Close-the-Loop Log Property Modeling Using Semi-Unsupervised Learning as a Proxy for Facies Classification

Sher Didi-Ooi[1], Andrew Derenthal[1], Michael Pyrcz[2], Christian Noll[3]
[1]Anadarko Petroleum; [2]University of Texas at Austin; [3]Anadarko Petroleum Corporation

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

Abstract

Understanding the combined effects of well log properties and subsequently the rock types derived from log interpretations are key steps in developing a comprehensive understanding of unconventional reservoirs. However, to characterize reservoir quality at either a basin-scale or for thousands of wells in a play can present a challenge to geologists and petrophysicists. This time-consuming challenge is further compounded by the significant heterogeneities that exist within a basin, as well as issues associated with data integrity. In this study we would like to highlight the advantage of analyzing thousands of clean well logs rapidly using statistical analyses and unsupervised learning techniques. The result of this geologic log property clustering highlights laterally continuous geobins that represent different paleo-environments existing within the Delaware Basin: from the complex margins of the carbonate platform to the distal part of the basin. Contrary to existing workflows using unsupervised learning, cluster analysis performance from can be quantified using key indicators (i.e. gap statistics). While this workflow allows geologists to quickly test out multitudes of hypotheses - the degrees of freedom in choosing an unsupervised learning algorithm, combination of well log variables and the number of clusters to use can present a challenge. Indicators such as silhouette scores, elbow plot and gap statistics can assist in quantitatively evaluating the performance of algorithm. Systems expert can help with the selection of the log curves and visual mapping using key geobodies principles can evaluate the success of the clusters. These processes can be subjective, which leads us to propose using variogram fitting as a QC step to constrain the

performance of the geobinning. Robust spatial interpolation models rely on the stationarity of geologic conditions, therefore considering that geobins represent various depositional environments or fairways within a basin, geobins would naturally segment and capture the heterogeneity of a reservoir. We see variogram fitting as a quantitative metric for judging the effectiveness of geologic log property clustering. This integrated workflow allows us to rapidly perform high-level data-driven reconnaissance of the rock property on a basin-scale. The geobin outputs may further assist in facies modeling, geologic mapping, petrophysical analyses and geologic modelling conditioning.

AAPG Datapages/Search and Discovery Article # 91200 © 2020 AAPG Annual Convention & Exhibition Online, Sept. 29- Oct. 1.