FaciesNet: Machine Learning Applications for Facies Classification in Well Logs

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9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

Facies or rock type classification based on well logs is essential subsurface information for hydrocarbon exploration and production. Well logs are much more extensive and available in all exploration wells, while the ground truth of facies can only be determined from limited cores due to their high cost of acquisition. Conventionally, physics-based mathematical relations between physical properties and facies need to be determined for a specific area or formation, which could be subjective and time consuming. To resolve this issue, several studies have incorporated cost-effective data-driven machine learning algorithms using well logs alone to classify facies by solving multiclass classification problem. Classifying facies based solely on features from well logs is challenging due to their differences in resolutions as well as overlapping feature values for different facies. Although previous study approaches are robust and able to predict facies at a degree of accuracy, the geologic information and facies sequences are missing causing the models to predict unrealistic stacked facies. Moreover, these models cannot differentiate between similar rock types that play a different role in exploration model and tend to predict the most abundant class. We recognize that overlying and underderlying facies are correlated, and stacking pattern of facies are significant for geological interpretation. A sequence-based machine learning model is, therefore, more appropriate than traditional multiclass classification approach used in the previous studies. We propose a novel machine learning architecture capturing geologic information, facies stacking pattern, and geologic correlations, FaciesNet. Our proposed model incorporates decoding and encoding deep convolutional neural network with sequence-based machine

learning model to predict geologically meaningful facies from well log data. We conduct the experiments on real exploration data from different hydrocarbon fields and show that FaciesNet out performs previous study approaches, leading to predictions of realistic stacked facies that can be found in cores or outcrops. FaciesNet architecture is very useful to train on existing wells and apply to a new exploration field.