

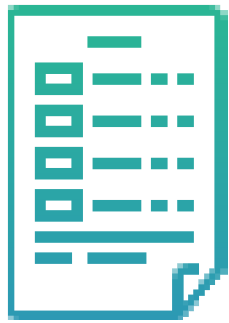


Seismic Inversion with Gradient Boosting

Marcelo Guarido, Luping Qu, Zhan Niu, Kai Zhuang, David J. Emery, Daniel Trad, and Kristopher Innanen

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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





Part 1:

GEOPHYSICS IN THE CLOUD



Competition:

Geophysics in the Cloud

Perform seismic inversion using machine learning models



Provided Data and Goals

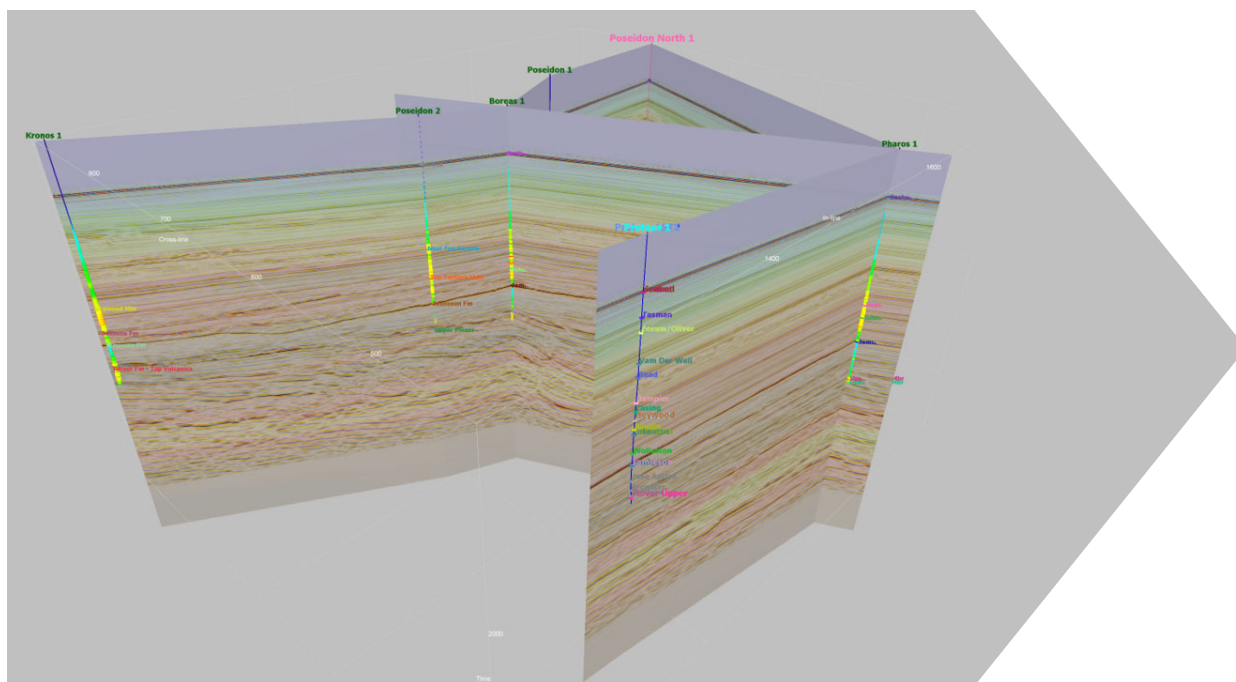
- 3 weeks competition
- Group effort
- Solutions should be done in Python
- Models were deployed on AWS
- Poseidon 3D

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

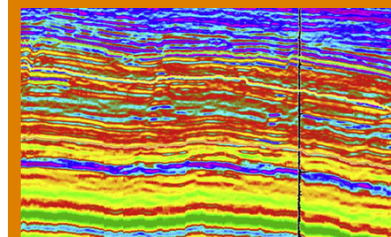


Provided Data and Goals

- 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

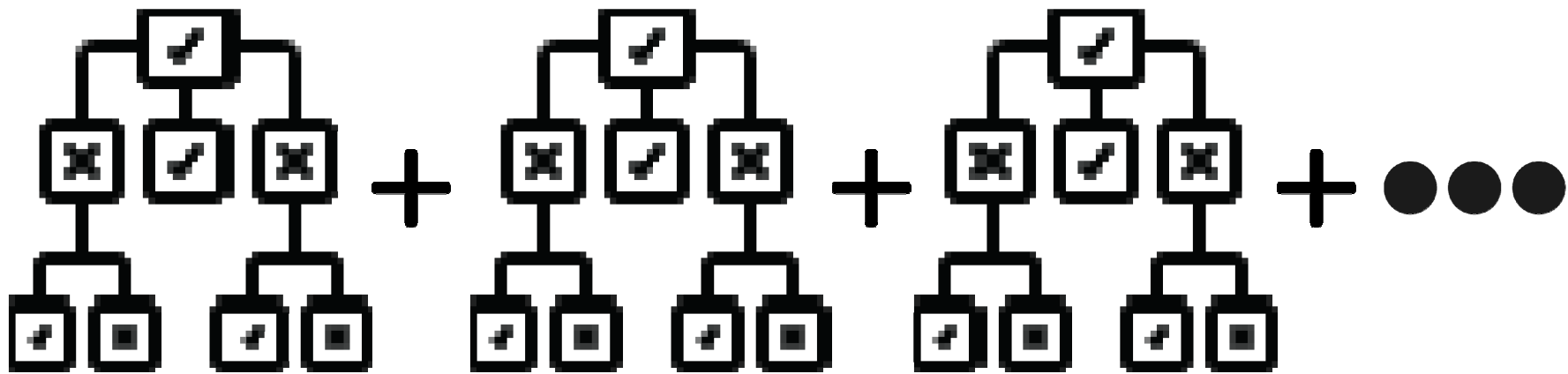
Part 2:

GRADIENT BOOSTING



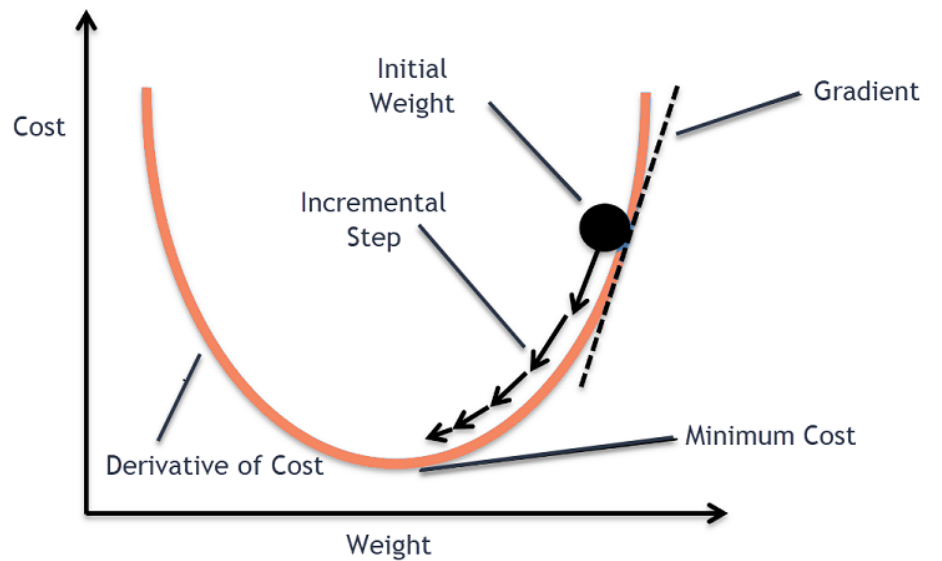
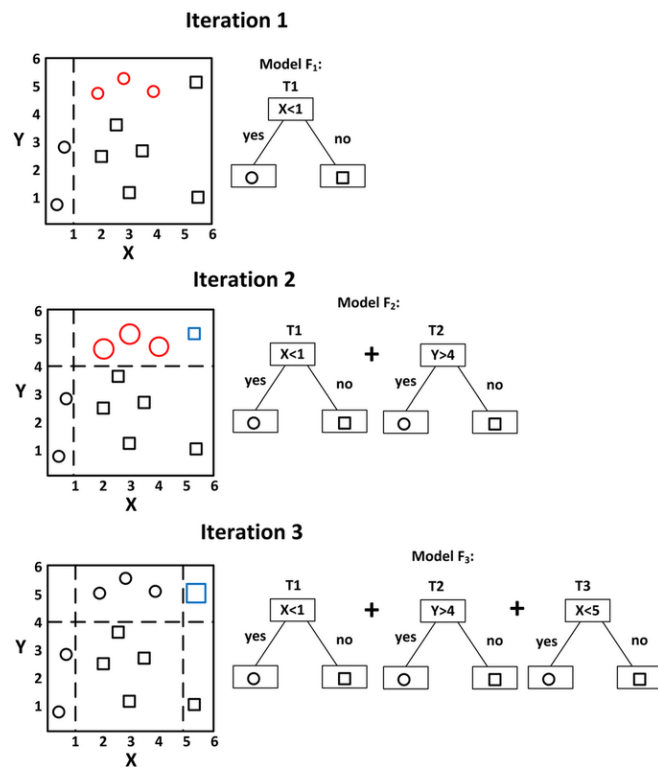
Gradient Boosting

An ensemble of decision trees



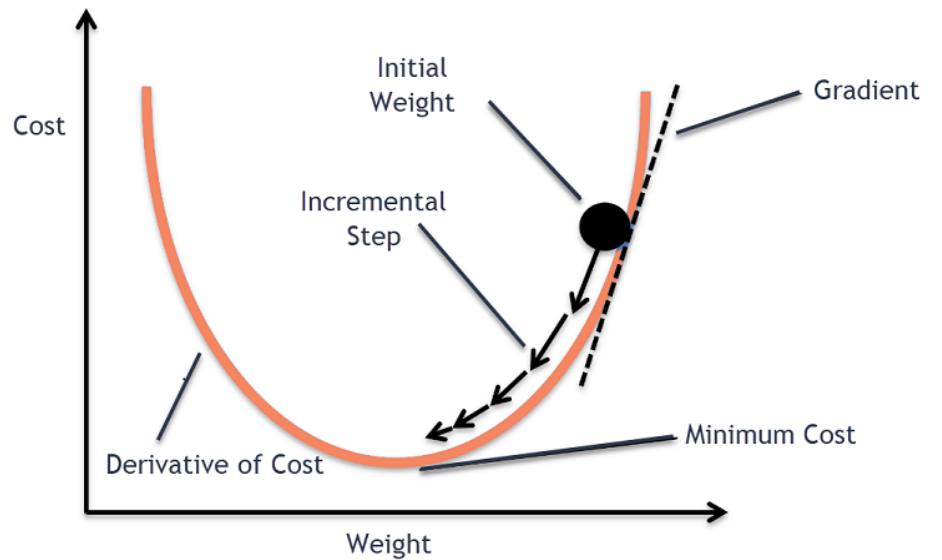
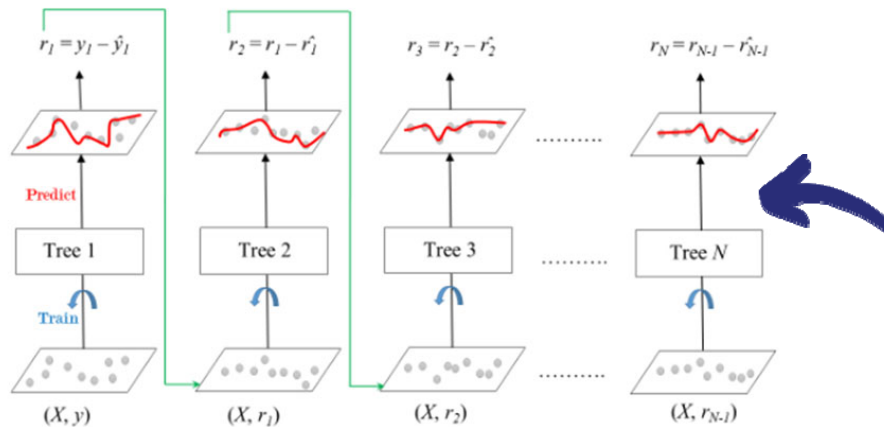
Gradient Boosting

An ensemble of decision trees



Gradient Boosting

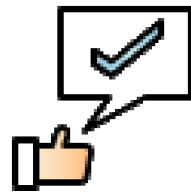
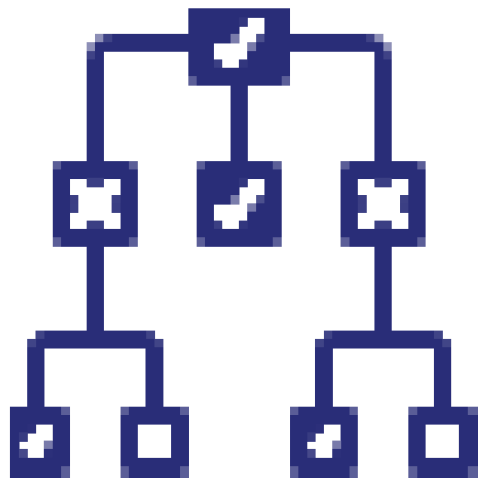
An ensemble of decision trees



dmlc
XGBoost

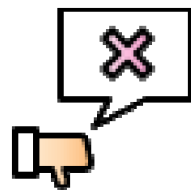


Gradient Boosting



Pros

- Requires less data preparation
- Numerical and categorical data
- No scaling or normalization
- Less overfitting
- Still relatively easy to interpret



Cons

- Sensitive to outliers
- Hard for parallel processes
- Can get quite slow

Part 3:

MODELING AND PREDICTIONS

```
mirror object to mirror
mirror_mod.mirror_object = mirror_ob

operation == "MIRROR_X":
    mirror_mod.use_x = True
    mirror_mod.use_y = False
    mirror_mod.use_z = False
operation == "MIRROR_Y":
    mirror_mod.use_x = False
    mirror_mod.use_y = True
    mirror_mod.use_z = False
operation == "MIRROR_Z":
    mirror_mod.use_x = False
    mirror_mod.use_y = False
    mirror_mod.use_z = True

#selection at the end -add
mirror_ob.select= 1
mirror_ob.select=1
context.scene.objects.active = mirror_ob
("Selected" + str(modifier.name))
mirror_ob.select = 0
= bpy.context.selected_objects[0]
data.objects[one.name].select = 1

print("please select exactly one object")

-- OPERATOR CLASSES -----

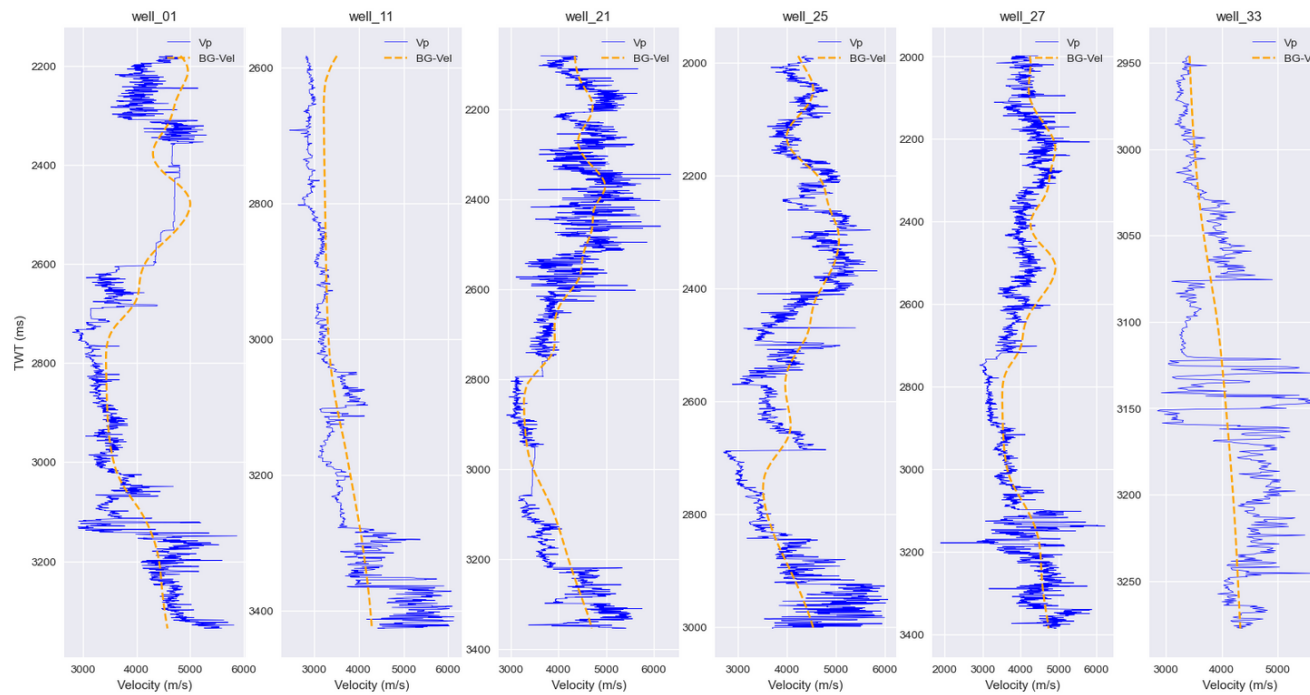
bpy.types.Operator):
    X mirror to the selected
    object.mirror_mirror_x"
    mirror X"

context):
    if not active_object is not None
```



Background

Inversion only at the wells locations



Modeling 1: XGBoost

Input

Seismic near, mid, far; velocity;

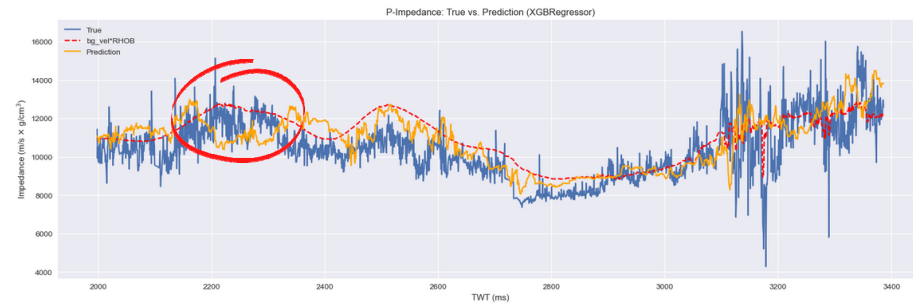
Input

Seismic near, mid, far; velocity; I_p ;

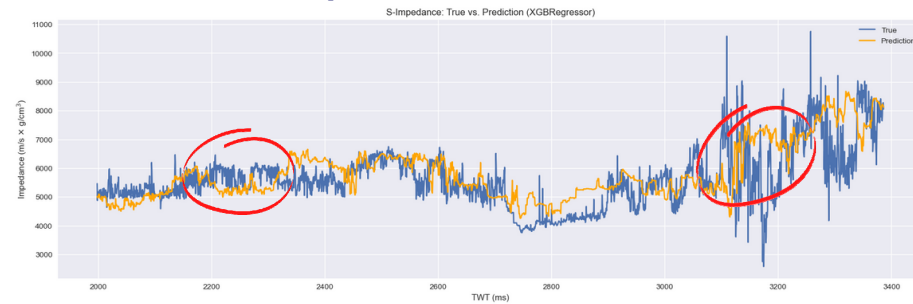
Input

Seismic near, mid, far; velocity; I_p ; I_s ;

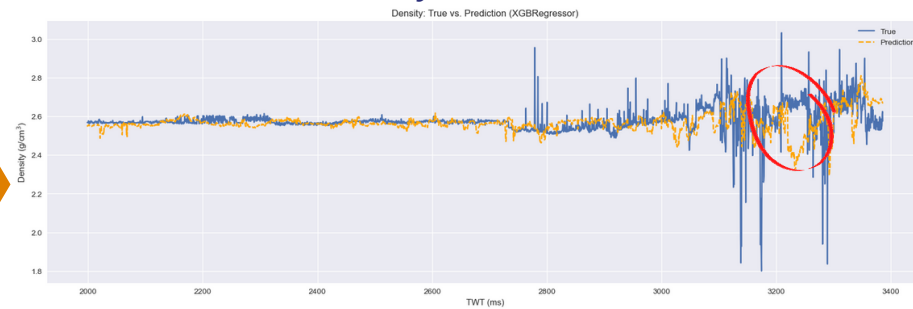
P-Impedance Inversion

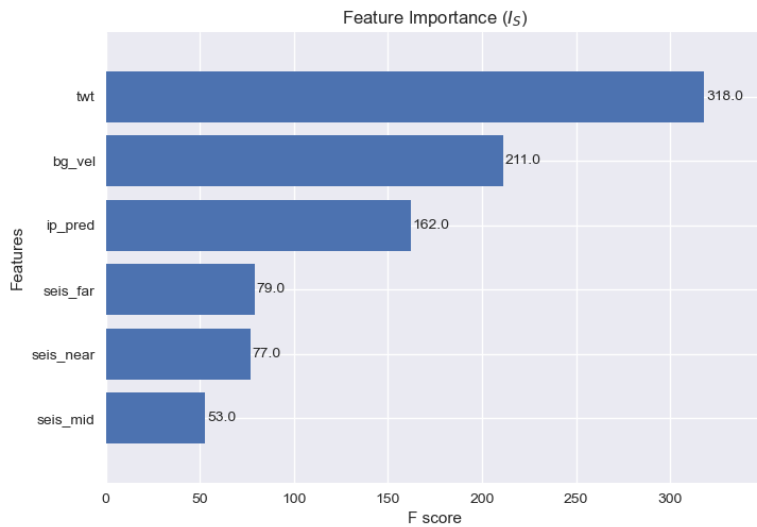
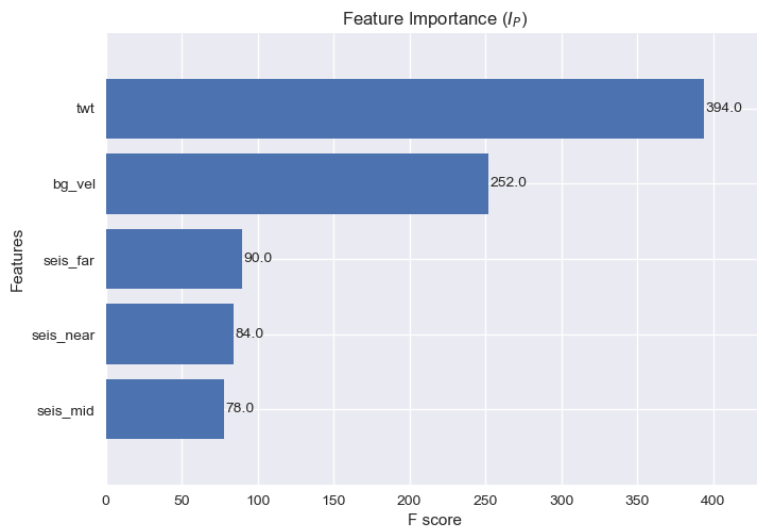


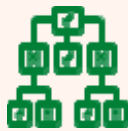
S-Impedance Inversion



Density Inversion

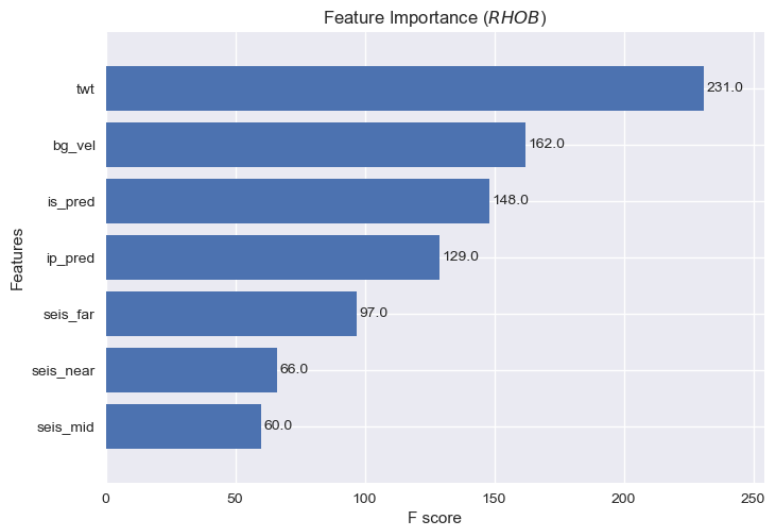






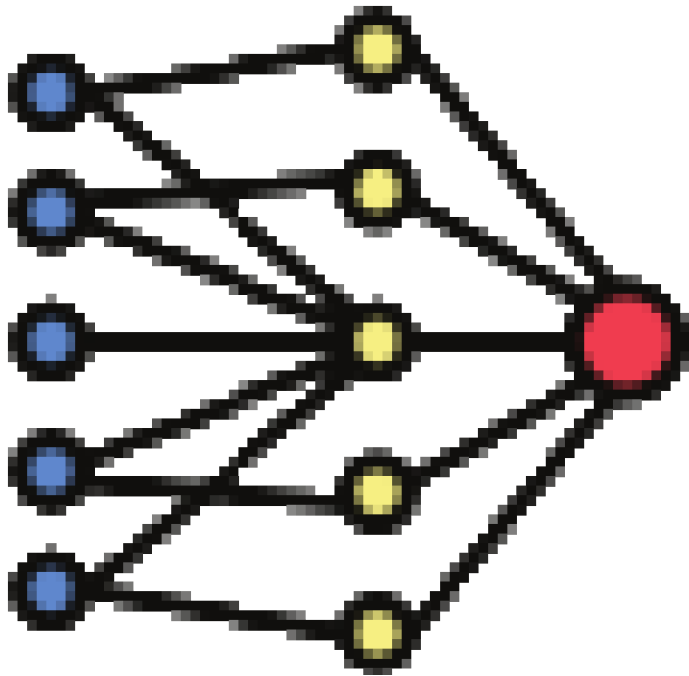
Model:

- Robust
- Interpretable
- Easy to apply
- Relatively fast

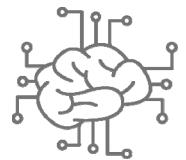


Modeling 2: Neural Networks

Multi-Layer Perceptron (MLP) Regressor



TensorFlow



Modeling 2: Neural Networks

Multi-Layer Perceptron (MLP) Regressor

P-Impedance Inversion

P-Impedance: True vs. Prediction (MLP Scikit-Learn)



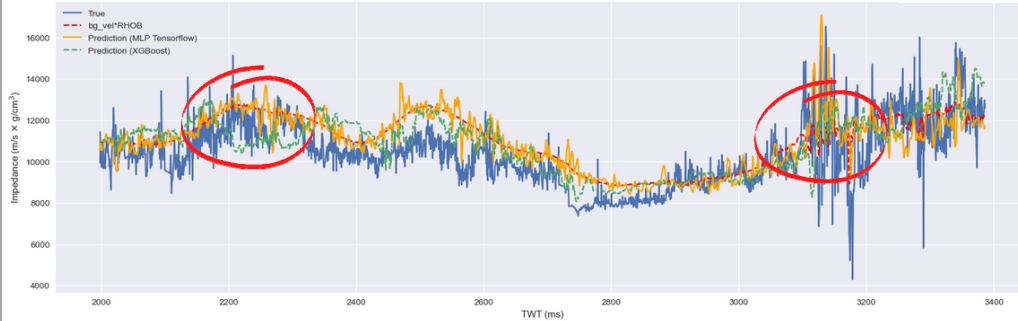
S-Impedance Inversion

S-Impedance: True vs. Prediction (MLP Scikit-Learn)



P-Impedance Inversion

P-Impedance: True vs. Prediction (MLP Tensorflow)



S-Impedance Inversion

S-Impedance: True vs. Prediction (MLP Tensorflow)





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*



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Thank You!



