

## Extended Abstract

**Proposing a new artificial intelligence recombination method in order to predict the rate of penetration using drilling log**Meysam Rajabi<sup>1\*</sup>, Hamzeh Ghorbani<sup>2</sup>

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**Abstract**

One of the most crucial and valuable resources accessible to humanity is underground resources. Their value is so significant that they exert control over the world economy. Drilling activities are indispensable for accessing these precious resources. Among the paramount factors in the realm of oil and gas well drilling is the rate of penetration of the drill bit. This study utilizes information from three wells located in an oil field in the southwest of Iran. The algorithms newly combined in this article comprise a fusion of the K-nearest neighbor algorithms, honey bee algorithm, firefly algorithm, and multilayer perceptron. This algorithm represents a novel and unique amalgamation of potent algorithms hitherto unused for predicting this vital parameter. Notably, this method excels at reducing data noise and enhancing the accuracy of parameter predictions. The results demonstrate that the mean square error for the testing and training data sets, as well as the entire dataset, stood at 1.05, 1.52, and 1.48, respectively. These figures underscore the algorithm's high-performance accuracy. Additionally, upon scrutinizing the Pearson's coefficient, it was ascertained that drilling bits nozzles significantly influenced the penetration rate.

**1. Introduction**

The only way to access hydrocarbon resources is to drill wells in permeable hydrocarbon layers, and considerable costs are spent on this process. In order to increase the efficiency of operations and reduce costs, it is very important to evaluate drilling efficiency. Therefore, field data must be carefully collected and then analyzed using appropriate tools.

The best understanding of drilling operations is obtained when the results of predictive models are compared and corrected with field observations. As by changing and improving the effective parameters in drilling, better and more efficient results can be achieved.

Optimizing drilling operations includes considering several variables such as cost, safety, and well completion, but along with these factors,

penetration rate is one of the basic variables in this operation. Because prediction of penetration rate is an important factor in the success of drilling projects and it is influenced by various factors such as weight on the drill, type of drill, mud circulation speed, fluid flow pressure, mud weight, well deviation, rotation speed and hydraulics. These factors are dependent on drilling conditions, geological factors, drilling depth and drill type, etc. The cost of drilling a hole with a drill is another important aspect in the evaluation of drilling performance.

**2. Methodology**

In this study, the combination of Firefly algorithm (FA), K-nearest neighbors' algorithm (KNN), Bee algorithm (ABC) and Multilayer (MLP) perception and three combined algorithms were used in this article. The combined algorithms used

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for ROP prediction include: FA-KNN, ABC-KNN and FA-KNN-ABC-MLP.

In order to develop recombinant methods, 70% of the collected data are used for training, 15% for testing the results, and the remaining 15% for validating the methods. In order to check the presented results and find a more efficient algorithm, the comparison of statistical parameters is used. Among the common statistical parameters, we can mention standard deviation, average relative error, percent error, coefficient of determination, average absolute relative error, and root mean square error (Equations 1 to 6).

$$PE_i = \frac{X_{Measured} - X_{Predicted}}{X_{Measured}} \times 100 \quad (1)$$

$$MRE = \frac{\sum_{i=1}^n PE_i}{n} \quad (2)$$

$$MARE = \frac{\sum_{i=1}^n |PE_i|}{n} \quad (3)$$

$$STD = \sqrt{\frac{\sum_{i=1}^n (PE_i - Dimean)^2}{n-1}} \quad (4)$$

$$Dimean = \frac{1}{n} \sum_{i=1}^n (X_{Measured i} - X_{Predicted i})$$

$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^n (X_{Measured i} - X_{Predicted i})^2} \quad (5)$$

$$R^2 = 1 - \frac{\sum_{i=1}^N (X_{Measured i} - X_{Predicted i})^2}{\sum_{i=1}^N \left( X_{Predicted i} - \frac{\sum_{I=1}^N X_{Measured i}}{n} \right)^2} \quad (6)$$

As a result, based on these two statistical parameters, the classification of methods is as follows:

Mean squared error: Galle and Woods > Maurer >

Firefly algorithm - K nearest neighbor algorithm > Honeybee algorithm - K nearest neighbor algorithm > Firefly algorithm - K nearest neighbor algorithm - Honeybee algorithm - multilayer perceptron.

Correlation coefficient: Galle and Woods < Maurer < firefly algorithm - K nearest neighbor algorithm < honey bee algorithm - K nearest neighbor algorithm < firefly algorithm - K nearest neighbor algorithm - honey bee algorithm - multilayer perceptron.

### 3. Conclusions

- In order to predict the penetration rate, from three new artificial intelligence hybrid algorithms, which include the firefly algorithm - K nearest neighbor algorithm, the honey bee algorithm - K nearest neighbor algorithm and the new hybrid firefly algorithm - K nearest neighbor algorithm - honey bee algorithm - multilayer perceptron, Used.

- After analyzing the findings, it was concluded that firefly algorithm - K-nearest neighbor algorithm - honey bee algorithm - multilayer perceptron shows higher performance accuracy compared to other algorithms and equations.

- The advantage of the new hybrid technique is that classification is done by presenting the first block (combination of firefly algorithm-K nearest neighbor algorithm) and prediction is made with the second block (combination of honey bee algorithm-multilayer perceptron) and the ability of the algorithm to reduce data noise It is activated with this feature.

### 5. References

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