dGB Earth Sciences - OpendTect

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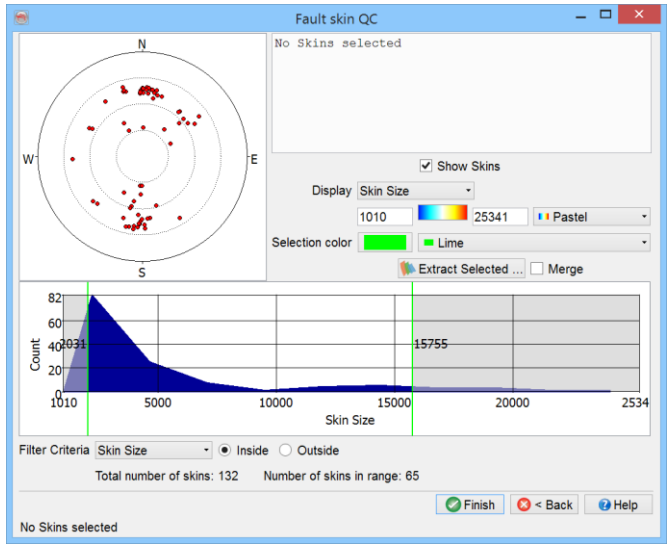
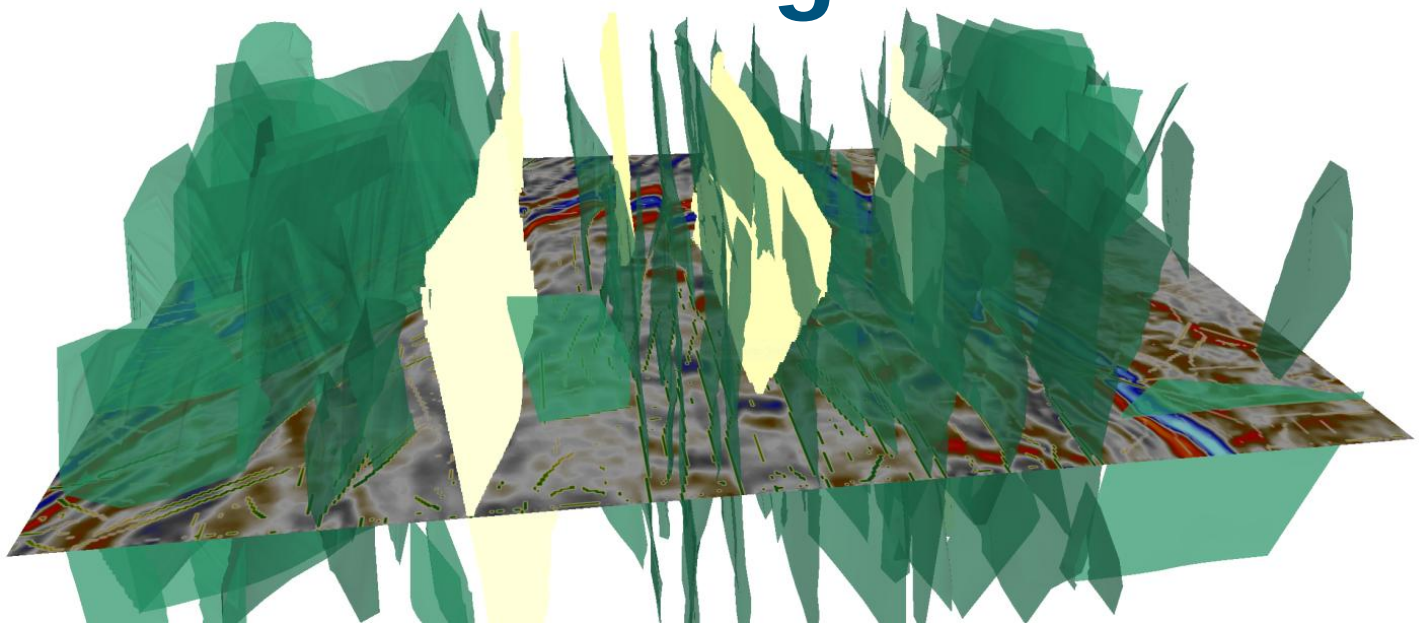
dGB Earth Sciences

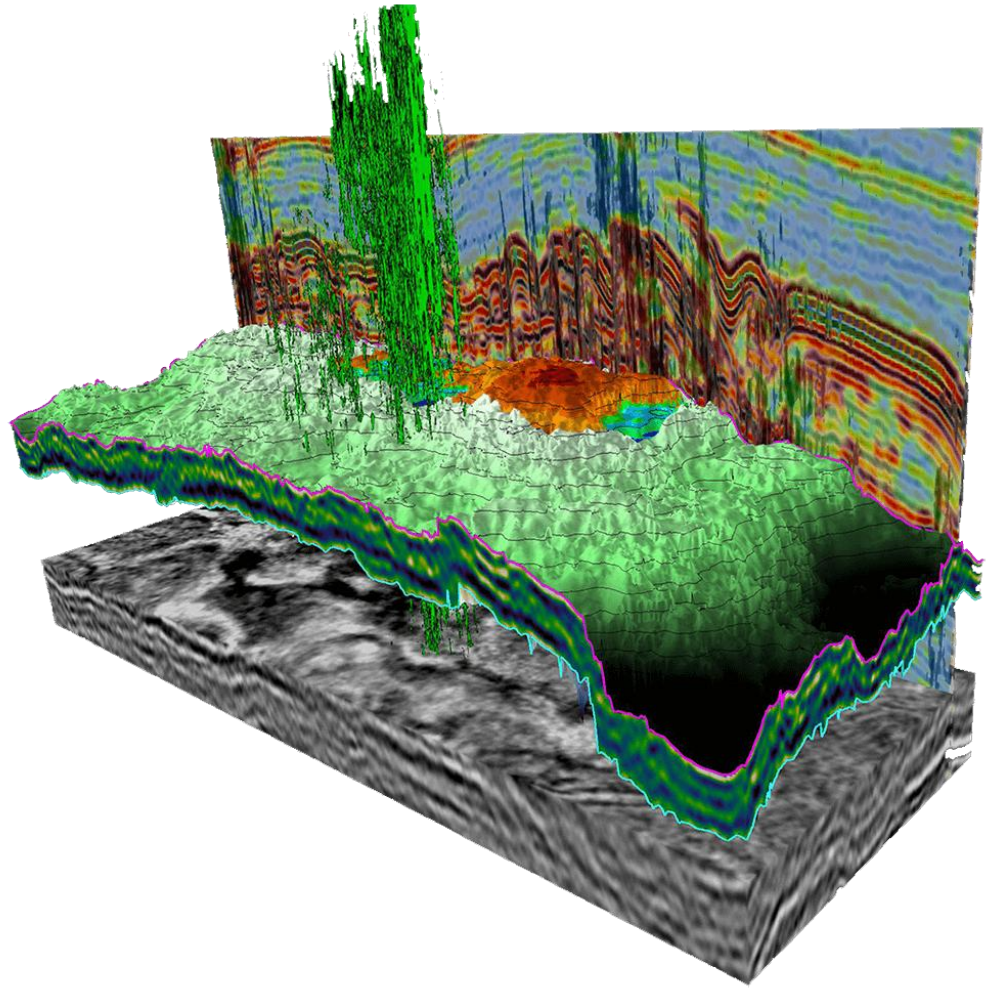
AAPG UPITCH INVENT AND INVEST

Detecting Discontinuities with Machine Learning





Industry Leader in ML and Fault Imaging



- Neural Nets since 1995
- Supervised and Unsupervised
- New Plugin Q2 2019
  - Keras, TensorFlow, Scikit Learn
  - GUI's for Python code..
  - 3 Modes – Wells and Seismic
  - EAGE 2019

This is who we are

- dGB – company behind OpendTect
- Open source software with possibility to extend free functionalities with cutting-edge commercial plugins
- Industry leader in innovative interpretation methods
- Worldwide presence – Netherlands, India & USA

OpendTect
Distinguished Achievement Award 2016
SEG SOCIETY OF EXPLORATION GEOPHYSICISTS

Who Uses OpendTect?

Thousands Open Source Users

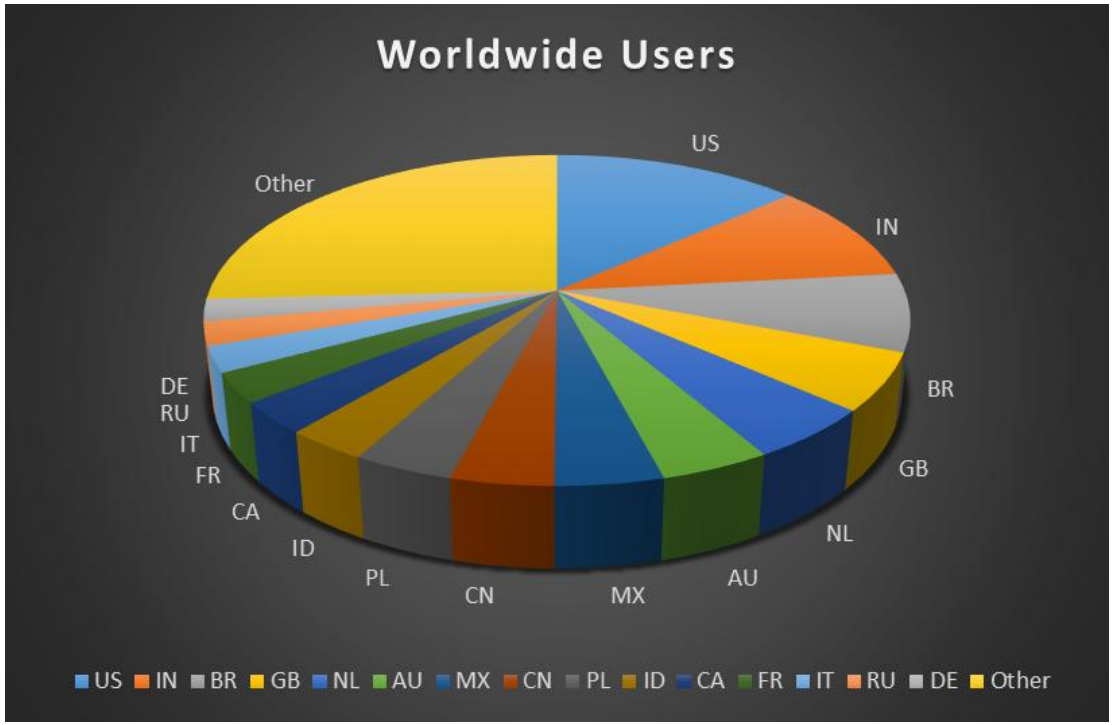
- E&P companies, Service Companies, R&D Institutes, Consultants, Geoscientists at home

Hundreds Commercial Users

- NOC's, Majors, Independents, Service Companies, R&D Institutes, Consultants

Thousands Academic users

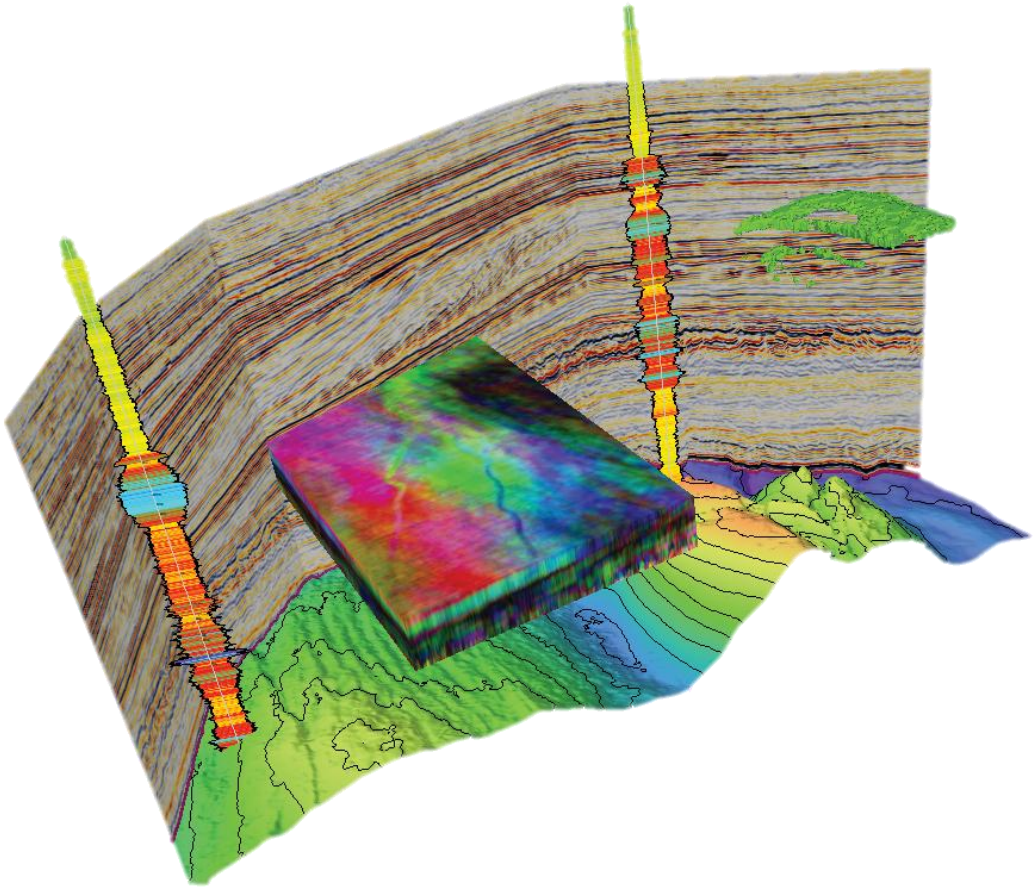
- More than 4000 academic licenses at 400+ Universities worldwide
- Equivalent to >250M$ license fees per year
- Free data sets from Open Seismic Repository



More than 36.000 users in 146 countries

Supported Free Functionalities

All tools needed for 2D and 3D seismic interpretation



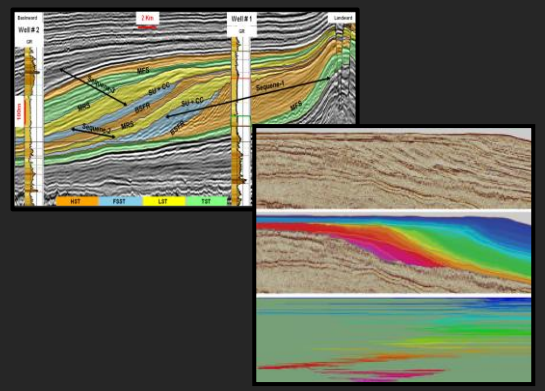
Key Features

- 2D, 3D & Prestack seismic
- 2D & 3D viewers
- Stereo viewing & Volume rendering
- Seismic Attributes & crossplots
- Spectral decomposition
- Movie-style parameter testing
- Distributed computing
- Horizon trackers
- Faults
- Well-tie
- Depth Conversion
- Geobodies and … a lot more …

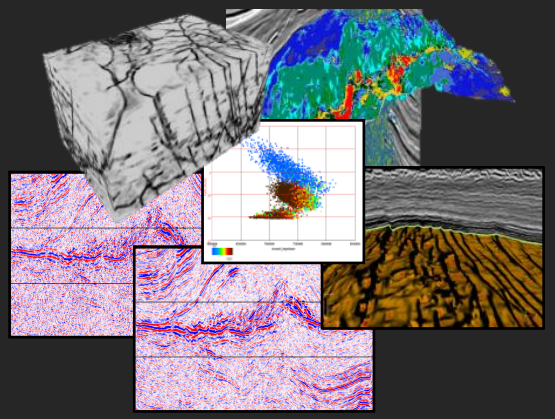
Development options: C++, Python, Matlab plus links to Madagascar and GMT

The dGB Playing Field

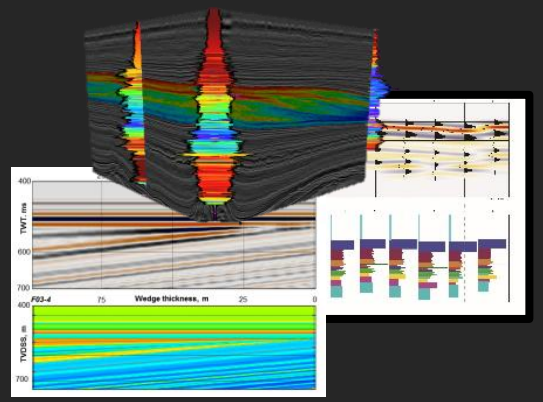
Seismic Sequence Stratigraphy



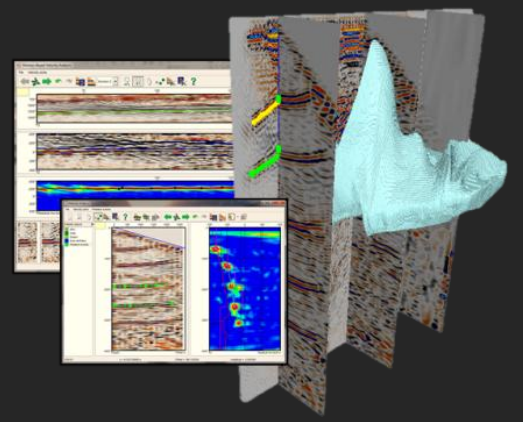
Attributes & Filters



Seismic Predictions



Other: VMB & PSDM; Potential Fields



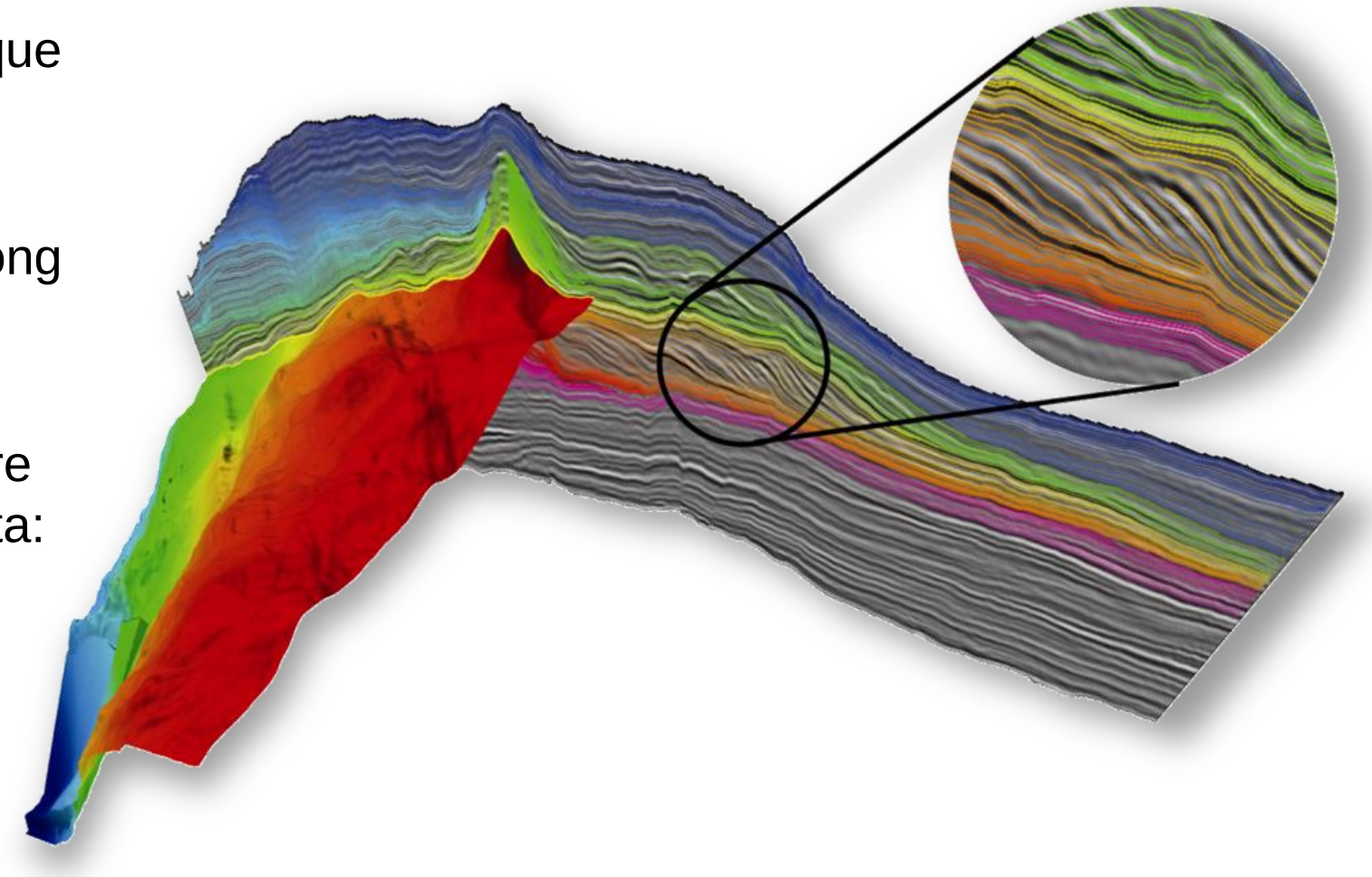
Unique Technology: HorizonCube

Global Seismic Interpretation Technique

Delivers a dense set of horizons, i.e. seismic events that are correlated along phase-consistent geologic time lines

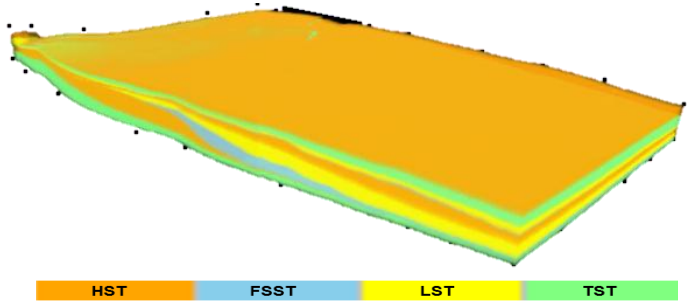
Is the starting point for extracting more geologic information from seismic data:

- Finding stratigraphic traps
- Building accurate geologic models
- Steering wells
- Avoiding geo-hazards
- …

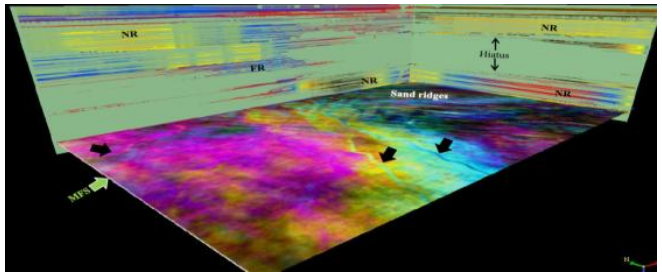


HorizonCube Applications

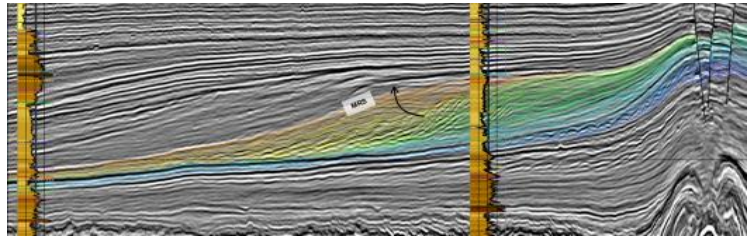
Systems Tracts



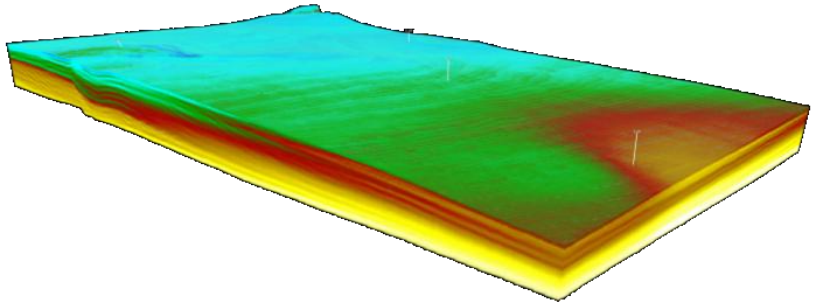
4D Wheeler Diagram



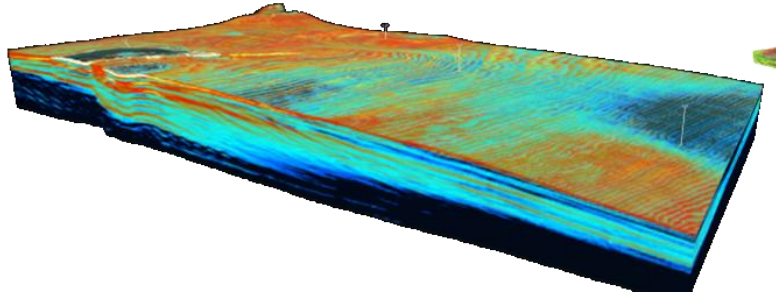
Well Correlations



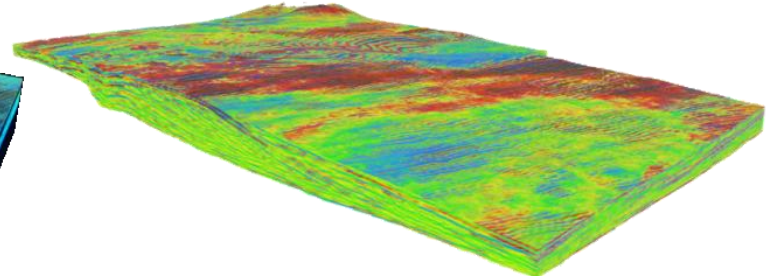
GeoModel



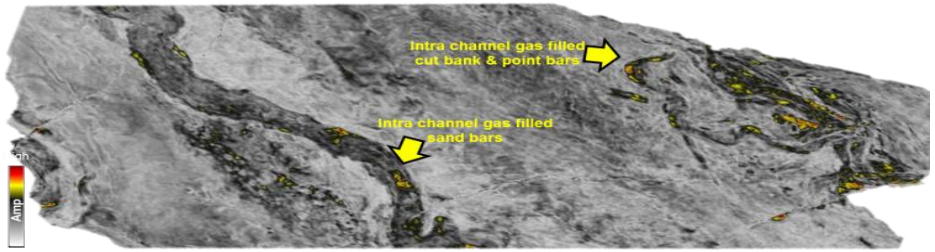
Seismic Inversion



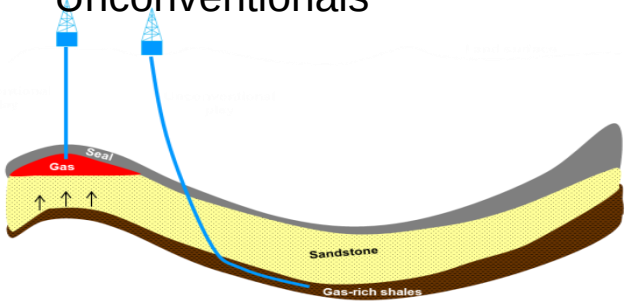
Rock Property Predictions



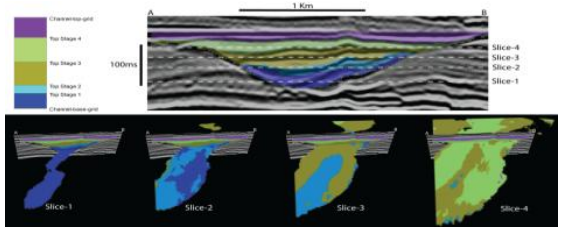
Pre-drill Geo-hazard Identification



Unconventionals



Well-planning



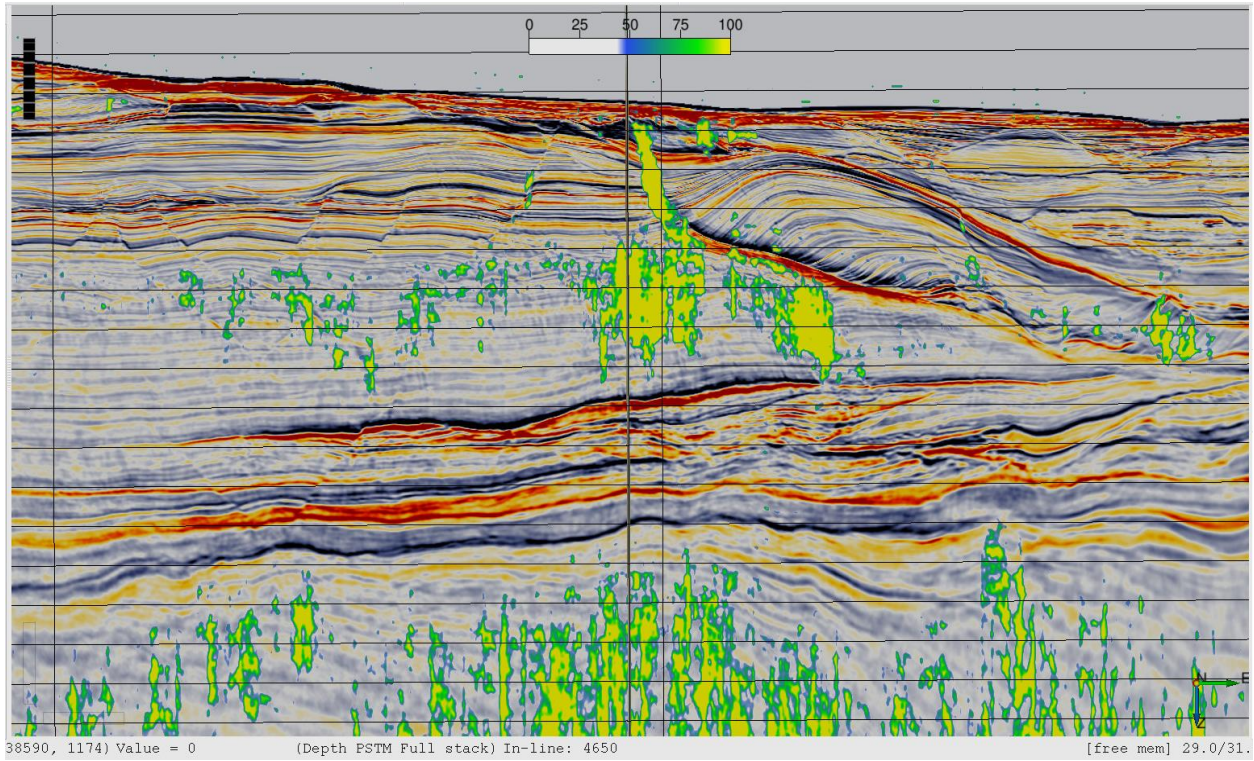
Prospect Ranking: ChimneyCube

Objectives:

- Identify plays and rank prospects

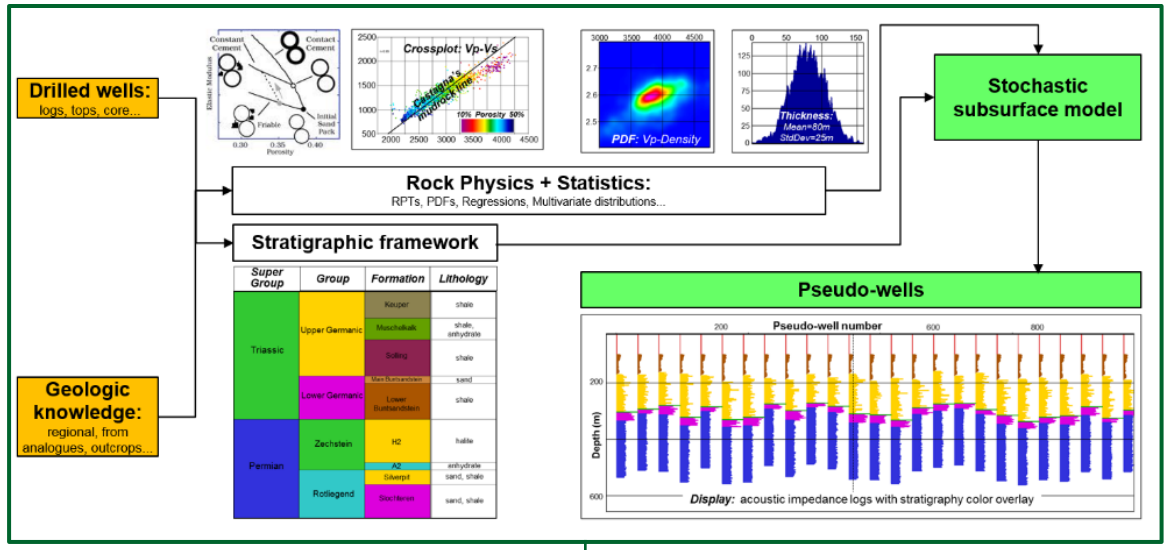
Solutions:

- Attribute analysis, spectral decomposition, coloured inversion
- HorizonCube / Sequence Stratigraphic interpretation
- ChimneyCube: fluid migration path interpretation



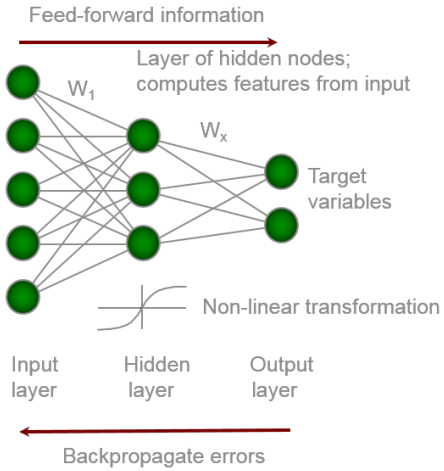
Seismic line with ChimneyCube overlay

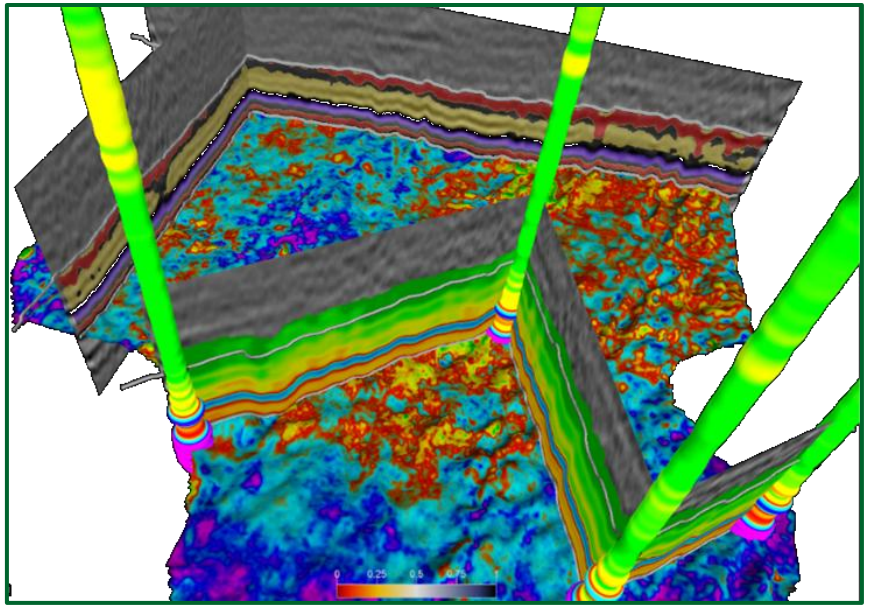
SynthRock



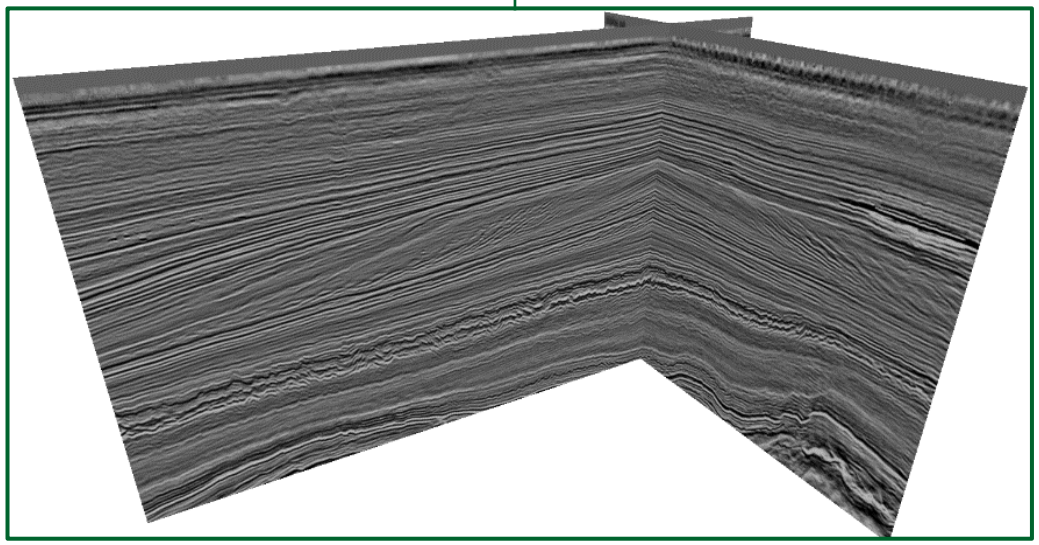
Subsurface Models: 1D/2D/3D

Machine Learning





Rock property prediction

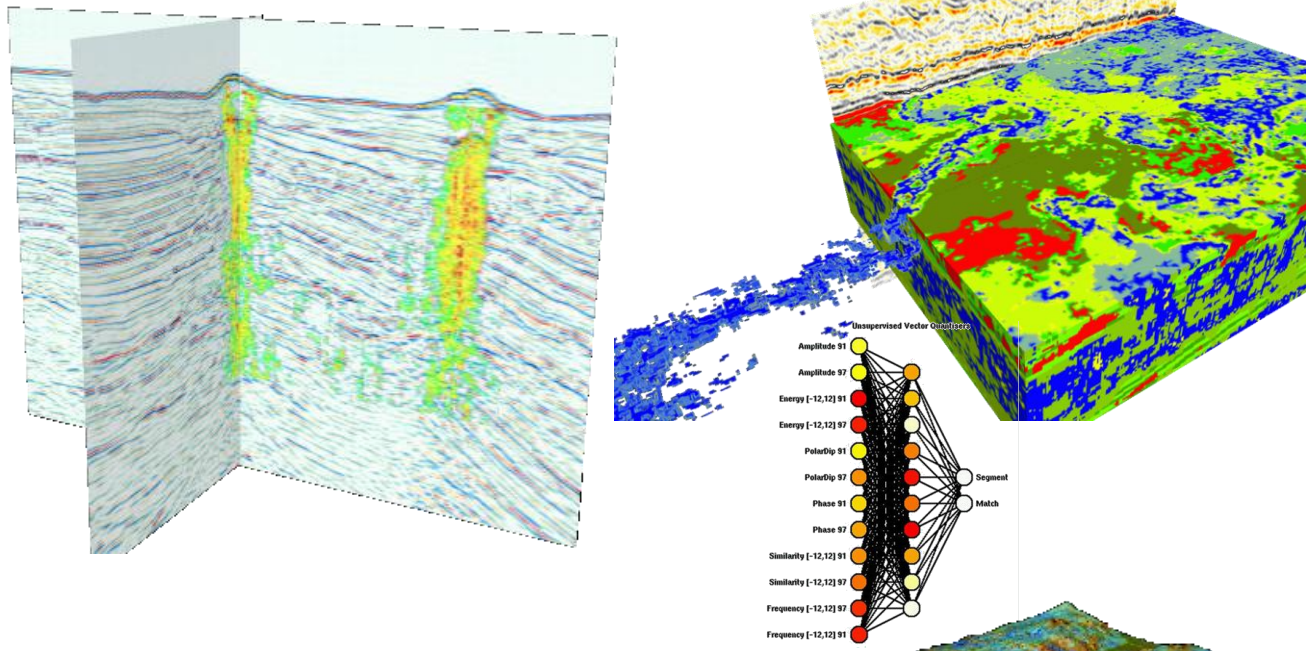


Seismic

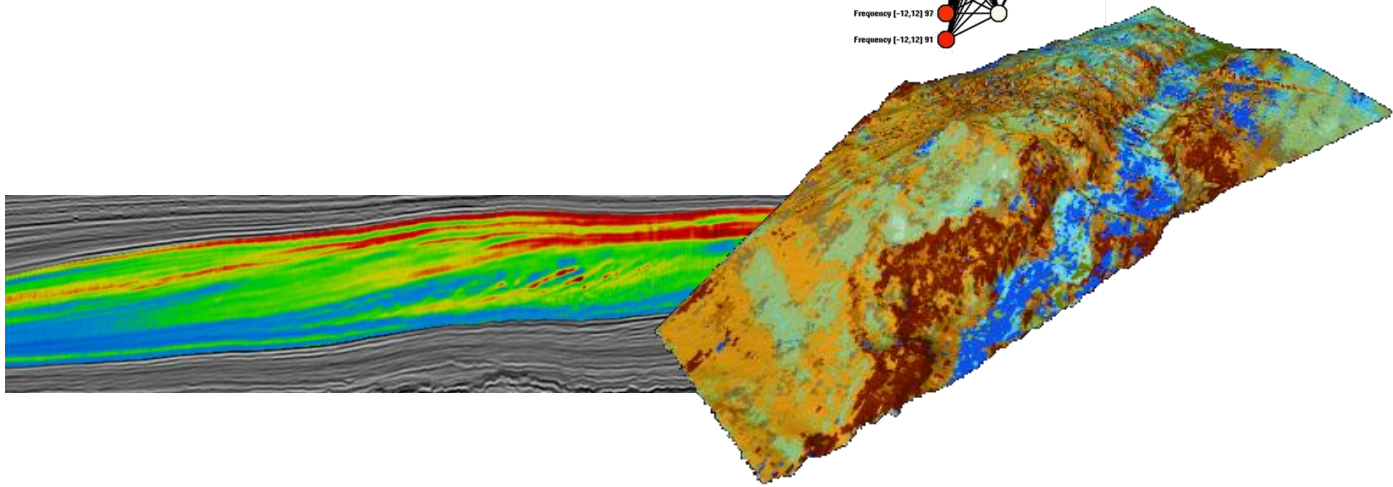
OpendTect's SynthRock plugin solves a key machine learning problem in seismic applications:
how to create representative training and test data sets!

Current Neural Networks Plugin

- Supervised MLP networks
  - Seismic Object Detection (ChimneyCube, Salt, Faults, Injectites, …)
  - Seismic Classification (Facies, Lithology, Gas-Oil-Brine, …)
  - Seismic Prediction (Porosity, Vshale, Sw, …)

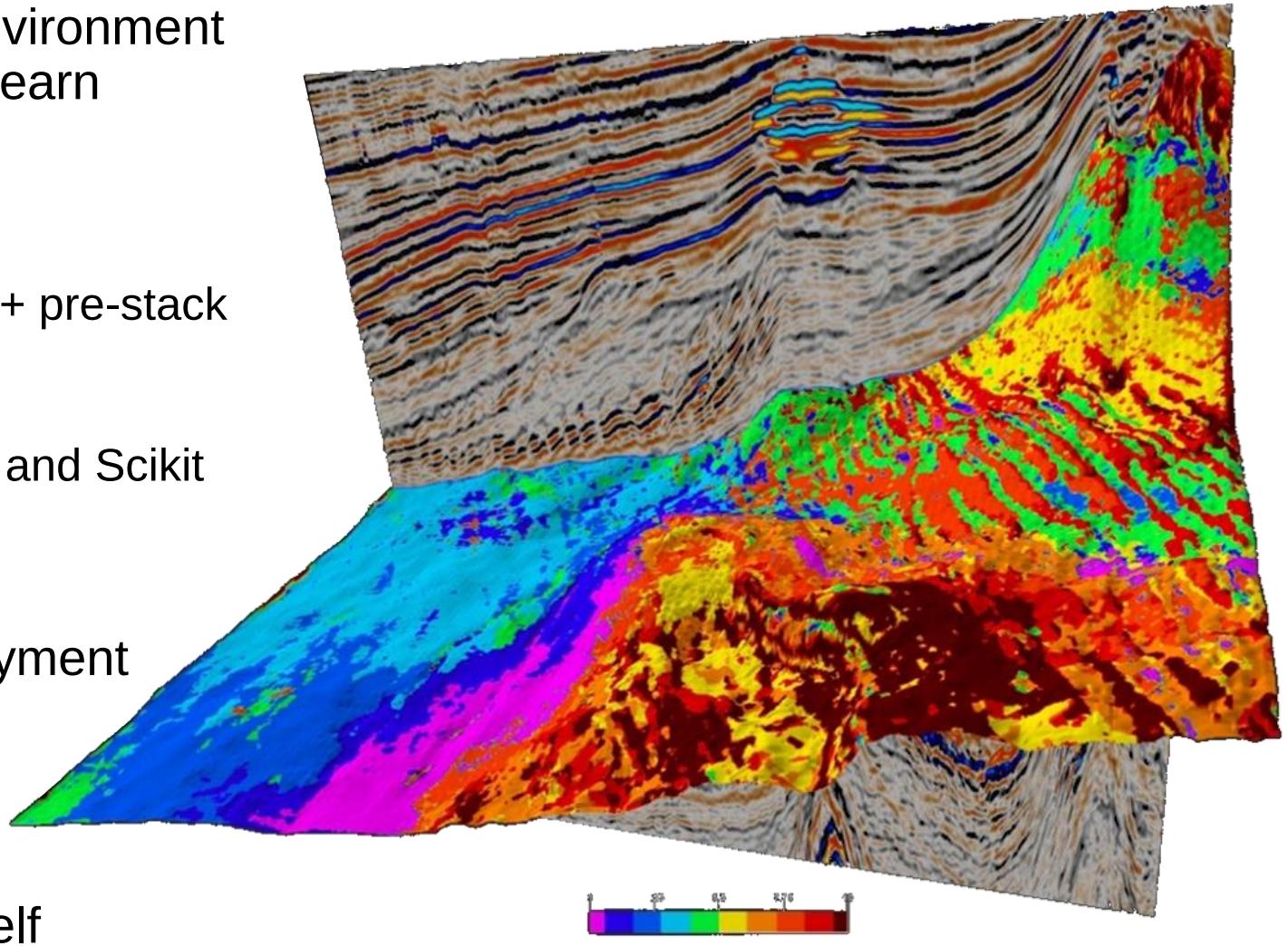


- Unsupervised UVQ networks
  - Waveform Segmentation (2D grids)
  - Attribute Clustering (3D volumes)



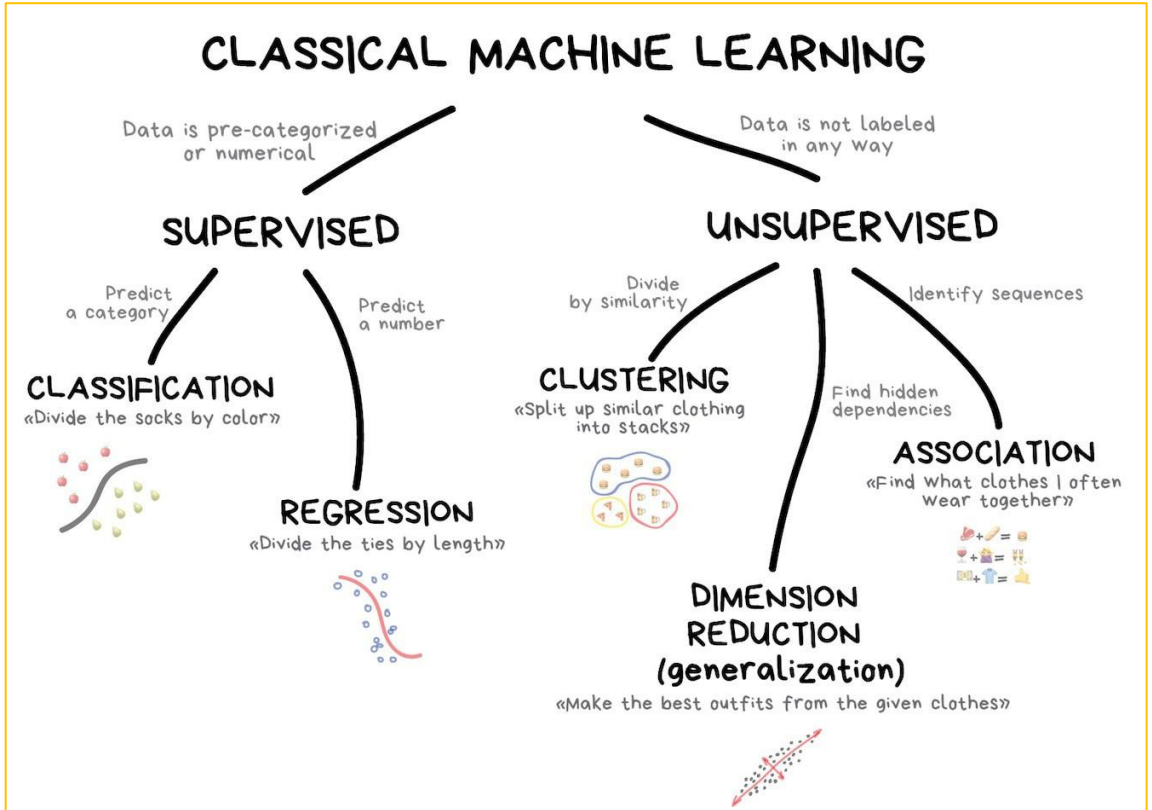
Project: Machine Learning (ML) Plugin

- New plugin that links OpendTect Pro environment to Python, TensorFlow, Keras & Scikit Learn
- Speeds up Machine Learning R&D
  - Data IO, SynthRock stochastic models + pre-stack synthetics, visualization and analysis in OpendTect
  - Machine learning in TensorFlow, Keras and Scikit Learn integrated in OpendTect
- Shortens time between R&D and deployment
- Gives users access to the latest Machine Learning tools and trained networks that can be applied off-the-shelf



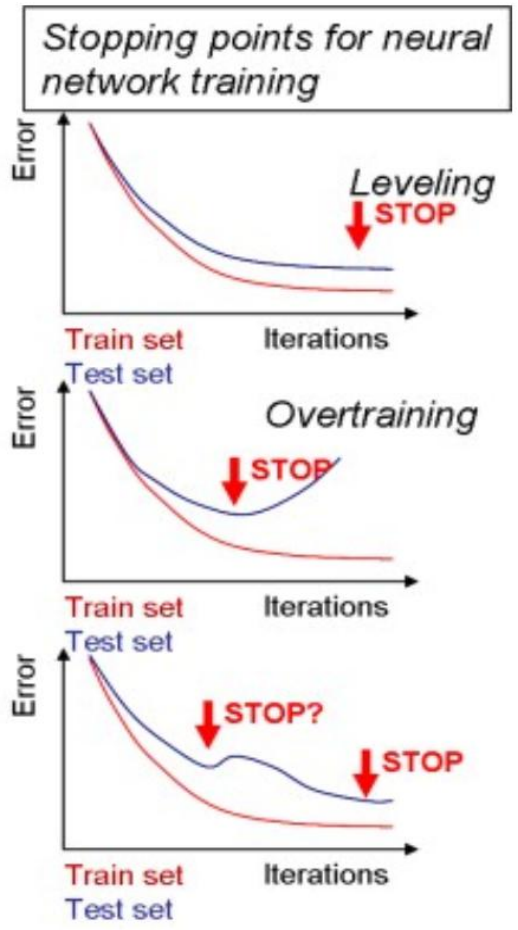
*Project sponsored by MOL Norway

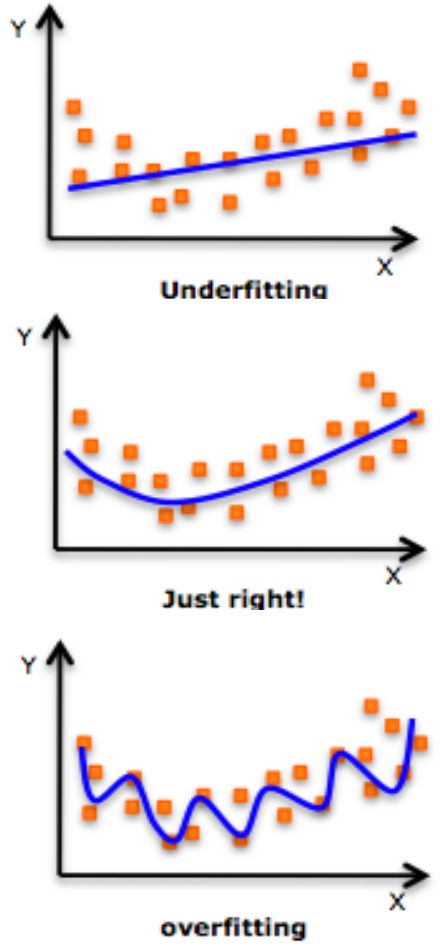
Let's take a step back..



- 'Classical' ML vs. old method
- ML – lot's of hype
- Why apply ML when we already have good discontinuity attributes?
- Optimization & improvement!
- Combine attributes using ML

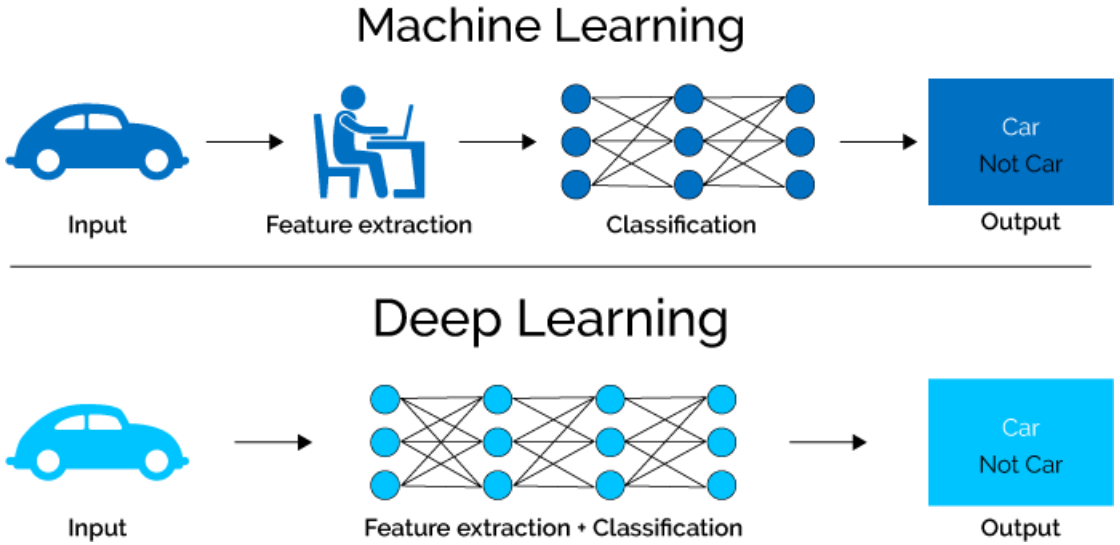
Let's take a step back..





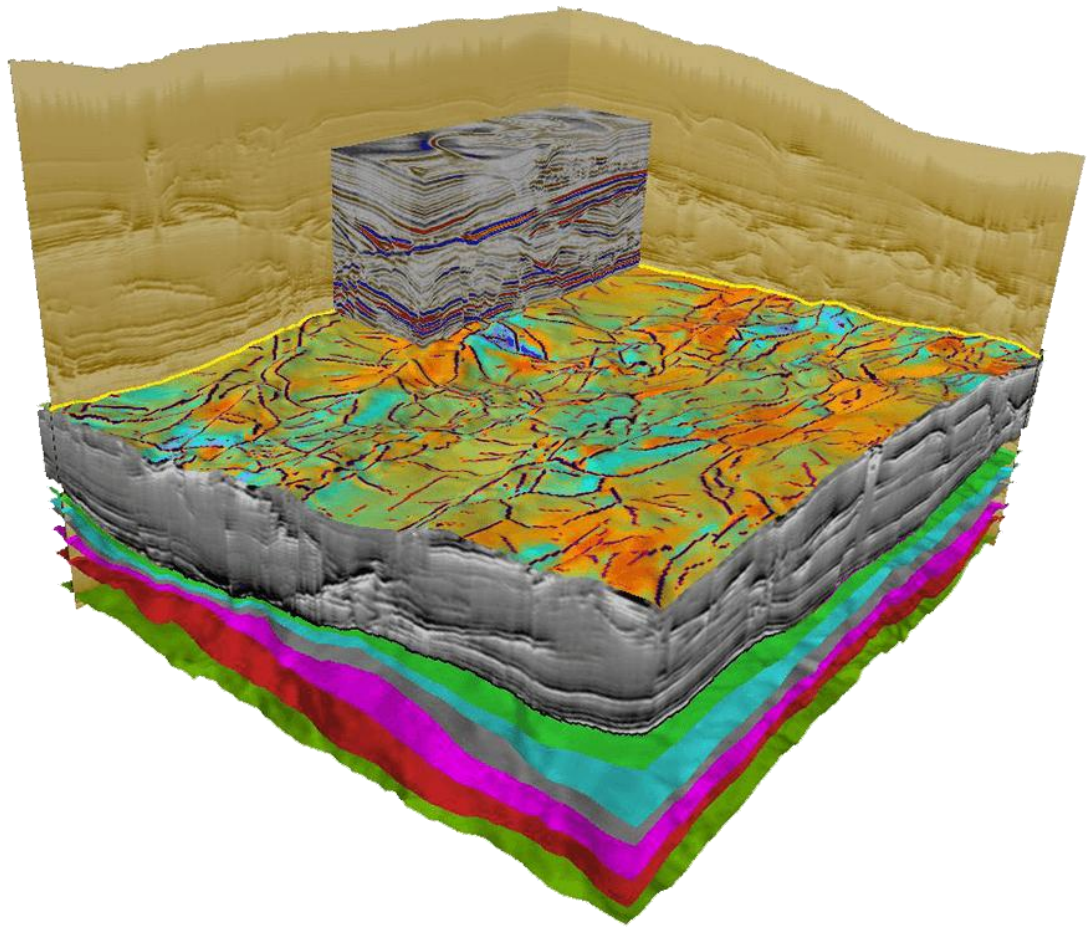
- Pitfalls in neural network training
- In supervised mode, user input is required
- User needs to avoid overtraining

This is our vision



- Enable access to complex machine learning algorithms for all geoscientists
- Advance ML technology
- Shorten development - deployment cycle
- Data is getting bigger..
- Keras, Tensorflow, SciKit Learn

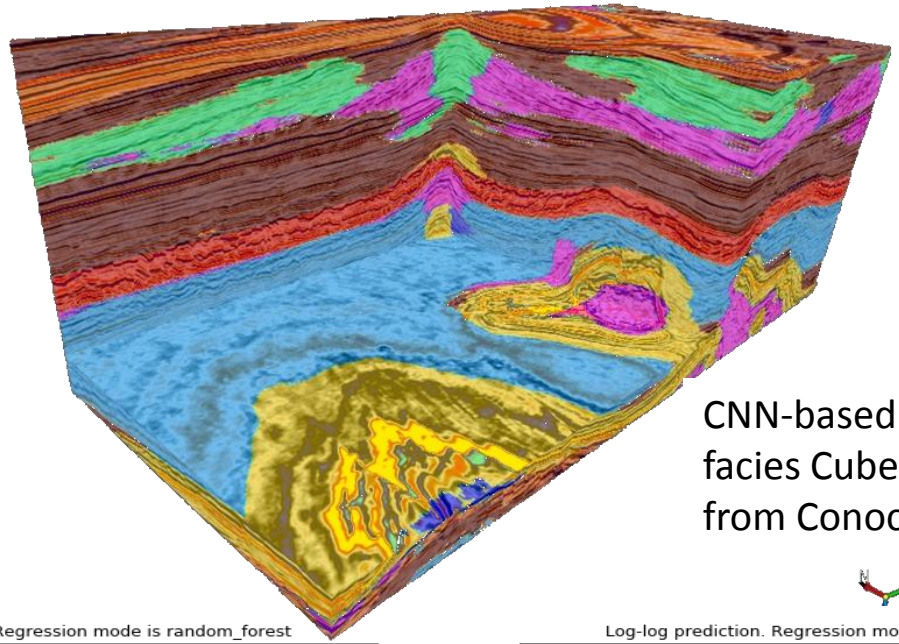
This is our vision



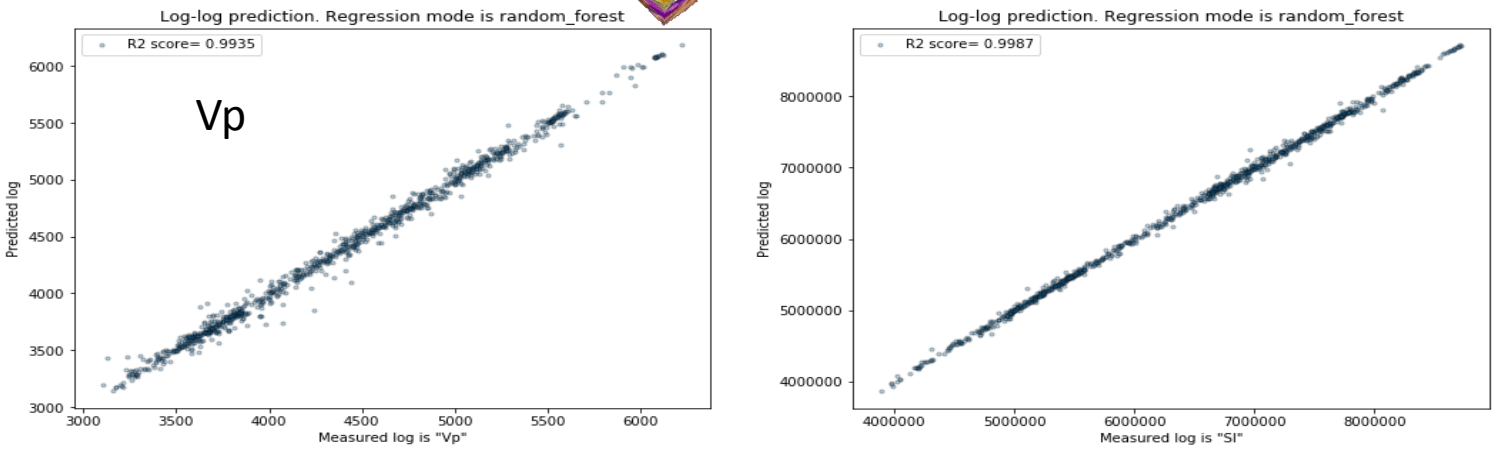
- Unique fault attributes in OpendTect
- Can be utilized when using ML for object detection
- Superior results by combining two worlds – advanced attributes and ML
  - Single attributes might highlight artifacts/non-discontinuities
  - ‘Clean up’ results through ML

Python ML Environment

- Python is an interpreted, high-level, general-purpose programming language
- Free libraries for Machine Learning R&D
  - TensorFlow
  - Keras
  - Scikit Learn
  - Bokeh plotting
- Can be applied on well- and/or seismic data

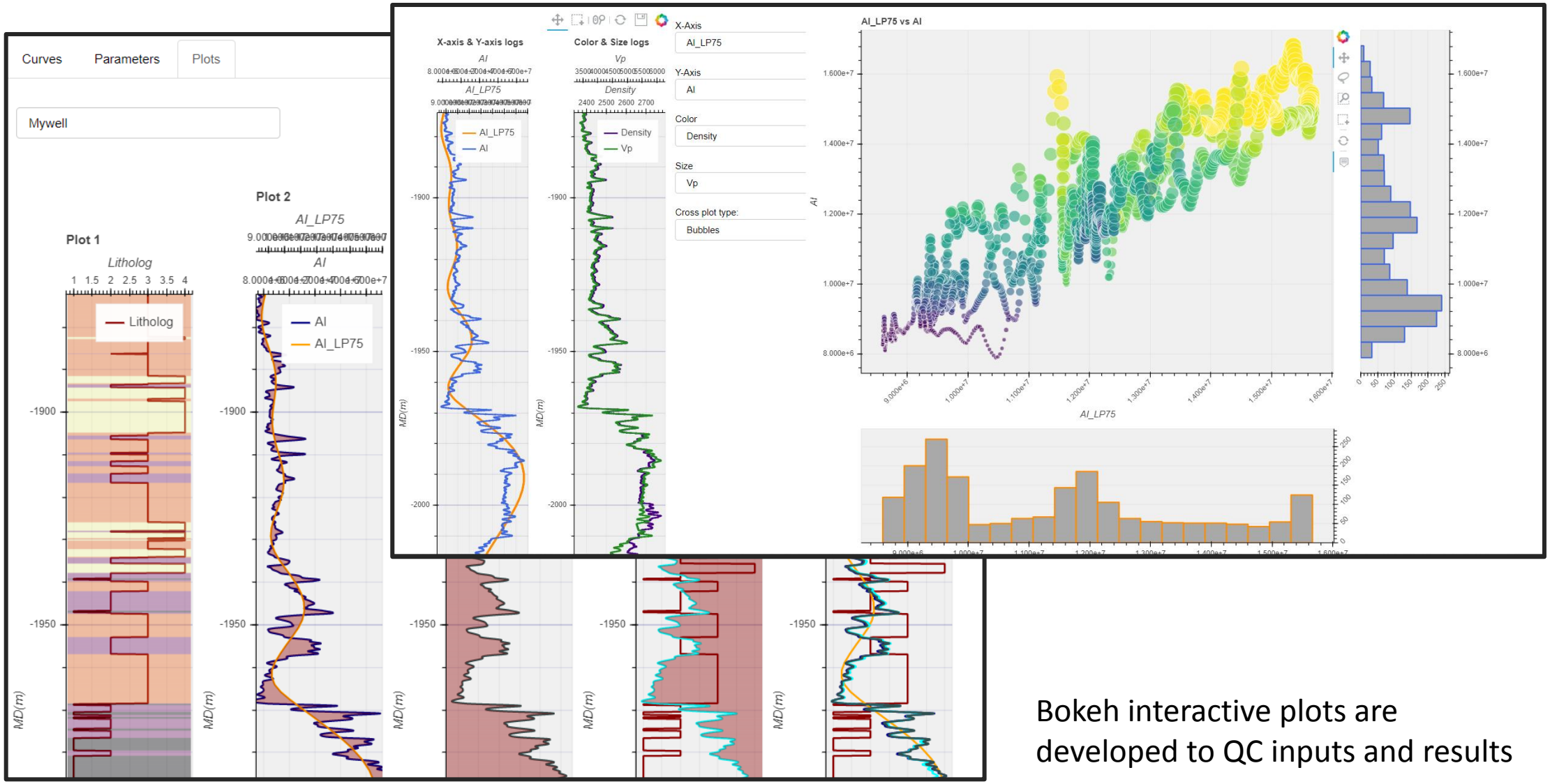


CNN-based seismic facies Cube (Malenov from ConocoPhillips)



Log-log predictions using Random Forest Regression

Bokeh Plots for QC



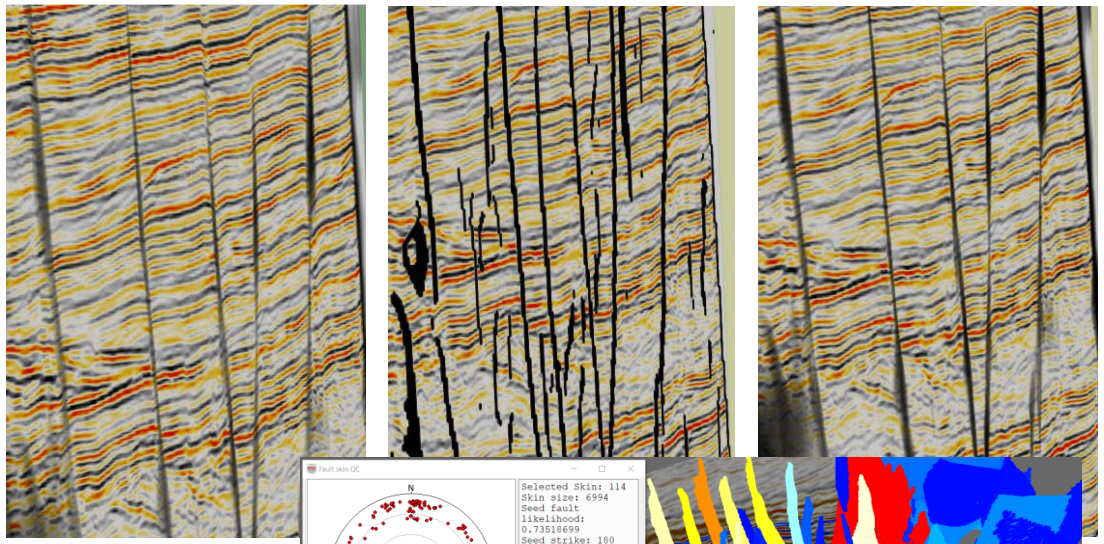
Bokeh interactive plots are developed to QC inputs and results

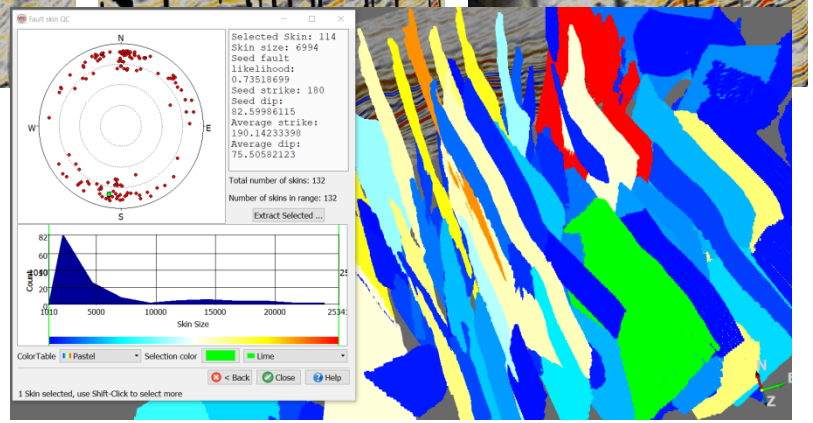
This is our process - discontinuities

NN with TFL

TFL

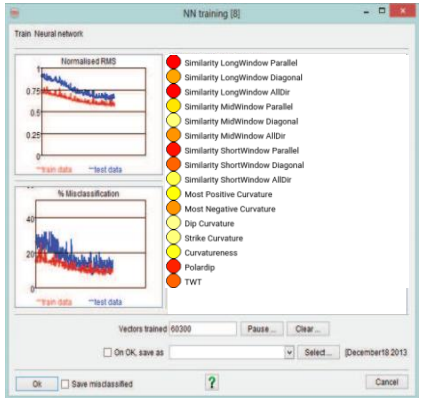
NN without TFL

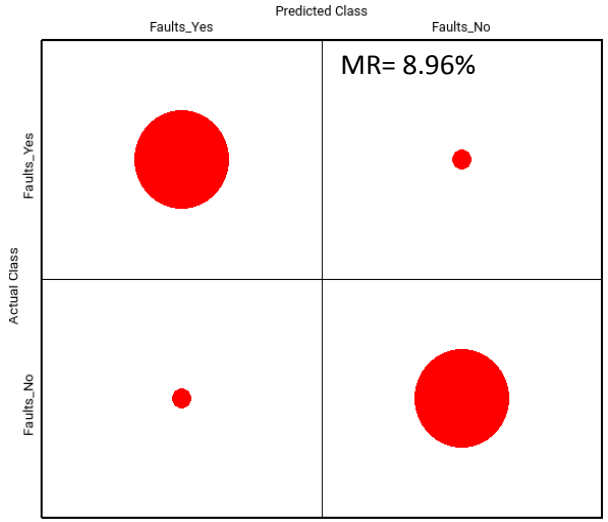




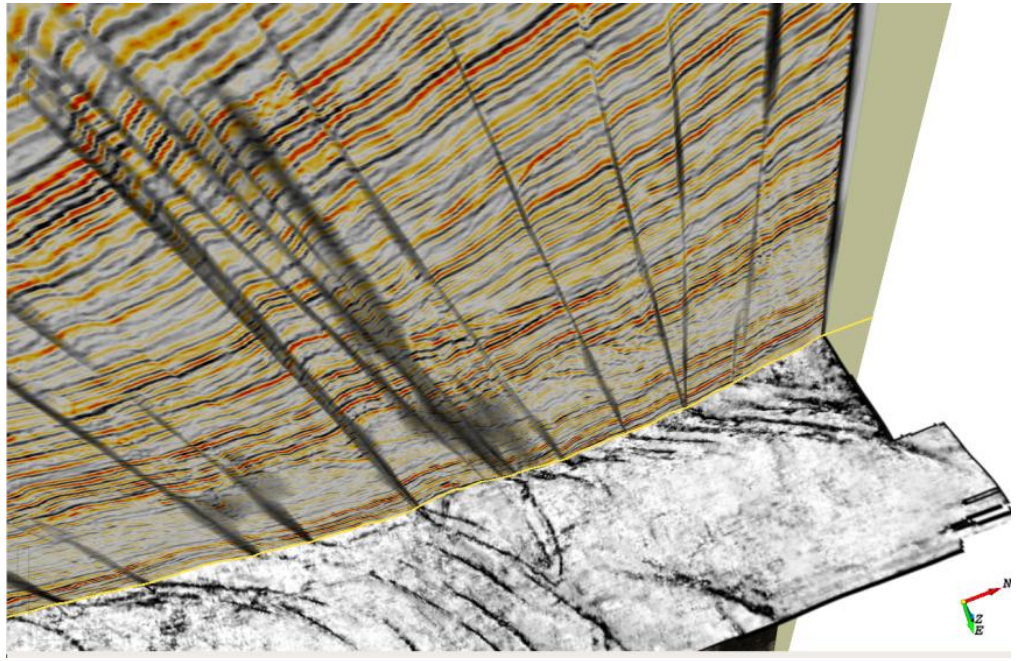
- Process TFL, utilize to optimize neural network
- Process TFL, utilize to optimize ML algorithms
- QC
- Automated fault plane extraction

Here are examples of successes

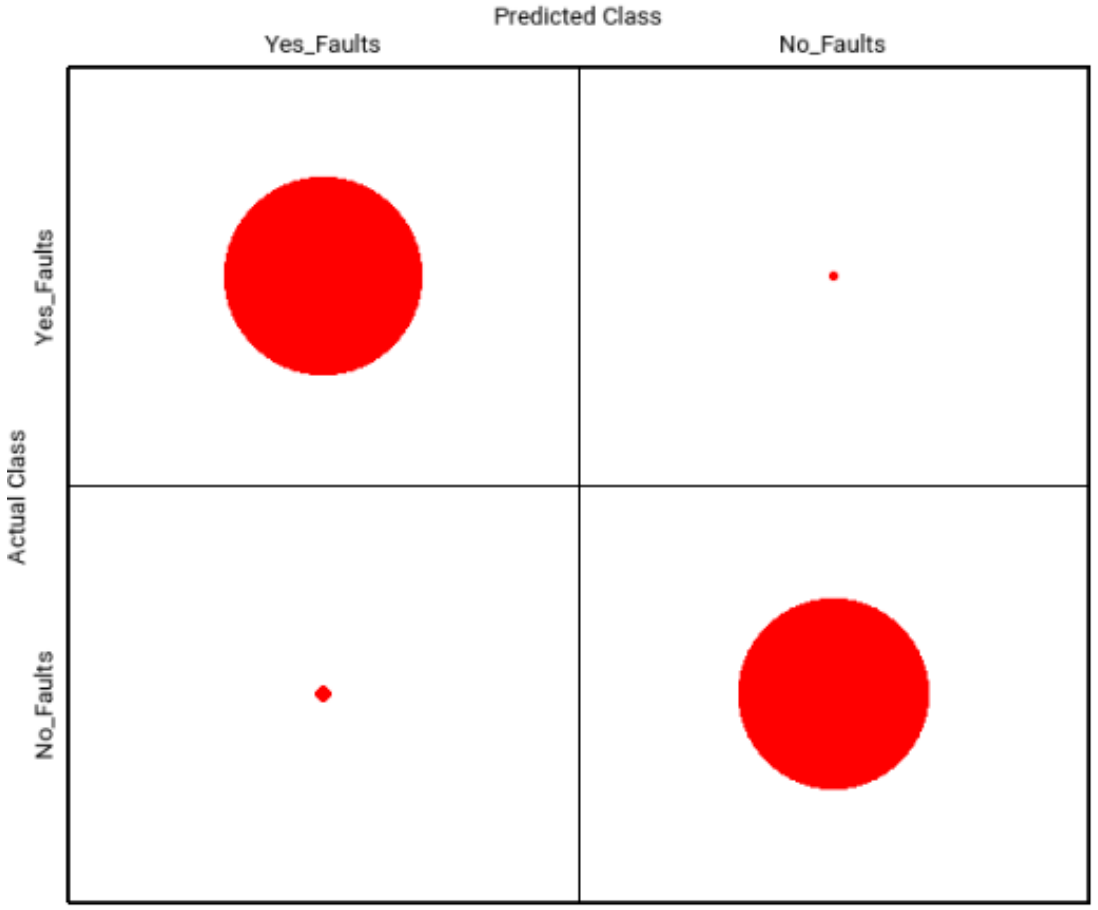




Kupe Field, Taranaki Basin, NZ

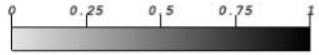


Here are examples of successes



Utica Shale, Ohio, USA

Refayee H. Jaglan H. Adcock S., 2016, Fault and fracture detection in Unconventional reservoirs: A Utica shale study: Unconventional Resources Technology Conference, Expanded Abstracts.



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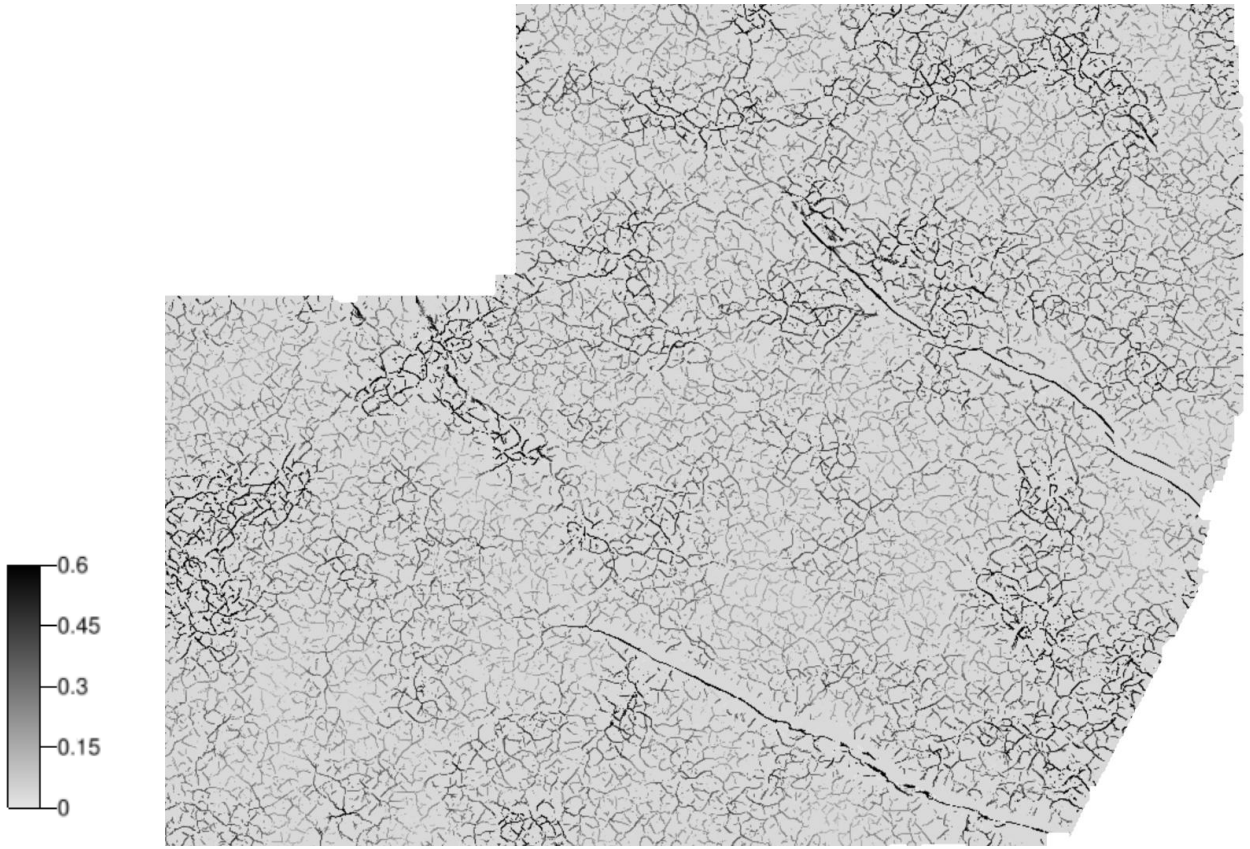
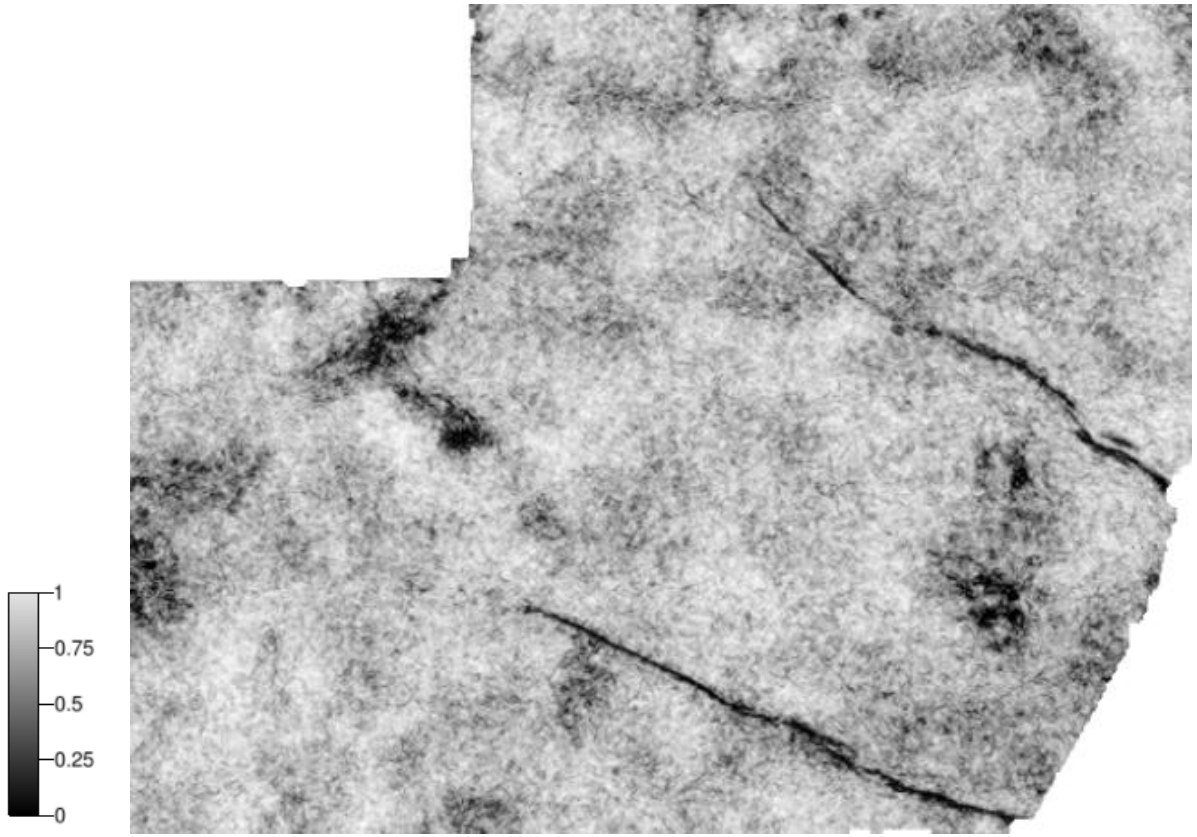
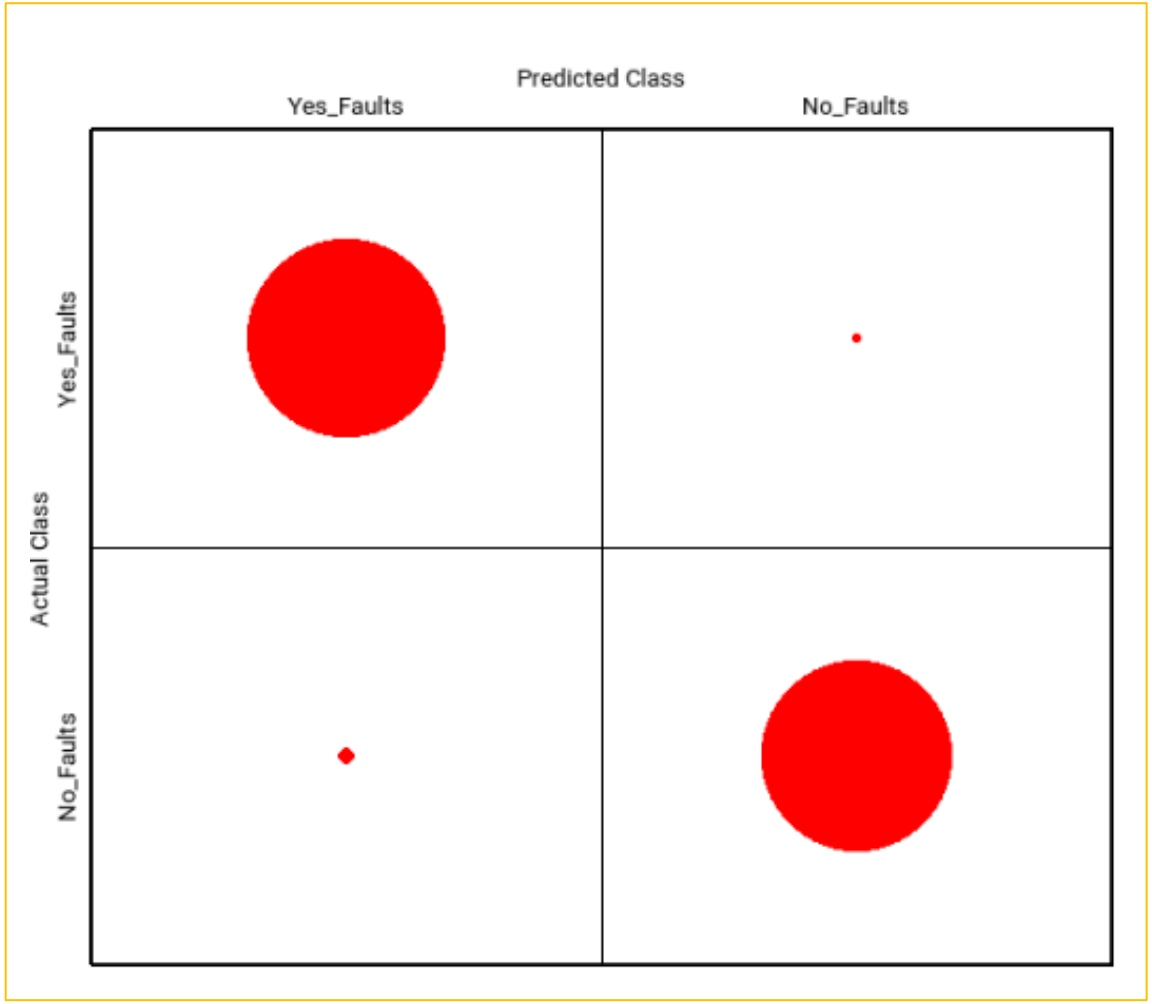


Thinned Fault Likelihood



Minimum Similarity

Here are examples of successes



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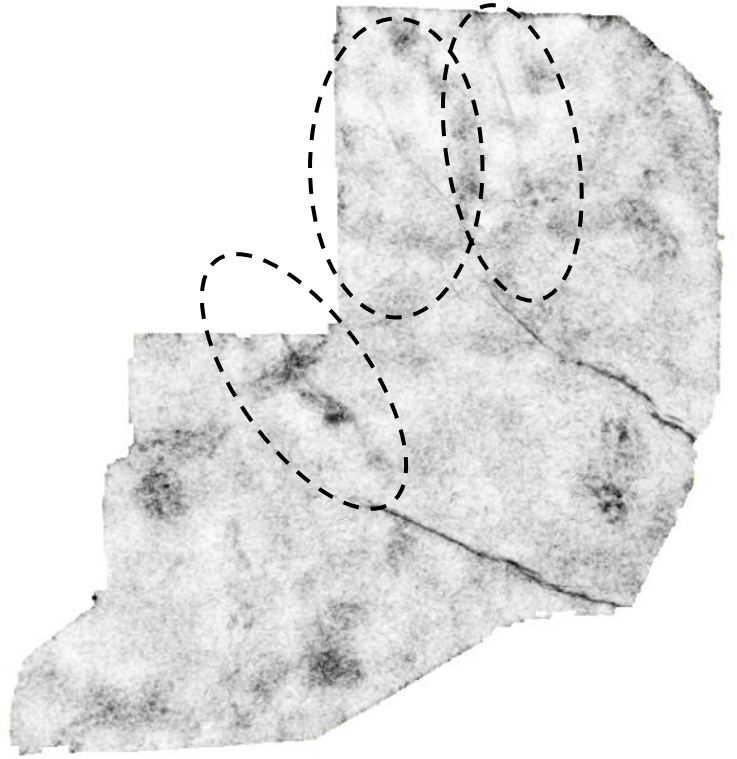

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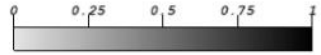

What is in it for You?

- Invest and sponsor development
  - Early access to license
  - Input during development
  - Case study on data of choice
  - Option to keep temporarily proprietary
- Acquire the plugin
  - Rental and purchase options
  - Utilize leading technology in project work
- Service work
  - Application of new technology by dGB specialists

More information

Visit dGB Earth Sciences to learn more

Grab a handout

Link to YouTube video

Visit booth **1043**