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Seismic Inversion with Gradient Boosting

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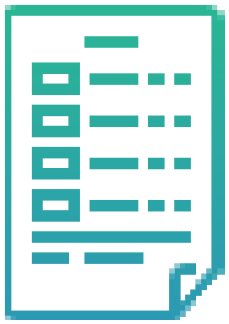

Today's Agenda

Part 1:	Geophysics in the Cloud
Part 2:	Gradient Boosting
Part 3:	Modeling and Predictions
Part 4:	Conclusions

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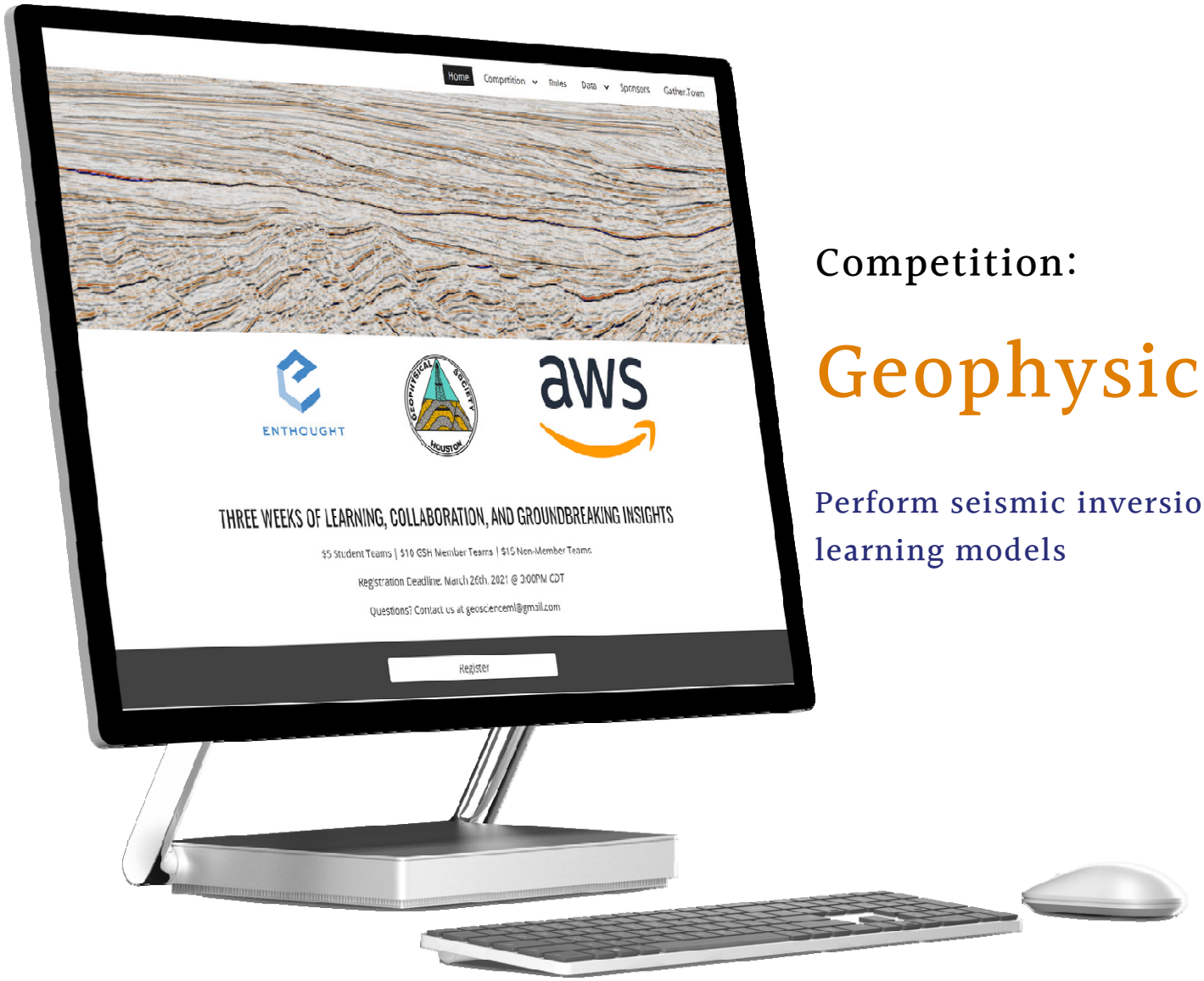
Part 1:

GEOPHYSICS IN THE CLOUD



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Competition:

Geophysics in the Cloud

Perform seismic inversion using machine learning models

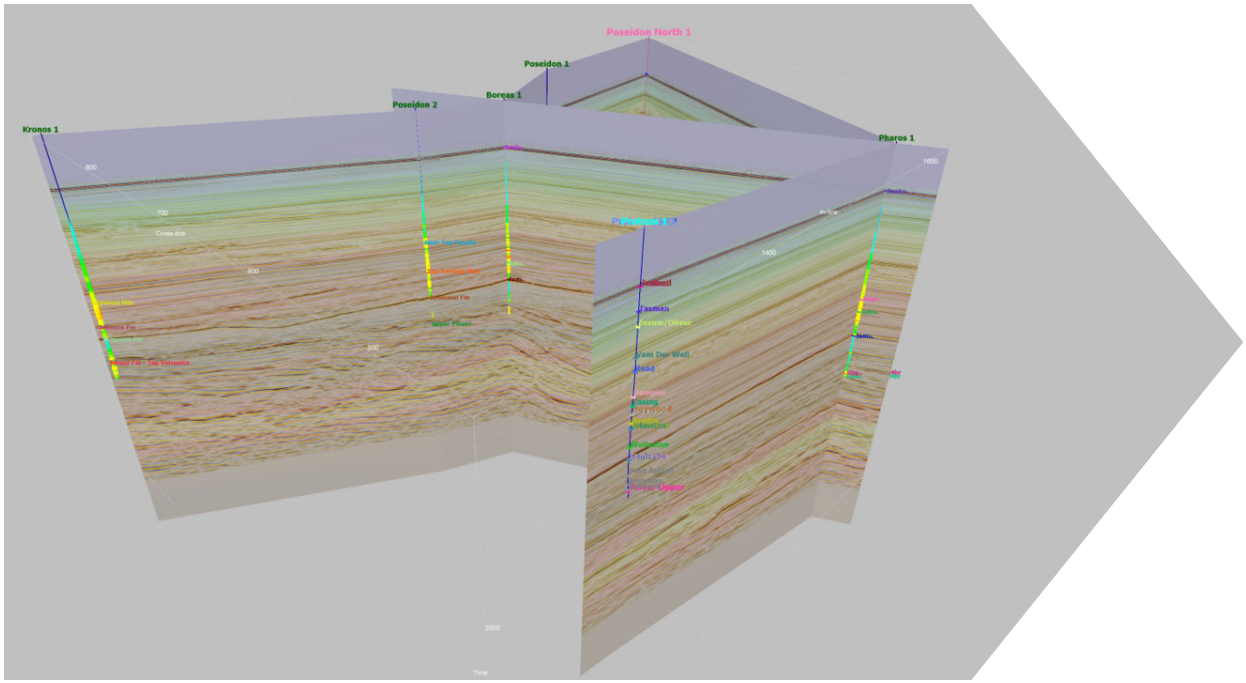
Provided Data and Goals

- 3 weeks competition
- Group effort
- Solutions should be done in Python
- Models were deployed on AWS
- Poseidon 3D

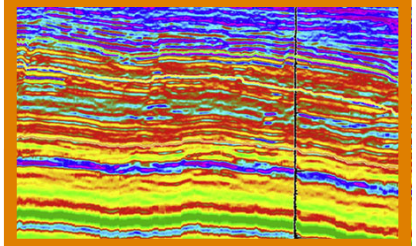
Provided Data		
Data Type	Contents	Comment
Seismic	Near, mid, far, and full stack	3D and Full stack with AGC
Velocity Model	Back ground velocity	Picked velocity
Well Logs	DTC, DTS, RHOB, GR, RSHAL, RDEEP, NPHI, CAL	6 wells tied to seismic
Horizons	WB + 4 tops	-

Provided Data and Goals

- Seismic, wells, and horizons were tied
- Seismic, velocity, and wells were in TWT



Goal



Using a machine learning algorithm, inversion for P and S impedances and Density

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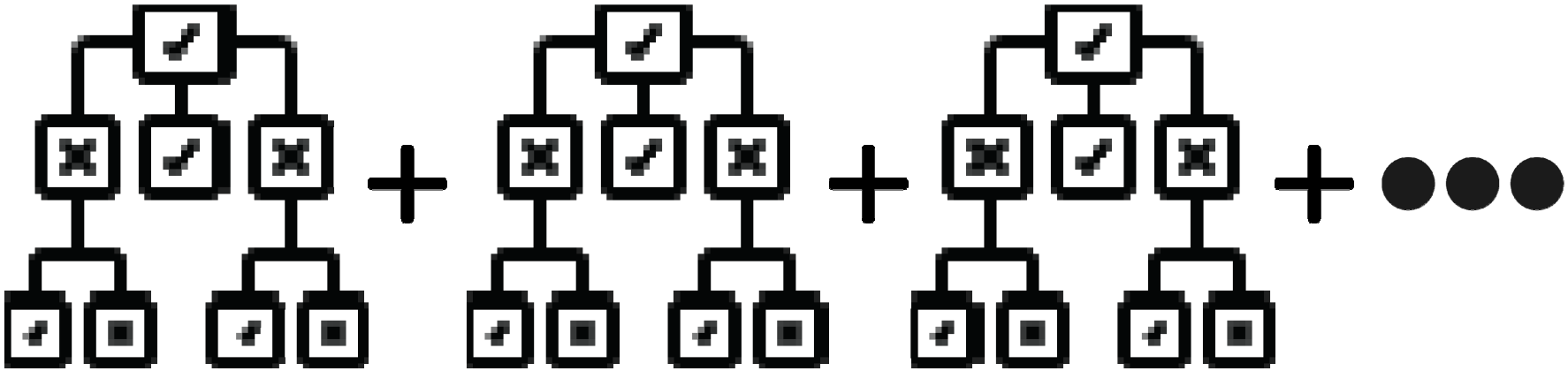
Part 2:

GRADIENT BOOSTING

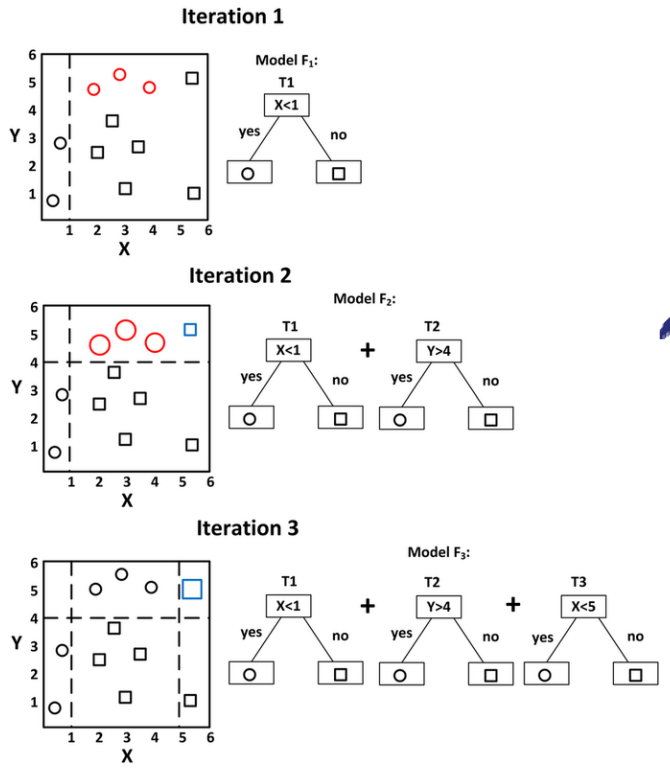
Gradient Boosting

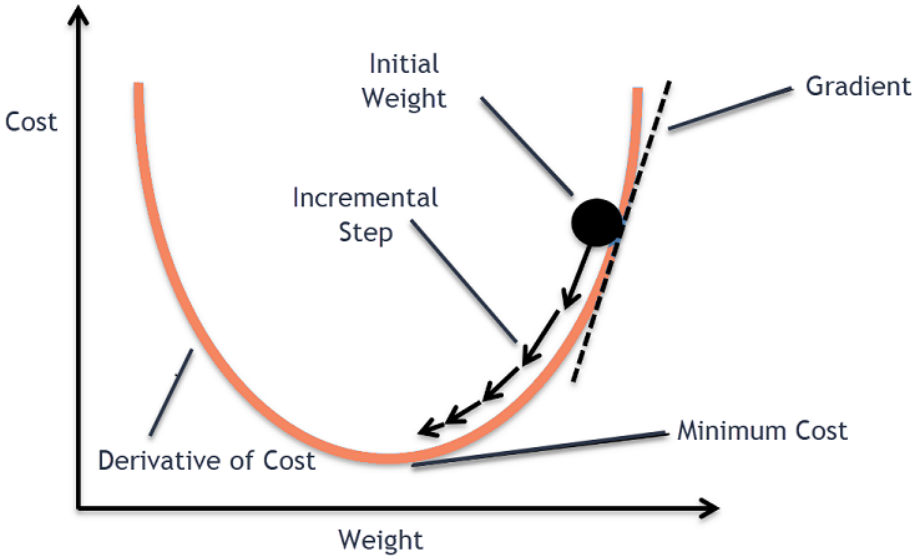
An ensemble of *decision trees*



Gradient Boosting

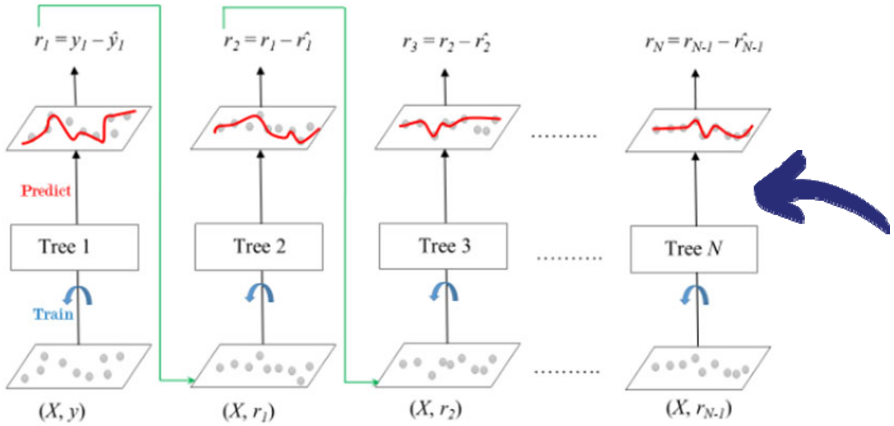
An ensemble of *decision trees*

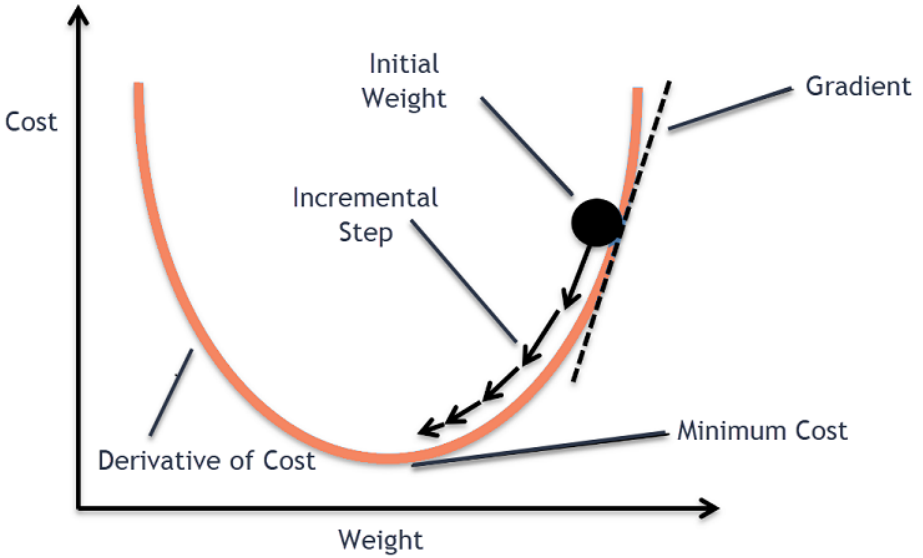




Gradient Boosting

An ensemble of *decision trees*

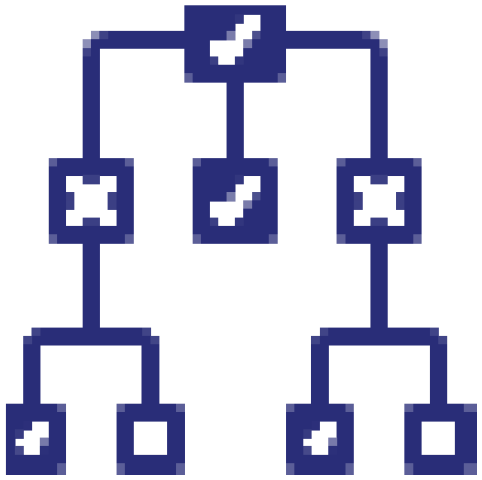


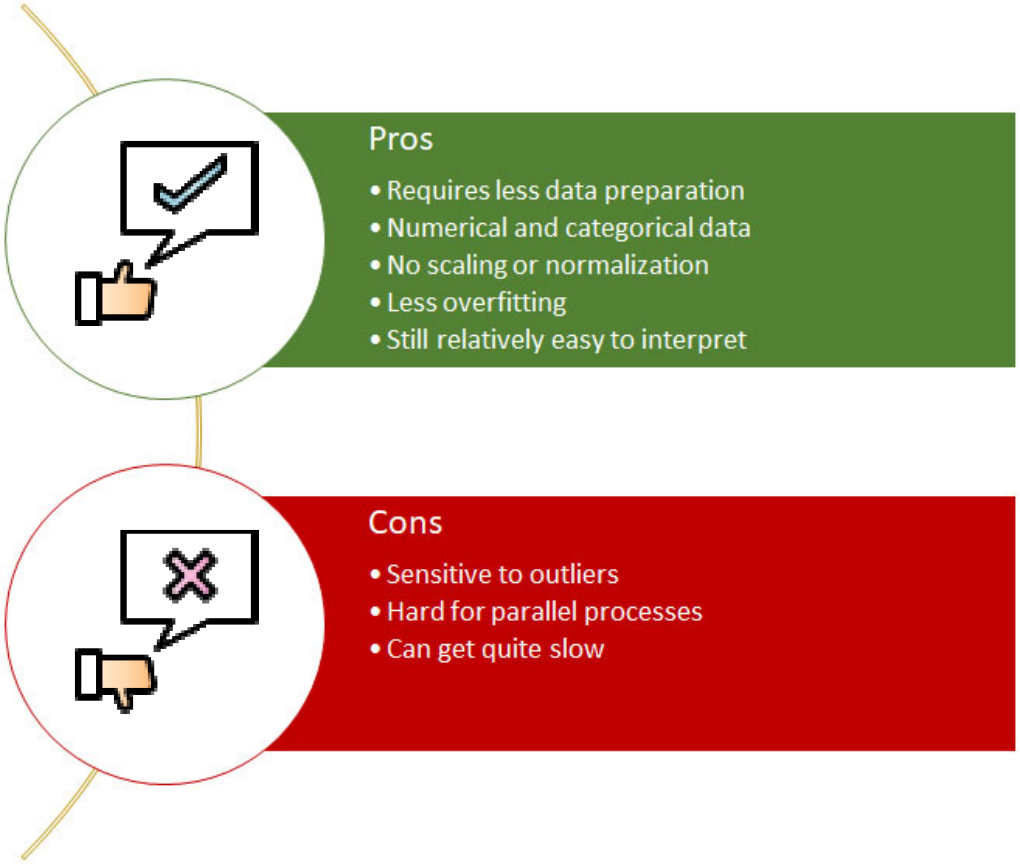


dmlc XGBoost

scikit learn

Gradient Boosting





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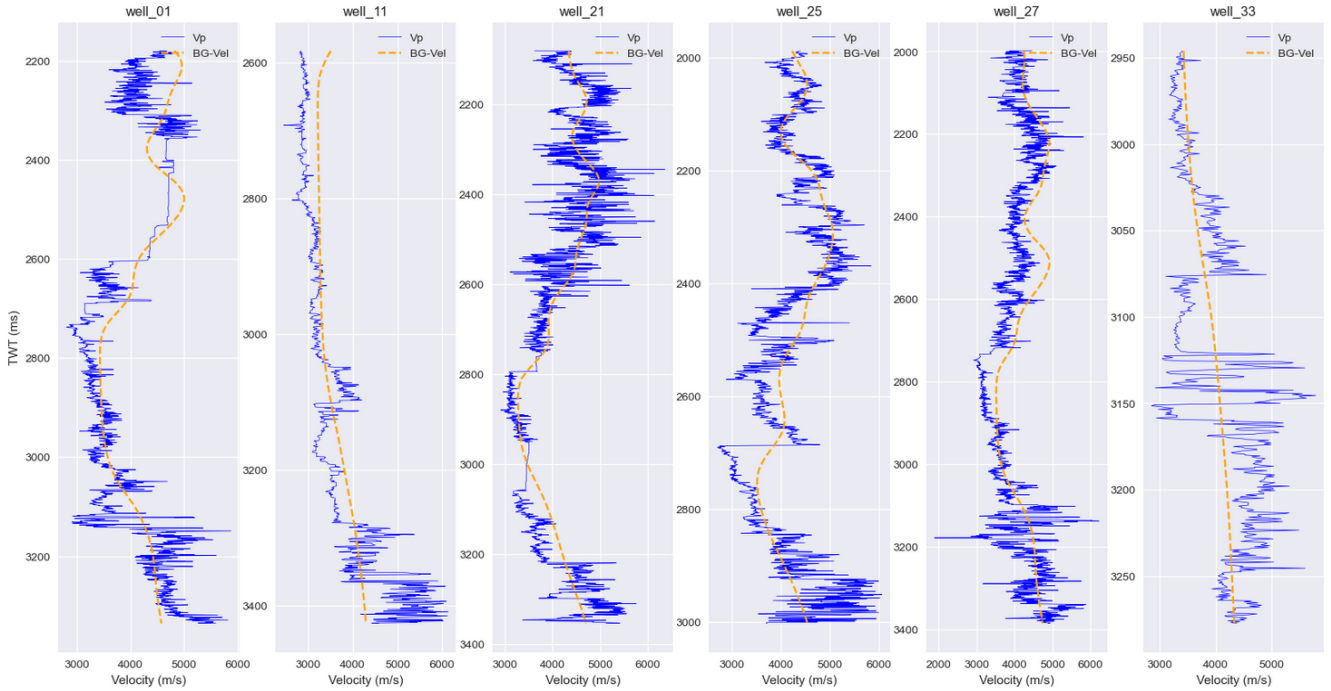
Part 3:

MODELING AND PREDICTIONS

Background

Inversion only at the wells locations



Modeling 1: XGBoost

Input

Seismic near, mid, far; velocity;

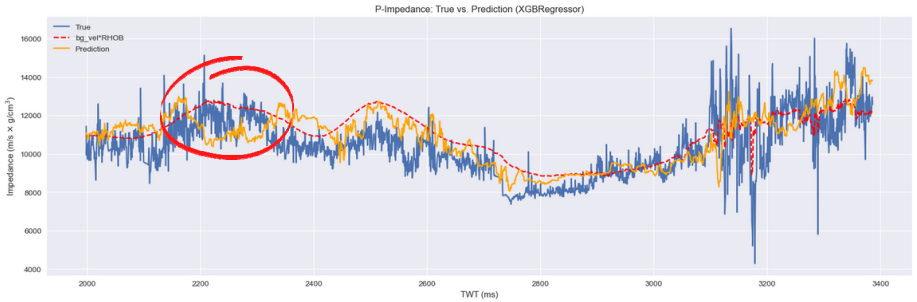
Input

Seismic near, mid, far; velocity; I_P;

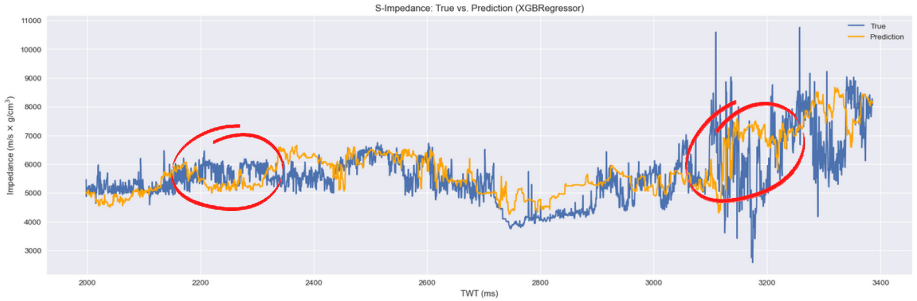
Input

Seismic near, mid, far; velocity; I_P; I_S;

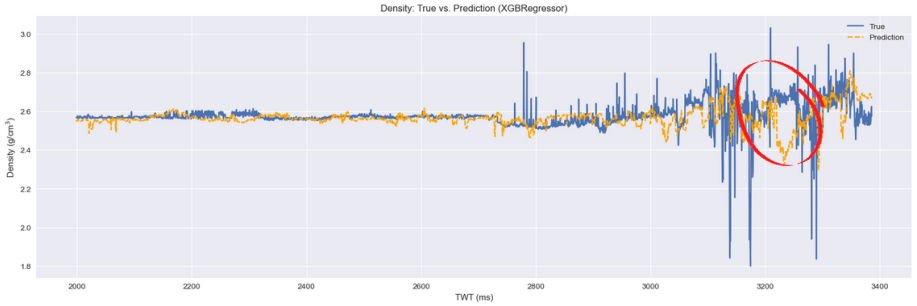
P-Impedance Inversion

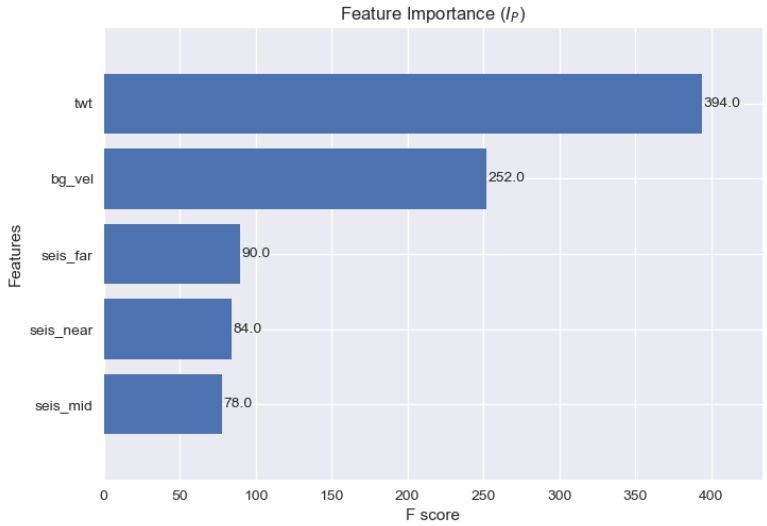


S-Impedance Inversion



Density Inversion





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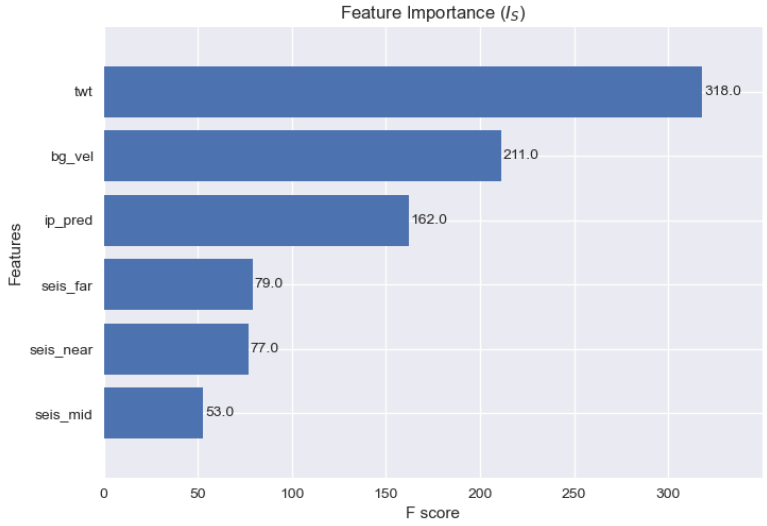
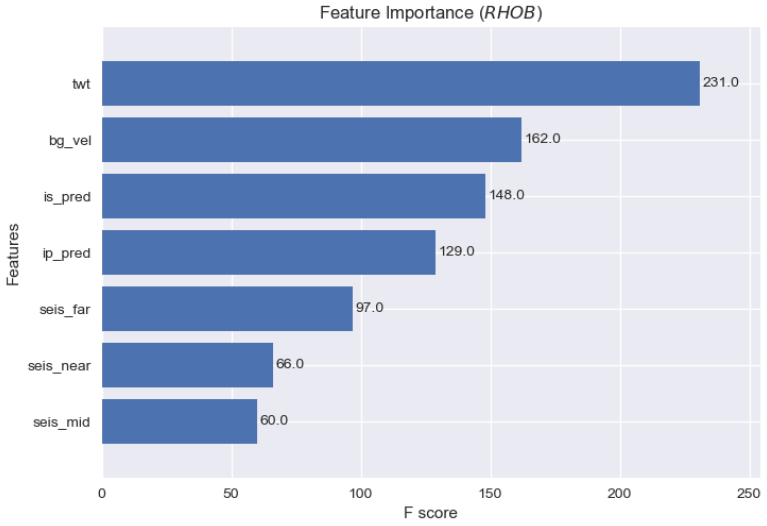
Model:

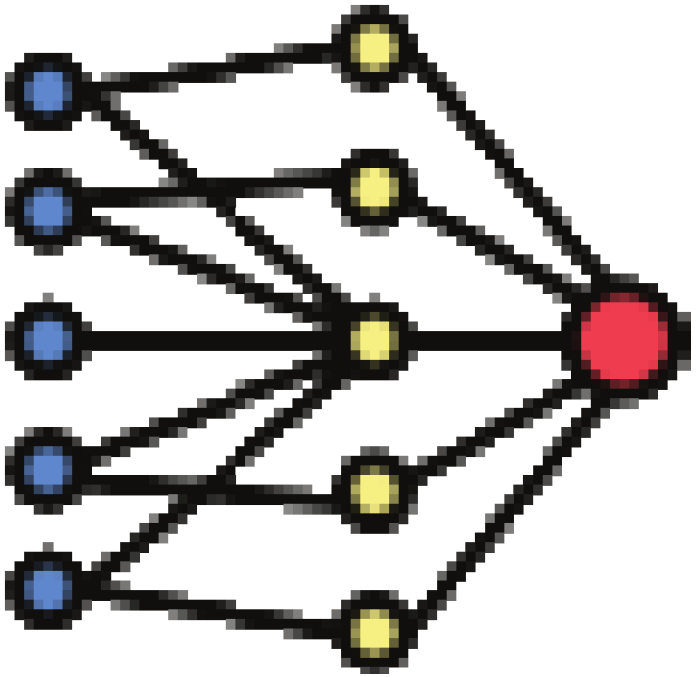
- Robust
- Interpretable
- Easy to apply
- Relatively fast





Modeling 2: Neural Networks

Multi-Layer Perceptron (MLP) Regressor



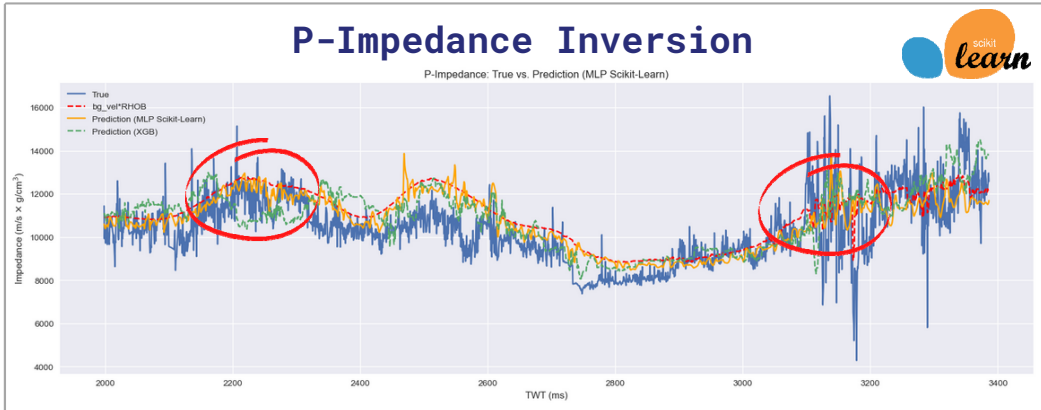
scikit learn

TensorFlow

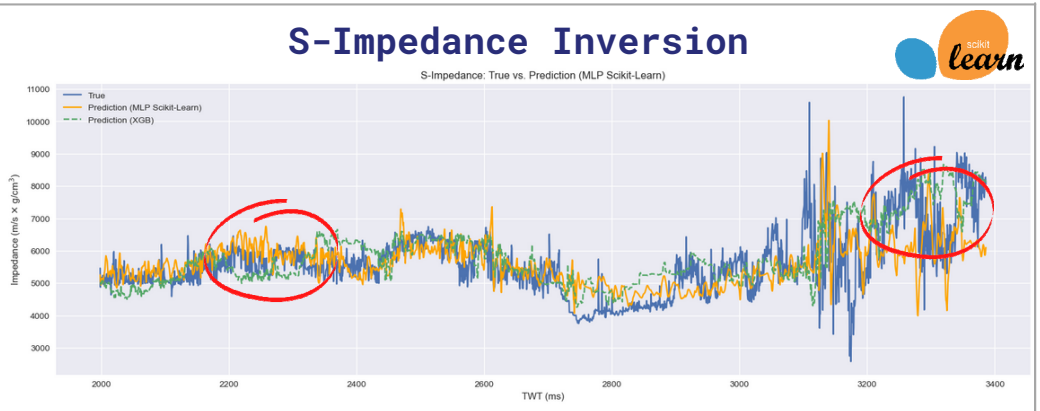
Modeling 2: Neural Networks

Multi-Layer Perceptron (MLP) Regressor

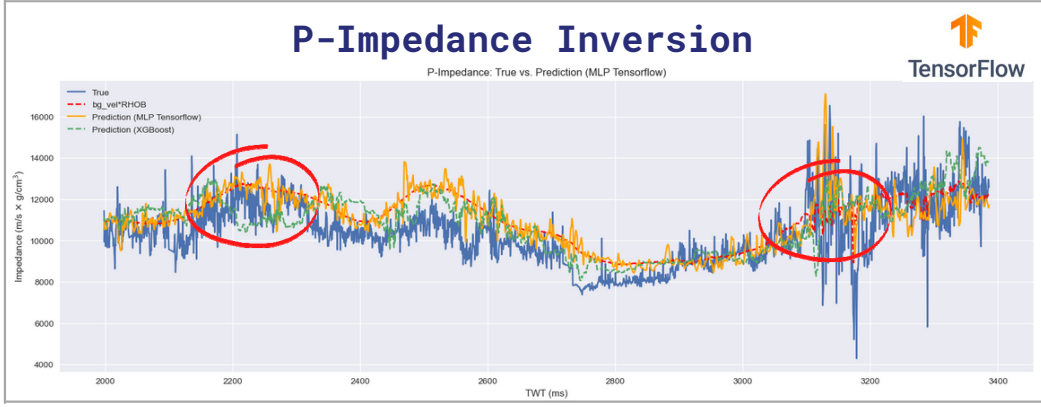
P-Impedance Inversion



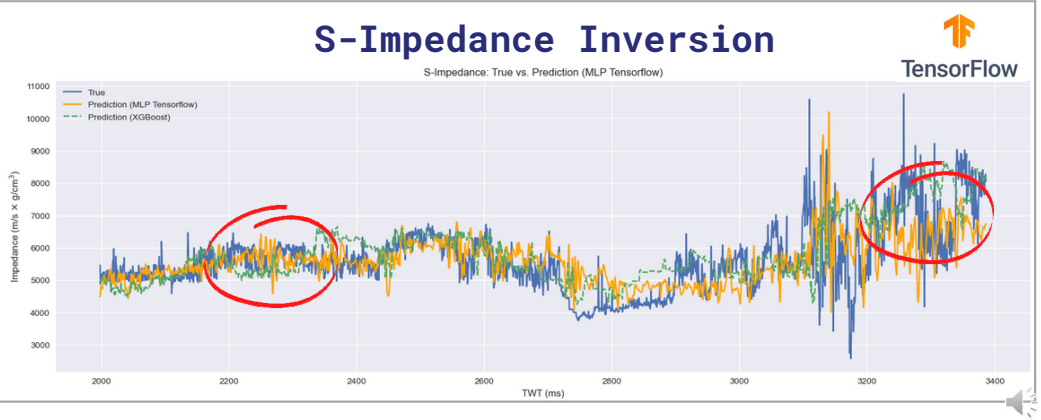
S-Impedance Inversion



P-Impedance Inversion



S-Impedance Inversion



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Part 4:

CONCLUSIONS

Conclusions

Geophysics in the Cloud

- Challenging competition
- Not enough time and data
- Excited for the next one!

Gradient Boosting

- Robust and relatively fast
- Worked well for all the inversions (despite some errors)
- Could invert *density*

Neural Networks

- Required more pre-processing of the data (standardization)
- Noisy
- Could not invert *density*

Acknowledgments

- CREWES Sponsors
- NSERC
- CFREF and GRI
- All the co-authors
- CREWES students and staff


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Thank You!