Interpreting Multiple Seismic Attribute Volumes Using Interactive and Machine Learning Techniques – A Hands-on Short Course

Course Description

An ongoing challenge to seismic interpreters is to identify and extract heterogeneous seismic facies on data volumes that are continually increasing in size. Geometric, geomechanical, and spectral attributes help to extract key features but add to the number of data volumes to be examined. Common interactive analysis tools include crossplotting, interactive animation, and 3D corendering where we examine more than one attribute at a time. When there are more than three attributes, principal component analysis, independent component analysis, self-organizing maps, and generative topographic mapping mathematically reduce the dimensionality of the data to a more manageable subset. Corendering different components and mapping against a 2D colorbar provides a means of user defined clustering, similar to that provided by k-means. The result of such unsupervised clustering is the identification of color-coded voxels that have similar expressions. Although data reduction and clustering techniques extract important patterns across attribute volumes, the interpretation of these patterns is like traditional interactive interpretation, where the interpreters integrate their geologic understanding of the depositional environment and tectonic deformation with well control to map areas that are more prospective or pose drilling hazards. In contrast, supervised classification such as Bayesian classification, probabilistic neural networks, and convolutional neural networks provides a statistical estimate of how likely any given voxel corresponds to one or more interpreter provided “labels”. Labels may include interpreter-painted seismic facies, hand-picked faults, or attribute vectors extracted about different facies, drilling problems, or fluid flow encountered by well bores. For both supervised and unsupervised machine learning analysis the interpreter can improve the results by using their understanding of the geology to provide a judicious choice of inputs and training data.

A novel part of the course is a hands-on component to compute attributes and seismic facies using software developed by the Attribute Assisted Seismic Processing and Interpretation (AASPI) consortium. Supplied data volumes are limited to those that are publicly available. However, participants will be able use a copy of the software for an additional three months at home or in their workplace to allow them to continue learning and identify which workflows provide useful results for their own non-publicly available data.

Target Audience

Geoscientists and engineers familiar with the objectives of 3D seismic interpretation. This is not an attributes course, but rather a course on how to integrate multiple attribute volumes to obtain a more unified interpretation. The instructor will summarize what each attribute measures and provide references to the theory and implementation of such attributes to interested participants.

Special Information

Access to a Windows-based computer with 4 or more processors (threads) and 50 Gbyte of free disk space. Instructors will provide participants with a 3-month license to the software as they register for the course.

Biographies

Kurt Marfurt is an Emeritus Professor of Geophysics at the University of Oklahoma, where he collaborates with students and staff conducting research to aid seismic interpretation. Marfurt‘s experience includes 23 years as an academician, first at Columbia University, then later at the University of Houston and the University of Oklahoma. His career also includes 18 years in technology development at Amoco's Tulsa Research Center working on a wide range of topics. At OU, Marfurt led the Attribute-Assisted Seismic Processing and Interpretation (AASPI) consortium with the goal of developing and calibrating new seismic attributes to aid in seismic processing, seismic interpretation, and data integration using both interactive and machine learning tools.

David Lubo-Robles is a Postdoctoral Research Associate in the School of Geosciences at the University of Oklahoma. David received a B.S. in geophysical engineering from Simon Bolivar University, Venezuela, and an M.S. and Ph.D. in geophysics from the University of Oklahoma. Working with the Attribute Assisted Seismic Processing & Imaging (AASPI) Consortium, his research interests include the development and application of innovative tools using machine learning, quantitative interpretation, and seismic attribute analysis to delineate geologic features amenable for energy and climate solutions.