Using Fuzzy Logic to Predict Petrophysical Parameters and Improve the Accuracy of Least Squares Regression Analysis

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Abstract

The least squares regression technique has often been used to predict petrophysical parameters, principally where large amounts of core data are available. This technique is an optimization algorithm which determines the “best” tendency among the variables, even though it does not adjust to all data points. Geological complexity increases the amount of data scatter and makes it difficult to extrapolate a clear trend from the data. This problem can be partially solved by subdividing the geological unit in question (a reservoir for example), gathering data for subdivisions and analyzing the results for the individual subunits separately. However, in many cases, only a small reduction in the data scatter can be achieved.

In this work we present a method for predicting petrophysical parameters in wells and in 3D seismic volumes in two study areas using Fuzzy Logic. This method integrates well data with conventional post-stack seismic attributes (for example instant amplitude and real amplitude of the seismic trace) and gives better results than those obtained from least squares regression analysis alone.

In the first example, at La Faja del Orinoco, Venezuela, the porosity values in wells were calculated using Fuzzy C-Means (FCM). To calculate porosity and reservoir velocity we also integrated conventional post-stack attributes and applied the FCM model.

In the Gulf of Mexico, the technique was applied to predict pore pressure in an attempt to define the mud density needed for drilling in an exploration area.

Cross-validation was done to compare the predicted and real values.