Repairing Well Log Data Using Machine Learning Assisted Workflow

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Abstract

Well log data are crucial inputs for reservoir quantitative interpretation (QI) studies. Logs of interest for QI include density and sonic (compressional and shear). They are used for a variety of applications like rock physics analysis, well to seismic tie, subsurface modeling, seismic inversion and validating QI predictions. Thus, having good quality well log data is essential. However, well log quality is often impacted by issues related to logging tool (e.g. tool calibration, tool functioning and depth determination) or borehole environment (e.g. borehole shape and size and drilling fluid). Such issues may lead to unreliable measurements or missing sections. Therefore, prior to conducting QI studies, it is important to quality check (QC) well log data and fix any observed issues.

The process of checking and editing density and sonic well log data is time consuming. It involves intensive human interaction and the results might be subjective. This becomes more challenging for regional QI studies involving tens of wells. In this paper, we present a workflow to automate the process of well log editing. The workflow is driven by automation and machine learning algorithms. The workflow consists of multiple steps: (1) Automatic gathering of well data (well locations, deviations, markers and logs) from different databases, (2) Automatic QC of data completeness, measurement ranges and consistent log naming and units, (3) Gamma Ray normalization, (4) Cleaning data outliers using machine learning algorithm, (5) Predicting data gaps and missing sections using machine learning algorithm and (6) Automatic uploading of updated logs to the database. The workflow has been coded using Python programing language and has been transformed to web application for easy user interaction and result visualization.

Preliminary results using commonly used machine learning algorithms (e.g. Isolation Forest, Local Outlier Factor and One Class SVM) are promising. Meanwhile, we are experimenting more advanced algorithms and fine-tuning model training, validation and testing. This automatic machine learning assisted workflow is expected to deliver consistent and better quality well data with faster turn around time and hence have better and faster QI impact on prospect maturation and well placement. As outlook, we are looking at the option of extending the workflow to repair petrophysical logs other than sonic and density. Furthermore, learnings from this workflow can be applied to other applications like checkshot QC and lithology clustering and identification.