Deployment of a Cloud-Based Deep Learning Model for Well Log Correlation at Scale

Seth Brazell
Generating Robust Stratigraphic Frameworks

Total Wells Correlated: 9,000+
Total Tops Interpreted & QC’d: 30,000+
Total Time: 20 Days

Delaware Basin
Central Basin Platform

40 km
Scalable Solutions to Reduce Subsurface Uncertainty

How do we efficiently harness all available data to generate robust subsurface models?

- Interpreter-driven, machine-assisted solution for high-density datasets
- Propagates defined markers w/ advanced deep learning algorithm & standard correlation techniques
- Objective, repeatable, scalable
- Actively deployed in exploration and development assets

Data from 100,000s Vertical Wells

- Greater Permian
- Delaware Basin
- Central Basin Platform
- Midland Basin
Existing Approaches to Well Log Correlation

- Well log auto-correlation attempted since 1970’s

- Resurgence in interest
  - Improved computing
  - Onshore unconventional plays with 1000’s – 10,000’s of wells

- Major limitations to existing approaches
  - Computationally too intensive
  - Restricted to a defined cross-section
  - Drift with distance
  - Get ‘lost’ at faults/facies changes

- Existing approaches are too rigid…

(Lineman, 1985)

(Wheeler, 2015)
Machine Learning: algorithms that perform a specific task without explicit instructions

Deep Convolutional Neural Network Architecture

Quantitative Match Probability

6+ Million Samples
Next-Gen Correlation Tool

Universal Deep CNN Pattern Recognition Model

3D Search & Correlation Tool
Advanced Methology

Propagation Logic

- Tops & comparison distances defined by interpreter
- Incorporates standard correlation rules
- Tops do not cross
- Adheres to structure and isochore statistics
- Minimizes false positives to reduce time spent reviewing

*Distance btwn wells = 4 miles*
Case Study: STACK Play, Anadarko Basin

20 Manually Correlated “Seed Wells”

20 Wells Interpreted. 3.6% Data Coverage. 30 minutes
Give an Example (Define Seed Wells)

Tune Parameters, Add Seed Wells | Run ML Correlation Tool

Define Next Steps | Generate Maps

Verify

QC Cross Sections
Stratigraphic Framework Evolution

Top of Meramec Structure Maps

Seed Well Selection
- 20 Wells Correlated
- 4% Dataset Coverage
- Time 30 Minutes

1\textsuperscript{st} Iteration
- 457 Wells Correlated
- 84% Dataset Coverage
- Time 9.5 Minutes

2\textsuperscript{nd} Iteration
- 510 Wells Correlated
- 94% Dataset Coverage
- Time 1.7 Minutes
Machine Learning Results: 97% Accuracy
Enabling Interpreters to Focus on Complexity

Manual vs. Machine-Assisted Top of Meramec
Case Study: Summary

• Deployed a novel tool for well log correlation
  • Pattern recognition using deep neural network
  • 3D search window & traditional correlation logic
  • Incorporated SME insights

• Iterative approach yields robust & accurate correlations
  • 2 tool iterations
  • 4% to 94% dataset coverage
  • 11 minutes compute time
Leveraging AI to Enhance Reservoir Characterization

1. Standardization
2. Stratigraphic Framework
3. Petrophysical Data QC
4. Petrophysical Modeling
5. Property Analysis
6. 2D Mapping
7. Visualization & Analysis
8. Value Extraction

Data Prep

Interpretation & Analysis

Prediction

Petrophysical Data QC

Visualization & Analysis
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