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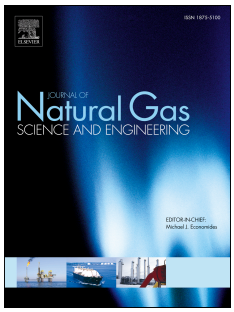

Evaluation of coupled machine learning models for drilling optimization

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Evaluation of coupled machine learning models for drilling optimization

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Abstract

Drilling optimization can provide significant value to an oil and gas project, especially in a low-price environment. This is generally approached by optimizing the rate of penetration (ROP) of the well, which may not always be the best strategy. Two additional strategies (or models) can be used to optimize a well – torque on bit (TOB) response to reduce vibrations at the bit or mechanical specific energy (MSE) to reduce the energy used by the bit. This paper evaluates these three models for drilling optimization based on several criteria. Models for ROP, TOB and MSE are built using a data-driven approach with the random forests algorithm using drilling operational parameters such as weight-on-bit, flow-rate, rotary speed, and rock strength as inputs. The drilling models are optimized using a meta-heuristic optimization algorithm to compute the ideal drilling operational parameters for drilling ahead of the bit. Machine learning is used to develop these models since these models are coupled which enable calculation of interaction effects. Results show that optimizing the ROP model leads to a 28% improvement in ROP on average, however, this also increases the MSE and the TOB which is undesirable. Optimizing the MSE model results in a (smaller) increase of ROP (20%). This is accompanied by a decrease in MSE (by 15%) and decrease in TOB (by 7%) which may result in longer bit life and additional savings over time. Hypothesis testing has been used to ensure that all simulations conducted in this paper show statistically significant results.

Keywords: MSE**,** ROP, data-driven, machine learning, drilling, optimization, data analytics