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

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Abstract

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 and independent component analysis tools mathematically reduce the dimensionality of the data to a more manageable subset. The goal of unsupervised classification tools including k-means, self-organizing maps, and generative topographic maps is to identify voxels that have similar expressions forming color-coded clusters. 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 provide 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.

A novel part of the course would be 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.

Kurt Marfurt is an Emeritus Professor of Geophysics at the University of Oklahoma, where he mentors students and conducts 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 contributes to 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. He has served as an SEG distinguished lecture short course instructor, as Editor-in-Chief for the AAPG/SEG journal Interpretation and is currently Director-at-Large for the SEG and the AAPG/SEG distinguished lecturer for 2021-2022.

Thang Ha is a research scientist at the University of Oklahoma and supports software development, deployment, and optimization of the AASPI consortium software. He holds B.S, M.S., and Ph.D. degrees in Geophysics from the University of Oklahoma and conducts research in 3D seismic attributes, data conditioning, and automatic classification of geologic facies via machine learning. He has expertise in Fortran90, C++, python, and MPI, working from Windows applications to Linux supercomputer clusters.

David Lubo-Robles received a B.S. in geophysical engineering from Simon Bolivar University, Venezuela, and an M.S. in geophysics from the University of Oklahoma, where he is currently completing his Ph.D. degree. His research interests include the development and application of modern machine learning and pattern recognition techniques, together with quantitative interpretation skills, including prestack inversion and seismic attribute analysis to delineate geologic features amenable to hydrocarbon accumulation. He has expertise in Fortran90, C++, python, and is currently mastering 3D graphics and TensorFlow.