Three Decades of Reservoir Modeling using Artificial Intelligence: Lessons Learned and Future Trends for Unconventionals

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The Winters and Summers of AI (Tad Gonsalves, 2018)

The long winter of AI in Oil and Gas
Evolution of Reservoir Modeling

- Geostatistics transformed reservoir modeling in the late 80’s to 90’s to better represent the reservoir framework and its rock properties.
Why AI in reservoir Modeling?

- Geostatistics uses many assumptions that are better suited to rock properties controlled mainly by deposition.
- Many rock properties are affected by processes that occur AFTER deposition (diagenesis, tectonics, etc.).
- Statistical methods have performed very poorly since the “statistics” of these reservoirs will always remain elusive.
- Carbonate and naturally fractured reservoirs are some of the examples where AI could provide better modeling approaches. We use the case of naturally fractured reservoirs to illustrate this point.
Why AI in Reservoir Modeling?

We understand how each geologic, and geomechanical factor affects density and orientation of the natural fractures. But we cannot understand how their combined effect works to create the resulting complexity.

In every naturally fractured reservoir, there is a unique relationship between its geologic drivers and the final complex distribution of the fractures that can be estimated and modeled very accurately with AI tools.
Why AI tools?

- We have very poor understanding of the drivers that control reservoir complexity ➔ AI Classifications and ranking tools allow us to understand the drivers.

- We need predictive models using limited data ➔ Modeling tools such as Neural Networks allow us to capture the intricate relationship that exist between the target reservoir property and its drivers with sometimes as little as one or two wells.

Blind well validation
AI Provides Tools - Domain Expertise Provides the Solution

4 people spent 2 years (8 man years) trying to figure out the right drivers !!!

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Denver, 1998
Focus on the drivers not on AI tools

• What we learned during these 3 decades using AI in reservoir modeling?

• FOCUS ON THE DRIVERS especially advanced high resolution seismic attributes

• Focus on many ways to compute the target reservoir property at the wells
Linking the Drivers to Cumulative Oil with AI tools

Seismic and Geologic 2D Attribute Maps

Neural Net

Cumulative oil at the wells

Cumulative Oil 2D Maps
Comparison between Average Permeability map and Cumulative Shale Oil Production
Combining Multiple AI Derived Reservoir Models: Definition of Shale Capacity “SC”

- The four shale drivers are used to define the SHALE CAPACITY SC ➔ Geologic “Sweet Spots” for landing and geosteering

\[
SC = TOC_{\text{net}} \times \Phi_{\text{net}} \times BRT_{\text{net}} \times FD_{\text{net}}
\]

- Where \( TOC_{\text{net}} = TOC > \text{cut-off} \) else 0
- \( BRT_{\text{net}} = BRT > \text{cut-off} \) else 0
- \( FD_{\text{net}} = FD > \text{cut-off} \) else 0
- \( \Phi_{\text{net}} = \Phi > \text{cut-off} \) else 0

SPE 167779, (2014)

Resource
Plumbing needed to turn resource into reserves

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Landing Zone Selection and Geosteering based on AI Tools

Geosteering technology increased production by 20% in one year for this shale operator

URTEC 2693870, (2017)
Real Time Live Geomechanical Models Derived Using AI Tools

AI derived real time 3D reservoir models using real time Logs derived from surface drilling data SPE 188087, (2017)

Using surface drilling data to create real time geomechanical logs, pore pressure, stresses and fracture index, AI tools are used to build real time 3D reservoir models that help geosteer the shale wells in the target zones.

Conventional geosteering with 2D cross sections And GR logs
AI Tools help when the reservoir interacts with a complex physics

- Adding to the reservoir properties, the fracturing parameters (proppant loading, number of clusters, stage length, etc..) to better predict performance of unconventionals
The Future of AI Tools in Reservoir Modeling

- Reservoir modeling
- Drilling and geosteering
- Refrac candidate selection
- Adaptive Fracing & Geoengineered completions
Will the Oil and Gas Industry Seize the Opportunity?

Artificial Intelligence: The Future Of Oil And Gas

Anoop Srivastava (http://www.digitalistmag.com/author/anoopsrivastava)

Few individuals and firms will be extremely successful using AI and Data Analytics. But the industry as a whole may not. Time will tell.
Discussion