A robust technique to predict formation fracture pressure of North Sea-Volve oil field using petrophysical log data

Krishna, Shwetank[1]; Thonhauser, Gerhard[1]; Irfan, Sayed Ameenuddin[2]; Keshavarz, Sahar[1]

1 Chair of Drilling and Completion Engineering, Montanuniversität Leoben, Parkstraße 27/III, A-8700 Leoben, Austria; 2 Department of Continual Education, Digipen Institute of Technology, 510 Dover Rd., Singapore.

Prediction of formation fracture pressure (FP) is necessary to optimize well geometry, analyze well stability, and design mud programs. Precise determination of FP helps prevent mud loss during drilling, production and injection selection, and hydrocarbon migration flow mapping. This study combines empirical equations with machine learning (ML) technique namely extreme gradient boosting (XGBoost), recurrent neural network (RNN), and convolutional neural network (CNN) to identify a robust approach for FP prediction using petrophysical log data. For the selection of a robust ML model to predict FP, some rudimentary steps are followed. The process starts with the collection of relevant well log data from three wells of Volve oil field, Norway, and sorting and normalizing all the gathered variables. Afterwards, the best input variable for FP prediction has been identified using the feature selection algorithm. The selected ML model is trained and tested using the gathered petrophysical logging data. Statistical analysis is carried out to analyse the performance of the applied ML model by calculating the mean absolute error (MAE), root mean square error (RMSE), relative absolute error (RAE), root-relative square error (RRSE), and coefficient of determination (R2). The best ML model with low prediction error is tested on another petrophysical well data of the same field to validate and assess the reliability and ability of the selected ML model. In addition, a parametric analysis is carried out to identify the effect of different petrophysical parameters on formation fracture pressure. According to the authors' knowledge, this is the first time a comparative study is done on XGBoost, RNN, and CNN ability to prediction formation fracture pressure.