Application of Bayesian Networks for Estimating Water Saturation

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Abstract

It has been developed a Descriptive Bayesian Network Model to estimate water saturation according to dependencies observed in petrophysical logs.
Estimating water saturation (Sw) in oil reservoirs has been one of the main tasks of Petrophysics, which has a direct impact on the risk of economic investment.
In 1942, Archie presented his equation which exhibits the principles of the relationship between resistivity, porosity, and water saturation.
Unfortunately, to estimate water saturation by conventional methods might be a complicated task if it lacks of the necessary information as certain logs, well information or core information, in addition to subjective decisions that can be made in its application.
Thus the problem consists of giving a good estimation with few resources (or logs) without losing the essence of the physical properties of rock characterization and their meanings.
In the last years there have been many papers that have applied Machine Learning Techniques such as Artificial Neural Networks (ANN) for estimating water saturation with their variants. Although they have shown to be functional, they have left a gap in physical meaning of the relationships of internal weights that are generated by ANN.
At present Bayesian Network Models have been applied, whose importance of physical dependencies in the system is weighted in some way. Thus, Bayesian networks provide a method for probabilistic inference based on the statistical dependence of a set of variables.
In this work, known dependencies between petrophysical logs, such as resistivity, neutron porosity, gamma ray, bulk density, sonic, and water saturation, are collected to apply them in the construction of a descriptive Bayesian Network.
This model is applied to a set of existing wells. The results are compared with those obtained using ANN and conventional methods.

Keywords: Bayesian Network, Water Saturation, Well Log Interpretation, ANN.