Mining Big Data Using Principal Component Analysis and Using Results to Find Oil and Gas with Neural Analysis of Multiple Seismic Attributes – Machine Learning!

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Abstract

Since the late 1970's the explosion of various kinds of seismic attributes derived from the acquired seismic signal has been the boon and the bane of the interpreter. Now the interpretation of reflection data requires powerful computers and advanced visualization software packages, but the interpreter is always looking for ways of distilling vast amounts of data down to essential volumes necessary to make prudent choices for reducing risk in picking drilling locations.

Seismic attributes are considered to be any measurable properties of the seismic signal. They can be measured at one instance in time or depth or a window of time or depth. They can be single trace measurements, multiple traces or even on a surface interpreted in the data. Common categories of seismic attributes would include the instantaneous (frequency, phase, Q), geometric (coherence, curvature), amplitude enhancing (sweetness, relative acoustic impedance, average energy), AVO (fluid factor, intercept gradient), spectral decomposition (either envelope based or wavelet based) and inversion (Poisson's ratio, density, brittleness and more).

The use of Principal Component Analysis (PCA), which is a linear quantitative process designed to understand which seismic attributes have interpretative significance by analyzing the variations in the data, has proven to be an excellent approach to sorting through vast amounts of data. PCA used in the interpretation workflow can help determine meaningful seismic attributes, and in turn, these attributes can be used as input into neural analysis in the creation of Self-Organized Maps (SOM). SOM analysis is a pattern recognition process using unsupervised neural networks, and can reveal the natural clustering and patters in the data which often are distinct geological features not easily identifiable using singular seismic attributes.

Several case histories using PCA and SOM in conventional reservoirs will be reviewed to show the importance of these time-saving tools when added to the interpretation workflow.