Stochastic Seismic

- Velocity Field
  - Azimuth
  - Dip
  - Strike
DETERMINISTIC TO PROBABILISTIC

Data
• Historical
• Real-time

Deterministic analysis
• Experience

Outcomes
• Situation A
• Situation B
• Situation C

Data
• Historical
• Real-time

Probabilistic analysis
• Experience
• Variability
• Complex relationships

Predictive Outcomes
• Situation A
  95%
• Situation B
  22%
• Situation C
  36%

Actionable workflows
• Workflow A
• Workflow B
• Workflow C
SEISMIC ATTRIBUTE ANALYSIS

METHODOLOGY

1. Data Integration
   - 3D Seismic Data
   - Well Logs
   - Faults
   - Grids & Horizons

2. Exploratory Data Analysis
   - Seismic Attribute Pattern Recognition

3. Principal Component Analysis
   - Most Significant Seismic Attributes
   - Dimension Reduction

4. Self-Organizing Maps
   - Create new attributes of classification and probability volumes

5. Unconventional Basin Characterization
   - “De-Risk” interpretation

Flow Assurance
Field Optimization
Reservoir Characterization
Drilling Performance
Well Categorization
SEISMIC ATTRIBUTE ANALYSIS

PRINCIPAL COMPONENT ANALYSIS AND SELF-ORGANIZING MAPS

PCA

SOM
• Identify natural clusters of attributes associated to each neuron
• Neurons have geologic significance
• Generate 2-Dimensional maplets
• Adapt seismic attributes in a multidimensional lattice

• Discriminate geologic and stratigraphic features
• Expose Direct Hydrocarbon Indicators (DHIs)
• Risk reduction through additional insights to complement interpretation
SEISMIC ATTRIBUTE ANALYSIS

ANALYSIS OF UNCONVENTIONAL RESOURCE PLAYS

- Reservoir geology
  - Thickness and Lateral extent
  - Mineralogy
  - Porosity and Permeability
- Geochemistry
  - Total Organic Content (TOC)
  - Maturity and Kerogen Richness
- Geomechanics
  - Acoustic impedance inversion
  - Young’s Modulus
  - Poisson’s Ratio (Vp/Vs)
- Faults, Fractures and Stress regimes
  - Coherency and Curvature
  - Fault Volumes
  - Velocity Anisotropy
  - Stress maps
SEISMIC ATTRIBUTE ANALYSIS

METHODOLOGY FOR IMAGE AND VIDEO ANALYTICS (IVA)

- Data Preparation
- Exploratory Data Analysis
- Model Building
- Operationalizing Models
SEISMIC ATTRIBUTE ANALYSIS  DEEP LEARNING WITH NEURAL NETWORKS

Partially Corrupted Input Features

Uncorrupted Output Features

Target Layer

Extractable Features

Input Layer

h1

h2

h3

h4

h5

Hidden Neurons

Hidden Neurons

Hidden Neurons

Hidden Neurons

Hidden Neurons

Extractable Features
SEISMIC ATTRIBUTE ANALYSIS

DICTIONARY LEARNING
MAPPING DISPARATE UPSTREAM DATA TO RESERVOIR CHARACTERIZATION

Seismic Data
- Well Logs
- Cores and Maps

Time-Lapse Seismic

New 3D Seismic

Single Trace Analysis
- Data Mining and Pattern Recognition
- Attribute Generation
- Seismic Trace Feature Identification
- Reservoir Heat Map

3D Seismic Data Comparisons
- Reservoir Characterization SOMs and Cluster Analysis
- Analytical vs Forecasted Results

Output:
- Real-Time Data Analytical Workflows and Key Performance Indicators
- Production Optimization Strategies and Tactics: Fluid Saturation and Reservoir Characterization Evolution

Analytical Workflows