ENTHOUGHT DEEP LEARNING AUGMENTS SEISMIC INTERPRETATION Ben Lasscock, Brendon Hall - Enthought Mason Dykstra, Mike Seeber - Anadarko Petroleum Corporation

summar

Seismic interpretation requires the repetitive application of pattern and texture recognition of seismic images, informed by the geologic understanding of a skilled interpreter. Al/Machine Learning (ML) promises to alleviate the repetitive nature of this task, accelerating discovery, providing more time for experts to focus on the science and gaining a deeper understanding of the subsurface.



An interpretation of the seismic data made by an expert. (left) A 2-D section taken from the Poseidon data (Source: Geoscience Australia) (right) A 2-D section taken from the F3 dataset. Colors represent parasequences.

The waveforms seen in the seismic data are the result of interference patterns that are reflective of a range of geological possibilities in the subsurface. Deep learning was explored as a way to resolve this non-uniqueness by replicating the interpretive understanding of an expert interpreter.





In this poster we demonstrate a method to automate the task of sequence stratigraphy. An interpretation is made on a minimal subset of 2-D sections taken from the 3-D data. A deep learning system is then trained to replicate this interpretation throughout. Minimal training data is required, <0.1% of Poseidon was labeled and <0.5% of F3 was labeled.

Methodology

Poseidon - Australia

Engineered 2-D wavelet based features were found to be good discriminators of texture in an unsupervised setting. Coupled to a multilayer percepteron, these features have reasonable predictive power.



Most Similar





Ensembling - Strength through diversity



PREDICTION

Prediction using an ensemble of three convolutional models was found to improve performance overall. The first is derived from the wavelet based features we have engineered, coupled to a multi-layer perceptron. The second is an application of transfer learning with VGG-16 pre-trained on imagnet. The third is a UNet architectures fully trained on the available seismic data. The method is designed to leverage future innovation in network architecture.

Post-Processing

The classification algorithm is responsive to local patterns and textures seen in the seismic; in addition to this, we have an a priori understanding of the geologic character of the solution, and in this case, the sequential order of the parasequences. Structurally oriented smoothers and a Viterbi decoding are applied to denoise the prediction based on these insights.



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Our algorithm classifies the parasequences in 3-D, to visualize the results we render the interface between neighboring sequences and render them as horizons. The quality of the prediction is seen in the level of detail in the rendered horizons.





Here we show the interface between the top of salt, and a low amplitude chaotic region above it. Additional enhancements to improve prediction around faults is left as future work.



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Poseidon (Source: Geoscience Australia)

(Left) The interface between parasequence above the basement (green) to the water bottom (blue).