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Abstract

Non-parametric transformation is the estimation of the optimal correlations of a dependent response variable (Y) and a set of independent predictor variables (X_i, i=1, …, n) to derive one transformation with the maximum correlation coefficient. It's a completely data-driven technique and doesn't require prior assumptions regarding functional forms of correlation. The main advantage of this technique is its ability to identify the best predictors (well log responses) that introduce the optimal correlations between the calculated and measured parameters before even going further in the prediction process.

Bahariya (BAH) formation is one of the main sources for oil production within the fields of Western Desert (WD), Egypt. It contributes to the cumulative oil production of WD by about 40 % with active drilling programs, waterflooding projects, and hydraulic fracturing activities. Reservoir properties and facies characteristics of BAH formation range from highly permeable to tight/shaly sandstone layers which show low resistivity, low contrast (LRLC) log behavior due to laminated sand intervals, presence of clay, and conductive minerals (Pyrite & Glauconite). Therefore, regional and accurate prediction of reservoir permeability for BAH across the broad WD using well log measurements becomes a challenge. The objective of this work is to introduce a systemic workflow for a regional understanding of BAH's reservoir characteristics, identification of rock units and reservoir permeability profile. Specifically, Alternating Conditional Expectation (ACE) algorithm has been applied on well log data from more than 70 cored-wells covering the different geological and depositional features, and more than 5500 core samples to derive optimal correlation for reservoir permeability.

The proposed approach incorporates two steps:

- Classifying the core data into lithofacies groups, and
- Applying the supervised learning, the non-parametric transformation, to predict the permeability from the optimized well logs responses.

This approach was applied to different testing wells addressing different geological and sedimentary features with variable log characteristics from the convention high resistivity to LRLC behaviors. The established permeability profiles exhibit high correlation coefficients; 0.892 average, up to 0.95

maximum with the measured core data, and high accuracy that matches the field experience even with LRLC characteristics. Such study is an original contribution to develop permeability prediction model using ACE approach for reservoir characterization, management, and simulation applications. The model can be run using only abundant and initially available triple combo logs for all wells.

Keywords: Bahariya Formation, Alternating Conditional Expectation (ACE), Non-parametric Transformation, LRLC, Permeability Estimation