USE OF “EARTH INTELLIGENCE®” FOR AUTOMATING GEOPHYSICAL DATA INTEGRATION

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Summary

Cheap access to HPC and Cloud computing have boosted the use of advanced AI machine learning algorithms to process, interpret and integrate geophysical data sets.

AI enables to scan the full space of geophysical data from their acquisition to their integration into Earth models. This deeply impacts the usual processing interpreting modelling workflows and eventually results in seismic images that seem to be “actual photos” or “3D prints” of Earth subsurface at the seismic scale.

However, the uncertainty quantification challenge is not solved and operators may still face significant differences between drilling expectations and actual results.

This paper introduces the concept of Earth Intelligence® to differentiate ML algorithms derived from consistent mathematical probabilistic models minimizing estimation errors (differences between drilling expectations and actual results) from conventional ones minimizing differences between output solutions and input data.

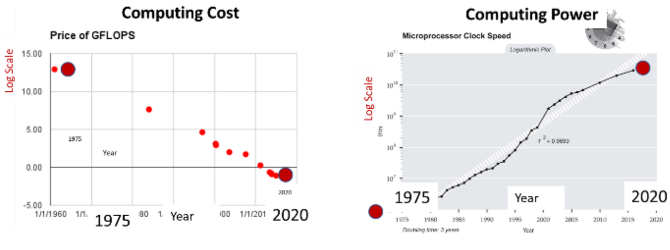
Although the use of conventional AI algos is rightful for processing or interpretating geophysical data, however EI algos should be preferred when integrating them to Earth models.

Moreover, using EI algos allows for full automation of geomodeling workflows and usefully replace 3D “blackbox” numerical models by traceable, shareable, storable and updatable P10 P50 P90 scenarios.

An example of EI case study is given to solve structural issues in exploration prospect targeting.

Introduction

Handling and processing Big Data sets is nothing new for geophysicists who have always been at the forefront of computing technology since its inception in the 70’s. 50 years of continuous exponential increase of computing power and decrease of computing costs (figure 1) have unlocked the use of complex “machine learning” algorithms greedy in computing time. The benefit of AI for processing and interpretation geophysicists is its ability to valorize the full set of acquired and processed data, not having anymore to look for short cuts, decimations and simplifications. One still outstanding major challenge to fully benefit from these “harder” seismic data is their integration into geomodels that support E&P decision making.



Trends in the cost of computing
from AI impacts aiimpact.org

The singularity is near
from Ray Kursweil Viking adult 2005

Figure 1: Correlated decreasing computing cost and increasing computing power between 1975 & 2020

Standard AI NN algos well perform for solving issues on processing and interpreting Big seismic data inputs, not for matching them to the always scarcer well information.

Specific AI algorithms must be preferred in this case and we shall call them Earth Intelligence® (EI) algorithms to clearly diffrenciate them and generate fruitful discussions about their effectiveness.

Artificial versus Earth Intelligence

When processing Big **Geo** referenced data sets, Classical ML algorithms (Neural Networks for example) work on minimizing the difference between the output and the input Geo Data sets (Figure 2). They are usually useful for Data processing and interpretation (3D seismic cubes for example) as they contribute to minimize uncertainty on input seismic data. Nevertheless, when applied to geomodelling issues, they are missing the uncertainty that is matching output Geomodels to actual Earth Resource, hydrocarbon bearing reservoirs for example. This Model - Resource difference can be rationally defined and modelled by using Topo Probabilistic Models (Ref 1). We introduce the term of Earth Intelligence to characterize the set of “kriging based” algorithms that work on minimizing the “a priori unknown” difference between the EI Model output and the actual reservoir (Figure 3).

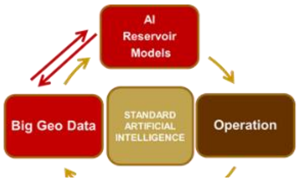


Figure 2 : Standard ML algos minimize distance output solution / input data

These Kriging/ Simulations algorithms (Ref 2) (and there is a huge variety of them, not only simple or ordinary kriging !), are ML algorithms that quantify and minimize the difference between Model and Reservoir (estimation error), enabling rational Uncertainty management through reliable P10 P50 P90 confidence intervals.

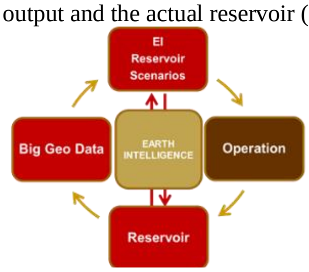


Figure 3 : EI ML algos minimize distance output solution / Actual Earth Resource

Replacing “knowledge based geomodels” by probabislitic “ P10 P50 P90 scenarios”

Earth subsurface numerical models aim at replacing the more or less unknown subsurface actual features at the time of making operational decisions throughout the resource exploration production life cycle.

Before the digital age, when seismic data were considered soft data and well data were few, geoscientists knowledge and expertise would fill the information gap when building 3D numerical models. This was the time of geomodelling computing platforms, enabling loading, visualizing and modeling operations as fast as possible. The resulting 3D numerical models would then replace the input data for best supporting operational decision making.

At the digital age, when "Data is the new oil" as Clive Humby coins it, the value is in the Data, that should be fully explored and mined instead of being left out after the modlling step. And this is actually the field for AI and EI to directly link the data to the operational decision without necessarily replacing them by numerical models. What operators actually need for making decision are scenarios, that are combinations of involved data sets, parameterized computational workflows and appropriate numerical supports (3D models maps expectation curves …). Current low, base, high case numerical models appear as "black boxes" difficult to share, question, and more than anything, update with new data in real time.

It is the role of AI and EI to automate the computational workflows and to optimize their parametrization. EI then replace knowledge based models by automated adapted probabilistic scenarios delivering P10 P50 P90 answers (be it figures, probability maps or numerical models) relevant to solve the operational issues.

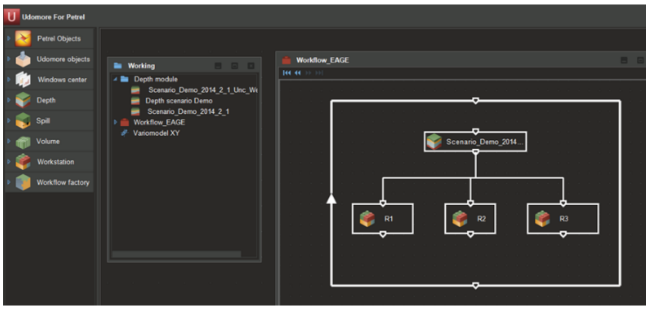


Figure 4: Example of User Interface of UDOMORE EI platform for automated computation of GRV on 3 prospect targets

North Sea Case study : Consistent prospect targeting

Operational Issue : Evaluate undrilled prospect structural GRV potential

Data: Figure 4

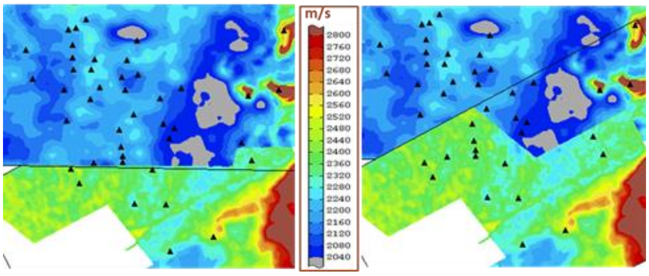


Figure 4: A set of overlapping seismic surveys and well exploration well data base

EI probabilistic workflow: Figure 5

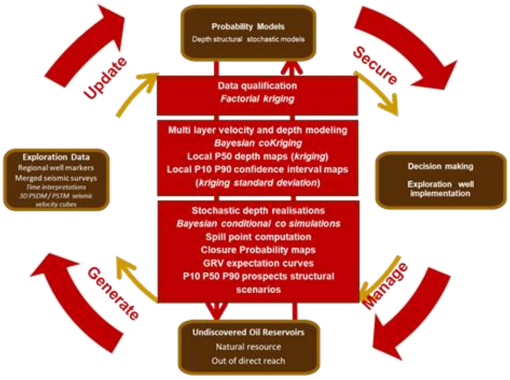


Figure 5 Automated workflow for compting alternative exploration scenarios scanning seismic, well and velocity data

Output : Figure 6

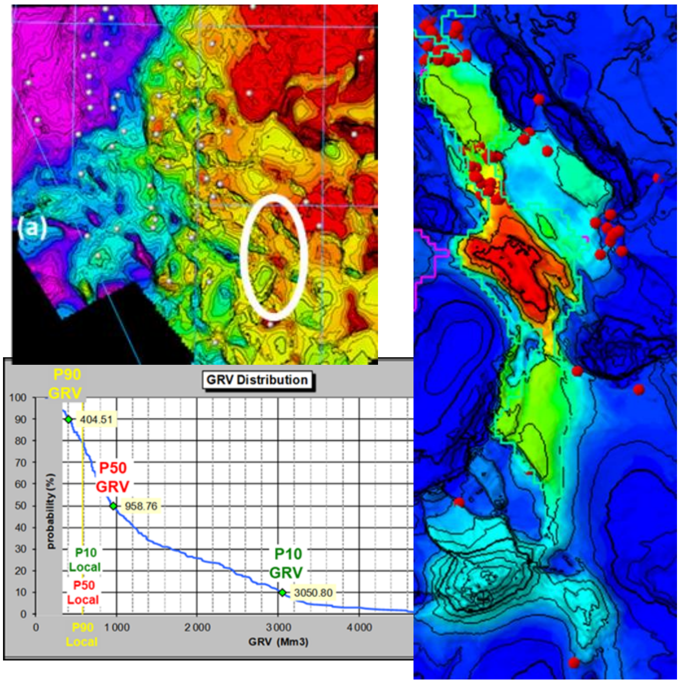


Figure 6: : Real time consistent computation of structural spill point locations, closure probability maps and GRV expectation curve with P10 P50 P90 structural scenarios that are positively benchmarked against existing knowledge based structural interpretations

Conclusion

Among all AI techniques developed to process interpret and integrate geophysical data in E&P decision processes, Earth Intelligence (EI) ML "kriging" algorithms are unique to consistently handle the uncertainty issue, that is the observed difference between E&P expectations and realisations. By doing so, EI ensures consistent and optimized integration of geophysical data, automation of geomodeling workflows, and ultimately replace current 3D geomodels by reliable, traceable, shareable, storable and updatable P10 P50 P90 scenarios.

Acknowledgments

SEISQUARE team for developing & marketing the UDOMORE EI platform.
ConocoPhillips Norway for permission to publish at EAGE 2018
Eric Andersen, Alessandro Mannini, and Mark Shahly for their support in implementing UDOMORE EI platform in PETRONAS , BEACH ENERGY and AKERBP

References

(1) Vera Pawlowsky Jean Serra 2019: Matheron's theory of regionalized variables Oxford University
(2) Luc Sandjivy (Seisquare): Kriging season 3 First EAGE Digital conference Vienna 2021
(3) Mickael Collet (Seisquare), Luc Sandjivy* (Seisquare), Robert Pfau (ConocoPhillips Norway)
Building a stochastic geophysical workflow for consistent prospect targeting: a North Sea Case Study EAGE 20