Expanding Machine Learning to Formation Evaluation

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Objectives

- To propose a model that would accurately determine the type of facies based on the log readings, speedily.
- To accurately determine the feature importances based of the machine learning model to aid in logging method selection
- Analyze the relationship between different log readings, and geological locations with facies classification

Presentation Flow

Data Information

Model Basic

Data Split Preprocessing

Model Results

Feature Importance Feature Ranking

Target Relation

Data Information

TARGET

1 : Non-Marine Sandstone

2: Non-Marine Coarse Siltstone

3 : Non-Marine Fine Siltstone

4 : Marine siltstone and shale

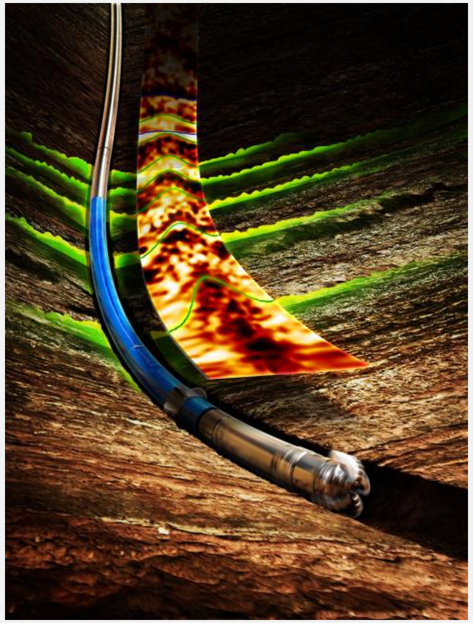
5 : Mudstone (Limestone)

6 : Wackestone (Limestone)

7 : Dolomite

8 : Packstone - Grainstone (Limestone)

9 : Phylloid-algal bafflestone (Limestone)



FEATURES

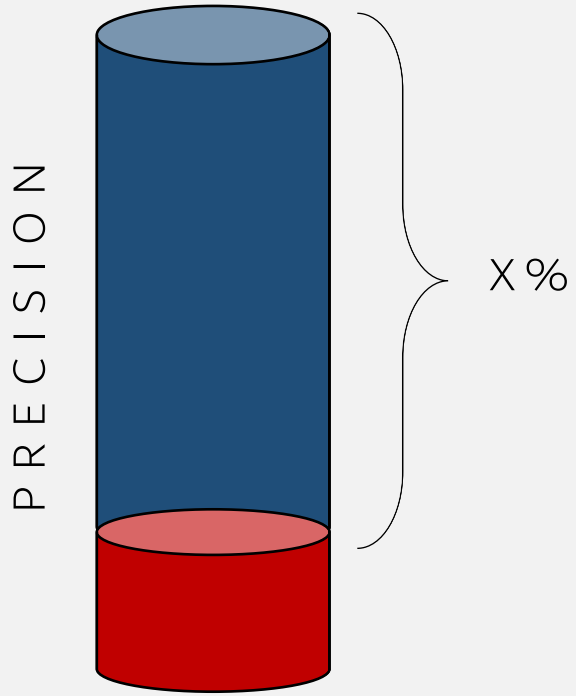
Log Readings:

- Gamma Ray (GR)
- Resistivity (ILD_log10)
- Photoelectric Effect (PE)
- Neutron-Density Porosity Difference (DeltaPHI)
- Neutron-Density Porosity (PHID)

Positional/Geological

Depth, Nonmarine-Marine Indicator (NM_M), relative position, Formation and well names

Model Basics – F1 Score



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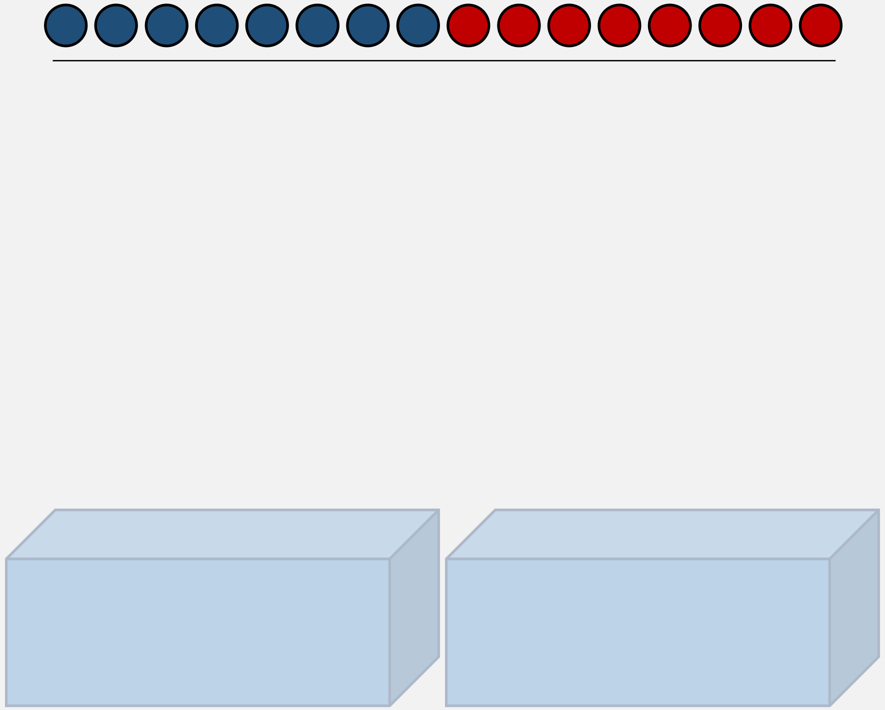

Model Basics – F1 Score

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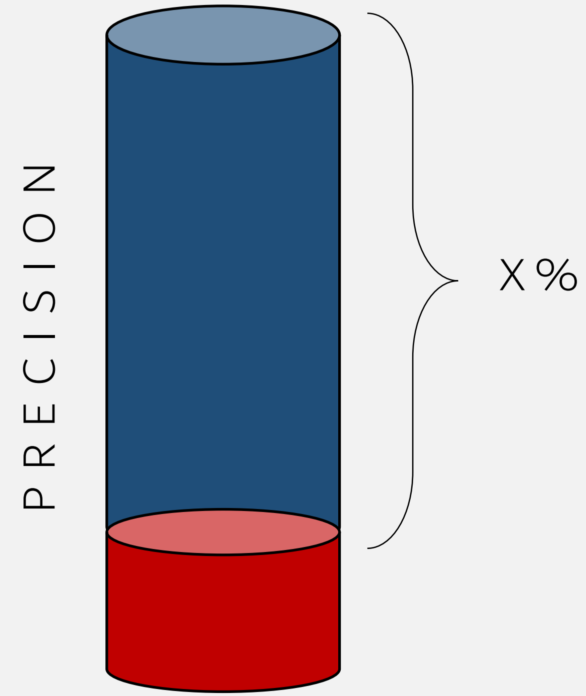
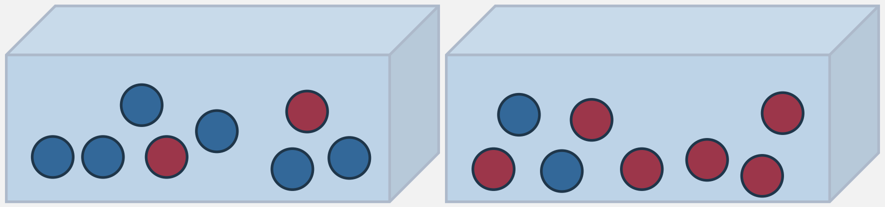
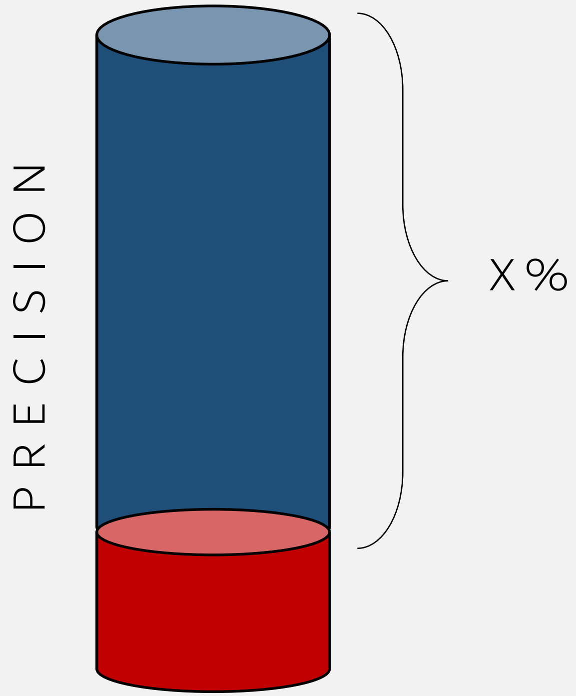
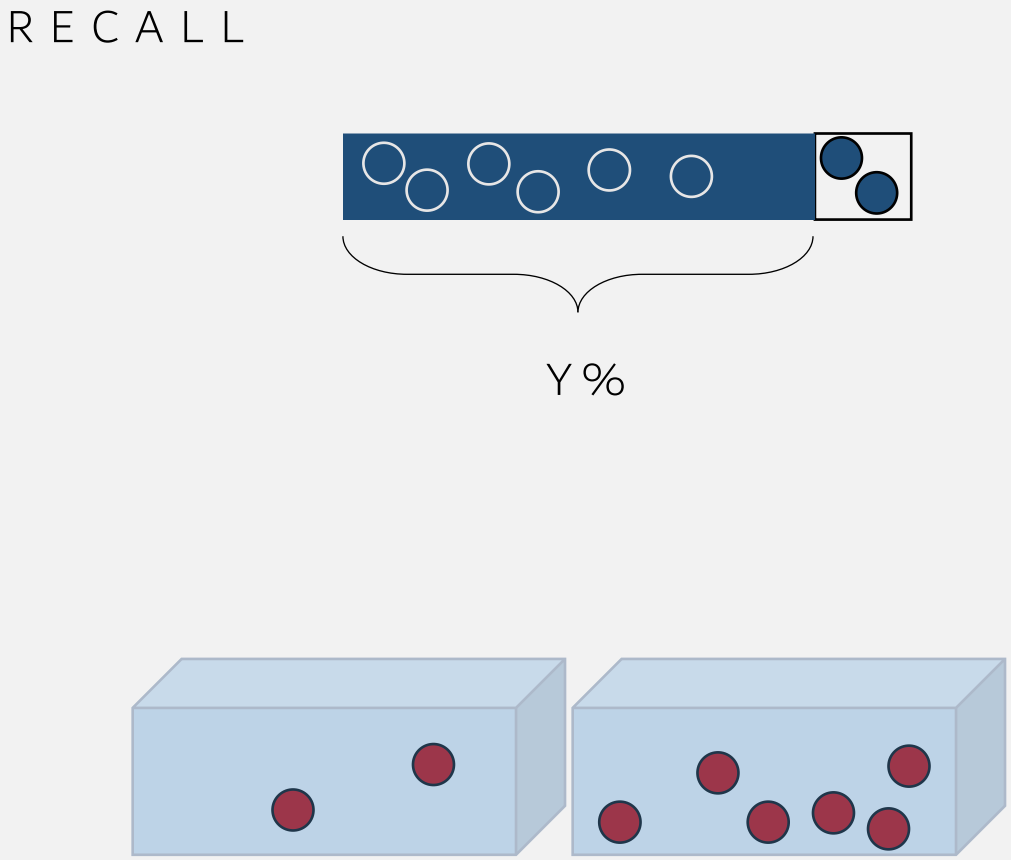


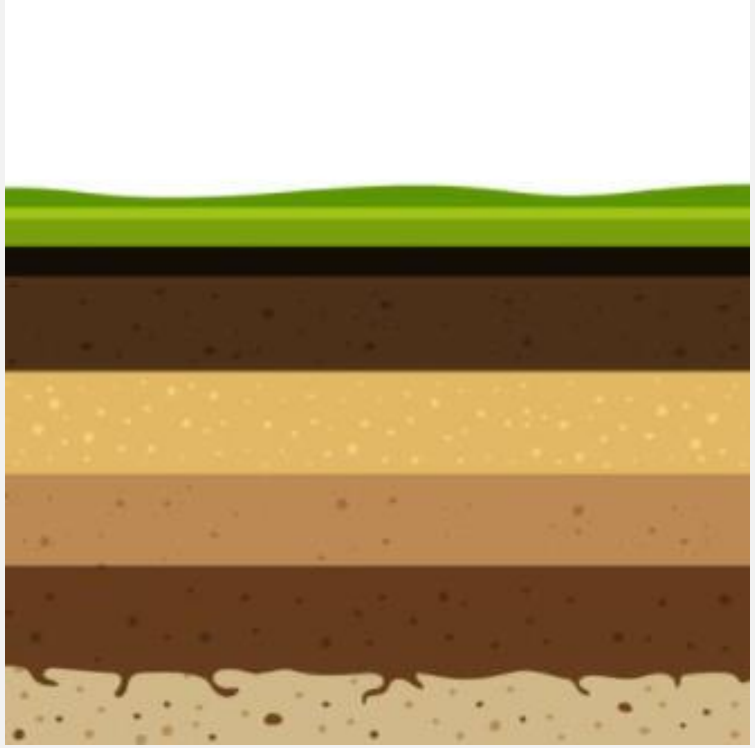


Model Basics – F1 Score





Data Split And Preprocessing



DATA SPLITTING

Data

Test   Train

Train   Validation

PREPROCESSING

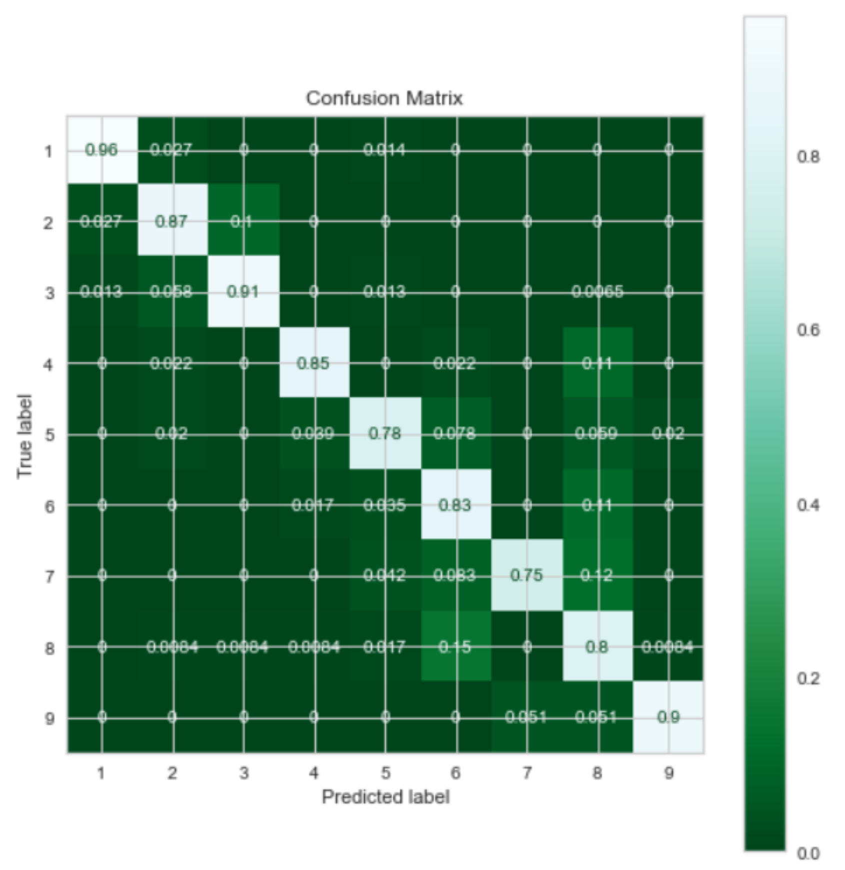
Filling Missing Values:
Using Distances

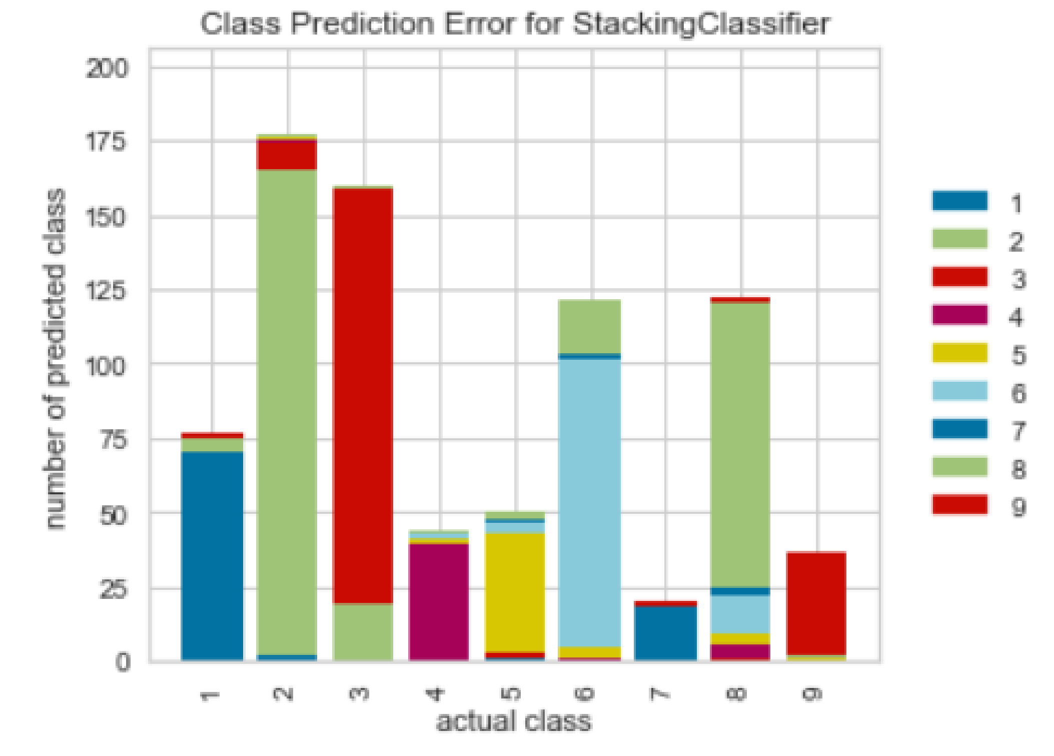
Scaling:
Using Median

Results on the Test Data

Time taken: 9.7s

Visual Evaluation

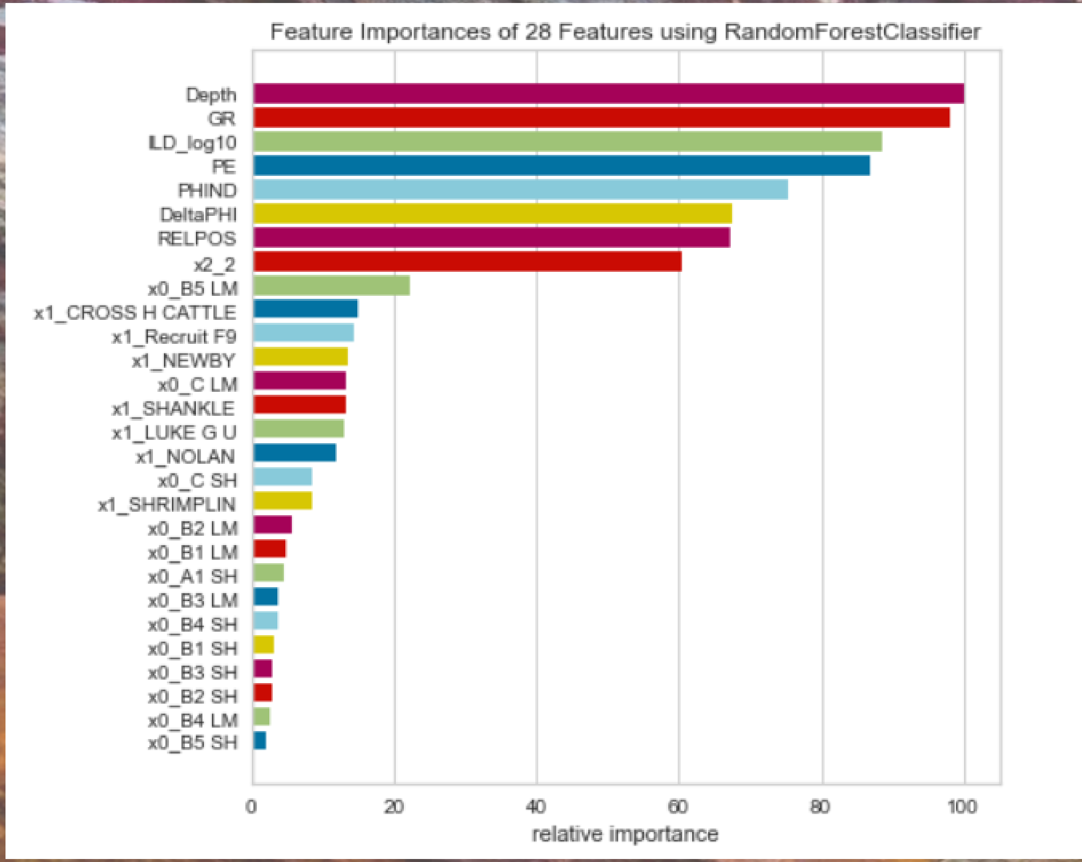


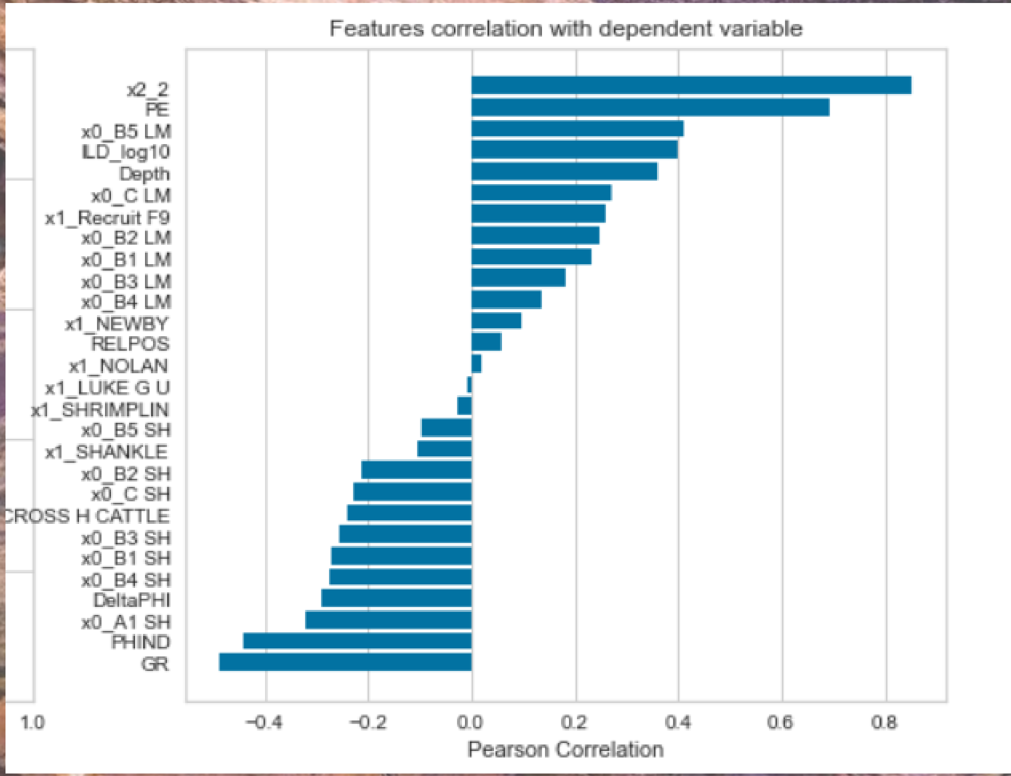


F1-SCORE: 0.86

Feature Rank and Importances

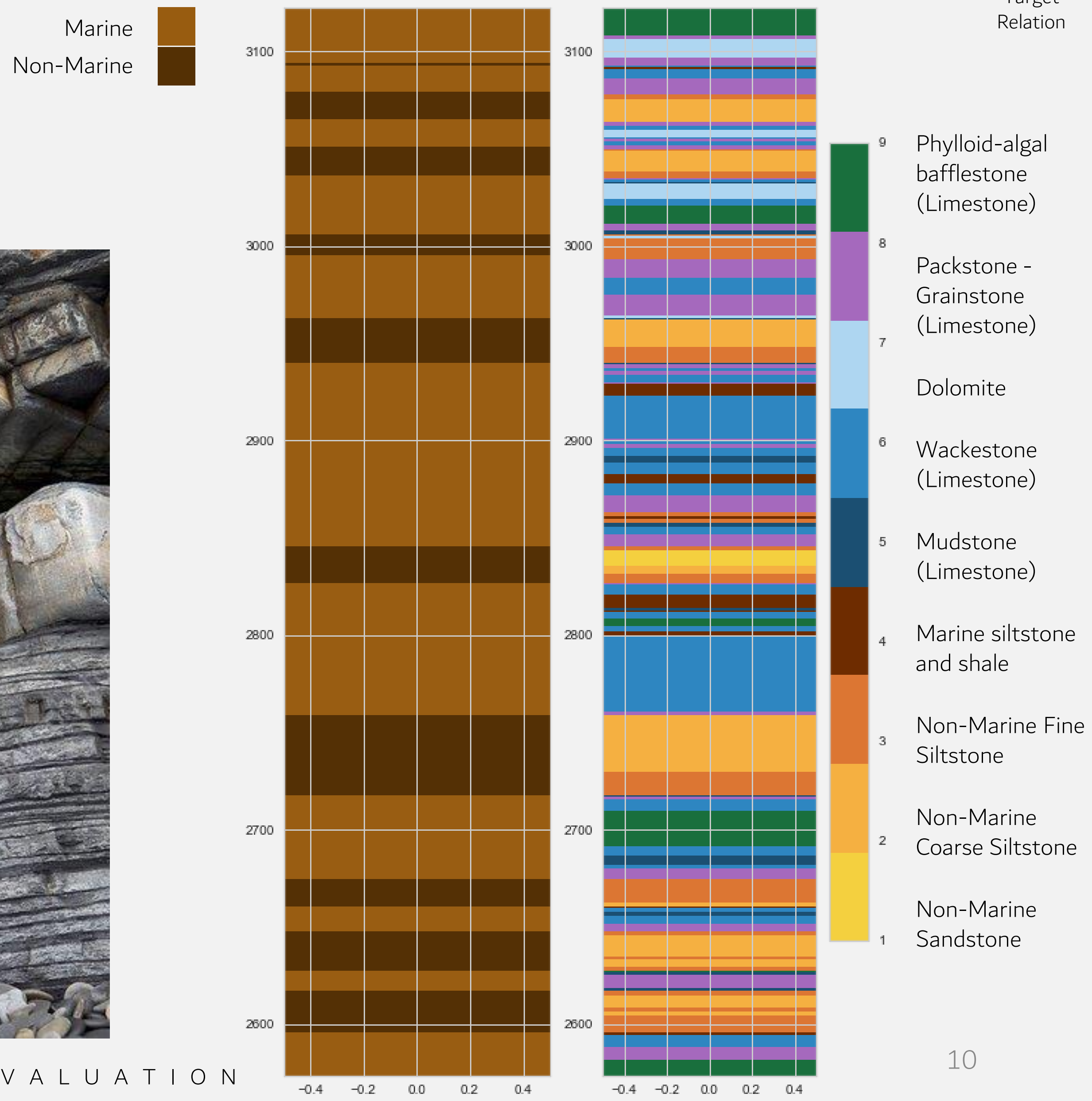
Feature Importance
Feature Ranking



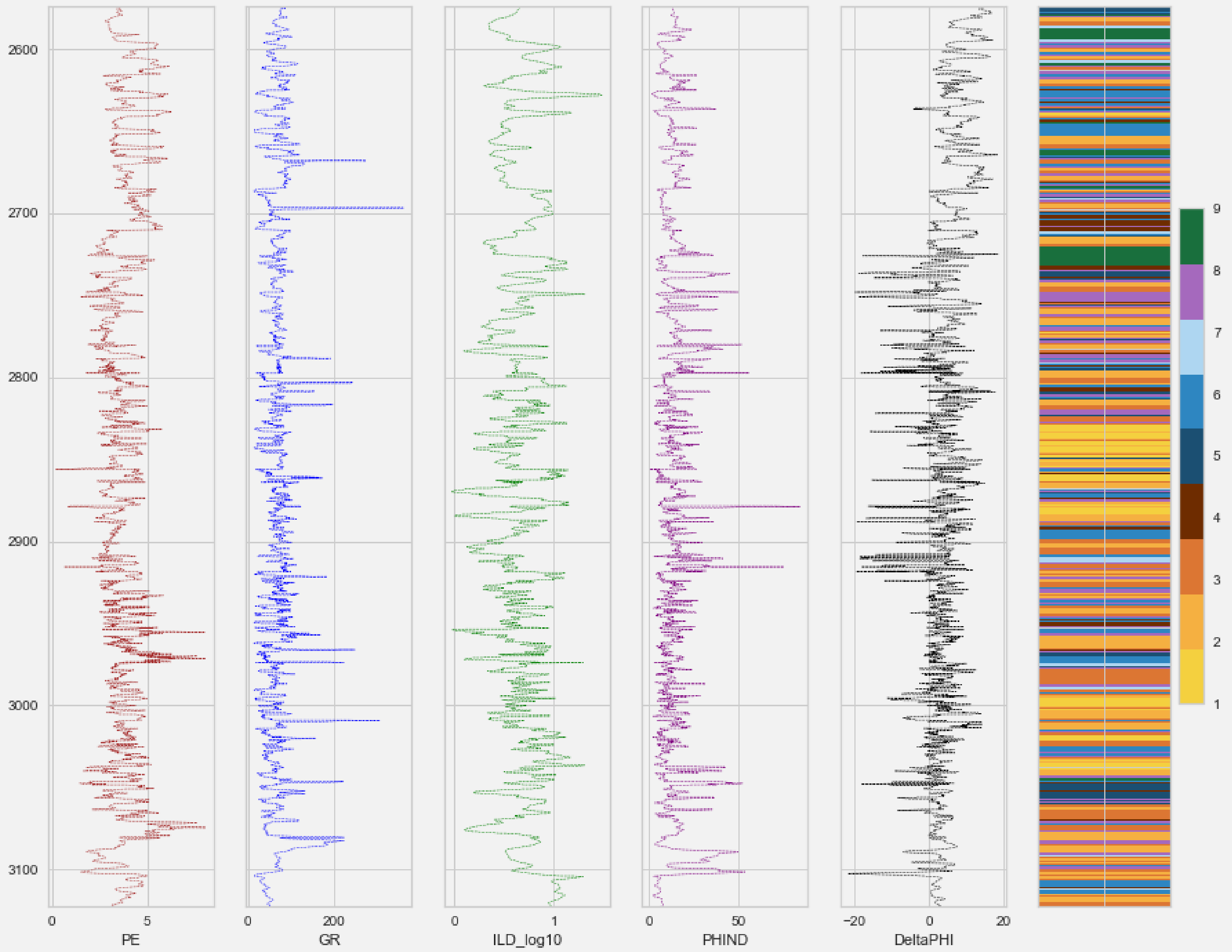


Relation with Target

Target Relation



Target Relation



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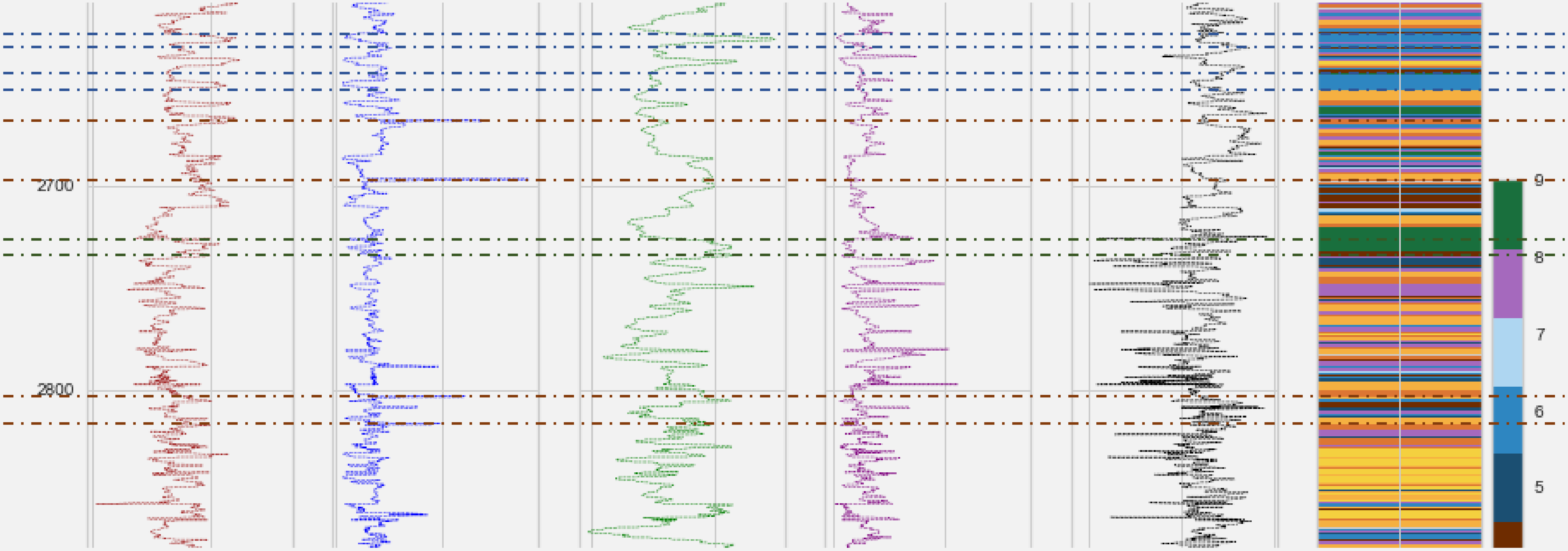
1 : Non-Marine Sandstone

Target
Relation



Conclusions and Recommendations

- The best model took 9.7 SECS to classify the data into separate facies with F-1 SCORE of 0.86.
- Machine learning model can be a very EFFICIENT and SPEEDY tool for facies classification compared to the cumbersome manual techniques currently used which take days to generate the results.
- The most important features that determine the accurate classification include the property of being MARINE or NON-MARINE, and the log values generated from PE, GR, N-D LOGS, RESISTIVITY and RELATIVE POSITION along with DEPTH. These show great influence since each of these values are unique to certain properties which define a facies.
- It is paramount, therefore, that these operations and data preprocessing is conducted meticulously before feeding in the data into the machine learning model.

Future Work

- Further IMPROVING the model to include other methods of DISTANCE CALCULATION since distance is proved to be a major factor in the results.
- Analyze the EFFECT OF CLASS IMBALANCE to further improve our model.
- Incorporate DEPTH MISMATCH and tail REMOVAL during preprocessing since it is time consuming.
- Expand and test this model for wells at DIFFERENT GEOLOGICAL LOCATIONS with other facies present to make this model applicable globally
- Use these PREDICTIONS AS A FEATURE in machine learning models to predict the main goal of facies classification.

Thank You!

Questions?