Development of an AI-based Well Integrity Monitoring Solution

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Abstract

The well barrier degradation incidents during well in operation are sometimes missed and left unnoticed even in the presence of state-of-the-art monitoring systems. This presentation discusses the Proof of Concept (PoC) results and outlines an AI-based product development journey. The solution is currently being developed for gas-lift producer, gas producer, and water injector wells in Norwegian offshore assets. The overall objective of PoC was to validate the hypothesis that AI can detect historical annulus leakages in these wells.

The product development was initiated by defining the scope through challenge exploration and prioritization, feasibility assessment, business KPI selection, and constraint analysis. The next step was understanding the data and problem through data acquisition, quality assurance, model research, class selection and target metric definition. Following that, AI models were developed and consequently evaluated using the pre-defined metric. In overall, the agile methodology was applied to manage the product development complexity and uncertainty in the PoC phase.

One of the key learnings in the PoC is that it was only possible to build specific models for each well type. Depending on the amount of available labels in the training dataset, either unsupervised or supervised machine learning (ML) models were developed. For the unsupervised ML models, isolation forest and autoencoder were evaluated. The isolation forest failed to detect complex anomaly patterns. A deep learning-based autoencoder, based on an LSTM (Long-Short Term Memory) model, later proved that it can be used to detect more complex anomalies. For the supervised ML approach, a LSTM classifier was developed. The LIME (Local Interpretable Model-Agnostic Explanations) framework was used to derive the most important sensors causing the anomaly prediction to enable the users to critically validate the AI suggestion. Together with the domain experts, two metrics were defined to evaluate the model performance: Detection Event Rate (number of detected events divided by the total number of events) and False Alarm Rate (number of false positives per month). The models achieved a sufficient level of performance with minimum 75% events were detected and less than 1 false positive per month per well in average.

This presentation highlights an innovative show case of developing AI model for well integrity monitoring. The application of anomaly detection in multivariate time series is a novel approach to solve one of the classic challenge. The presentation also summarizes key insights on the application of agile approach in data science project to solve E&P domain challenge. In general, it outlines lesson learnt on building a scalable AI-based product to promote digitalization in the E&P industry.