Evaluation of Hybrid Prediction Models for Accurate Rate of Penetration (ROP) Prediction in Drilling Operations

Abdelhakim Khouissat¹, Dr. Mohamed Riad Youcefi², Ghoulem Ifrene¹, and Doina Irofti¹

Search and Discovery Article #42586 (2023)**
Posted July 4, 2023

*Adapted from extended abstract based on oral presentation given at 2023 AAPG Rocky Mountain Section Meeting, Bismarck, North Dakota, June 4-6, 2023
**Datapages © 2023. Serial rights given by author. For all other rights contact author directly. DOI:10.1306/42586Khouissat2023

¹Department of Petroleum Engineering, University of North Dakota College of Engineering and Mines
²University of Laghouat, Algeria

Abstract

The precise prediction of the rate of penetration (ROP) is of utmost importance for optimizing drilling operations and minimizing costs while increasing efficiency. However, the complex and nonlinear nature of the drilling process can pose significant challenges in achieving accurate ROP predictions. To address this challenge, multiple hybrid prediction models have been developed, and their accuracy in ROP prediction has been compared.

To accomplish this objective, we created three different hybrid models, including Artificial Neural Network – Genetic Algorithm (ANN-GA), Artificial Neural Network-Particle Swarm Optimization (ANN-PSO), and Support Vector Regression (SVR) to estimate ROP. These models were trained and tested using drilling data collected from surface sensors, including drilling parameters such as weight on bit (WOB), revolutions per minute (RPM), flow rate, ROP, and drilling torque.

The hybrid models were able to accurately estimate the ROP for the given drilling conditions and lithologies by utilizing these parameters. Furthermore, the models' accuracy and effectiveness were assessed by training and testing them using the collected drilling data.

Upon evaluating the performance of the three algorithms, our study shows that SVR (Support Vector Regression) outperformed ANN (Artificial Neural Network) in accuracy and precision when predicting the target variable. SVR consistently provided more accurate and precise predictions, capturing the underlying patterns in the data effectively. While ANN-GA (Artificial Neural Network with Genetic Algorithm) performed better than ANN-PSO (Artificial Neural Network with Particle Swarm Optimization) in the training dataset, it exhibited lower accuracy during testing. This highlights the importance of evaluating algorithm performance in both training and testing scenarios. The
results also emphasize that complexity doesn't always lead to better predictions. SVR offers a promising choice for accurate and reliable predictions, but further research is needed to explore the contrasting performances and optimize these algorithms.

Reference:


Evaluation of Hybrid Prediction Models for Accurate Rate of Penetration (ROP) Prediction in Drilling Operations

Abdelhakim Khouissat¹, Dr. Mohamed Riad Youcefí ², Ghoulem Ifrene¹ and Doina Irofti¹
¹Department of Petroleum Engineering, University of North Dakota College of Engineering and Mines
²University of Laghouat, Algeria

Introduction

• Importance of precise ROP prediction: ROP prediction plays a crucial role in optimizing drilling operations, minimizing costs, and enhancing overall efficiency.
• Challenges in accurate ROP prediction: The complex and nonlinear nature of the drilling process poses challenges for accurately predicting ROP.
• Hybrid prediction models: To overcome these challenges, several hybrid prediction models have been developed and compared to improve the accuracy of ROP prediction in drilling operations.

Problem Statement

• The accurate prediction of drilling rate of penetration (ROP) is challenging due to the complex and nonlinear nature of the drilling process, geological variability, uncertainties in drilling parameters, and the lack of sufficient data.

Project Goal

• Develop and compare hybrid prediction models for accurate ROP estimation in drilling operations.
• Address challenges associated with the complex and nonlinear nature of the drilling process.

Methodology

1. Data Collection
2. Data Pre-processing
3. Select Learning Algorithms
4. Training Candidate Models and Validating

Results

• SVR outperforms ANN in terms of accuracy and precision for predicting the target variable, it provides more accurate and precise predictions for the target variable.
• ANN-GA outperforms ANN-PSO in the training dataset but exhibits lower accuracy than ANN-PSO during the testing phase.
• SVR excels at capturing the underlying patterns and relationships within the data, thereby generating more dependable predictions.
• Choosing more complex algorithms does not always lead to better prediction results.

Conclusion

References