AAPG Datapages/Search and Discovery Article #90319 ©2018 GEO 2018 13th Middle East Geosciences Conference and Exhibition, Manama, Bahrain, March 5-8, 2018

Feasibility of Moment Tensor Inversion for a Single-Well Microseismic Data Using Neural Networks

Oleg Ovcharenko[1], Jubran Akram[1], and Daniel Peter[1]

[1]King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia.

ABSTRACT

Knowledge about seismic source mechanisms of microseismic events given as moment tensors can provide important information about the geometry and nature of fractures in the reservoir. For microseismic data acquired in a single well, accurate estimation of moment tensors is challenging due to poor signal-to-noise ratio (S/N) and acquisition geometry constraints. We, therefore, discuss the feasibility of using artificial neural networks (ANNs) for moment tensor inversion of three-component microseismic data from a single vertical well. The ANNs can provide effective models from data-driven learning for solving complex and ill-posed problems. We solve a nonlinear regression problem using a feedforward network, which is trained using a synthetic dataset from a homogeneous velocity model. The trained network is then applied on another set of synthetic data for performance evaluation. Furthermore, we investigate the effect of number of hidden layers and choice of optimization algorithm on the accuracy of inverted results. Our results suggest that it is difficult to find an optimal neural network architecture that would always provide the best performance. In our testing framework, an ANN configuration with nine hidden layers and [144, 72, 72, 36, 36, 18,18, 9, 9] neurons in each of them yields the best accuracy, reaching about 90% correct results with a 2% error assumption, whereas the adaptive learning rate technique (RMSprop) is found to be the most efficient in terms of prediction accuracy. Our results also indicate that for the homogeneous and isotropic velocity model, neural network can reliably invert for the full moment tensor without explicitly specifying microseismic event locations and velocity model.