Machine Learning Applications in Quantitative Interpretation Workflow-
North Sea Examples

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Thanks OGA and Equinor provided open data.
General QI Workflow integrated with Machine Learning

- Fill missing log data
- Predict log data like Porosity, Sw etc.
- Classify Lithology types

- Rock Physics Study on wells

- AVO Analysis
  - Horizon, Fault and Salt dome interpretation
  - Inversion

- Pre-/Post-seismic interpretation and inversion

- Integrated seismic attributes analysis

- Rock and fluid property prediction
Log Prediction using Machine Learning
(Supervised Machine Learning Task)

- Preprocessing:
  - Raw Data (Well log data)
  - Labels (NPHI)
  - (GR, Density, P-wave, S-wave, ILD)
- Learning:
  - Training Dataset
  - Test Dataset
  - Learning Algorithm
  - Randomforest
- Evaluation:
  - Labels (NPHI)
  - Final Model
- Prediction:
  - New Log Data
  - Labels (NPHI)

Feature Extraction and scaling
Feature Selection
Dimensionality Reduction
Sampling

Model Selection
Cross-Validation
Hyperparameter Optimization

(Edit from Sebastian etc., 2017)
Log Prediction using Machine Learning

Mid North Sea High Well log data

Error Analysis

Mean Average Error (MAE)
Root Mean Squared Error (RMSE)

Using Original logs
Using Original + Geophysical logs
Using Original + Geophysical + Math logs

Ori
Ori-Geo
Ori-Geo-Math

Mean Average Error (MAE)
Root Mean Squared Error (RMSE)

Variable Importances

Using Original logs
Using Original + Geophysical logs
Using Original + Geophysical + Math logs
AVO Analysis using Machine Learning

- AVO anomaly analysis can be considered as a clustering process, different AVO classes can be put into different clusters.
- This is unsupervised machine learning task (Clustering).
- Fuzzy c-means clustering can be used to solve the problem quickly.

**Input Data**
- Pre-stack Gathers
- Partial Angle Stack Volumes
- Number of Clusters

**Fuzzy C-Means Clustering**
- A “soft clustering” technique, which allows one piece of data to belong to two or more clusters.
- Membership grades are assigned to each of the data points. These membership grades indicate the degree to which data points belong to each cluster.

**Outputs**
- Labelled Cluster volume
- Probability of Cluster Membership Volume for Each Cluster

(Edited from Laura etc., 2018)