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AI-Based Reservoir Facies Classification and Missing Data Imputation Using Core and Wireline Data

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Abstract

In this study, we pay attention to the imputation of missing data and the facies classification in subsurface reservoir characterization. The imputation and facies classification is very critical in the study because missing data relationships between geological and petrophysical properties would be obscured, which in turn may be responsible for lowering the accuracy of facies classification and permeability prediction. We imputed missing data through two advanced imputation techniques, EXTRA TREES and XGBoost, which preserve dataset complexity and, hence, ensure better predictions. The workflow has been designed to make classifications of different types of rocks so as to better estimate some key parameters, especially permeability, by some AI techniques, SVM, GPC, RFC, NNC,

KNN, DT, LR, XGBoost, and LightGBM. These models were employed with wireline log and core data for improved subsurface reservoir characterization. Stacking involved base models and a meta-model to boost classification accuracy further. This approach works successfully for reservoirs with high variability in facies, and it is particularly useful in leveraging the strengths of different models to capture complex patterns in heterogeneous reservoirs. The best performance in imputing missing data was established by Extra Trees, with RMSE 0.256 and MAE 0.323, followed by XGBoost. For the classification problem, LightGBM attained the highest accuracy of 0.98, followed by XGBoost at 0.97 and Random Forest at 0.94. Stacking with a RandomForestClassifier as the meta-model improved overall accuracy as well, so this would be highly effective for future predictions of permeability. © The Author(s), under exclusive license to Springer Nature Switzerland AG 2025.

Author keywords

AI; Classification Performance; F1-Score; Facies; Feature Engineering; Hyperparameter Tuning; Imputation; LightGBM and Random Forest; Stacking; XGBoost

Indexed keywords

Engineering controlled terms

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Engineering uncontrolled terms

Classification performance; F1 scores; Facies; Feature engineerings; Hyper-parameter; Hyperparameter tuning; Imputation; Lightgbm and random forest; Random forests; Stackings; Xgboost

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Abstract

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