GAN-Based Multipoint Geostatistical Inversion Method and Application

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Abstract

In oil field development (during middle and late stages) the stochastic modelling has become a conventional modelling technology. Multi-point statistics (MPS) generate model realizations by training image (TI) that are consistent with prior information. This method often generates a model with discontinuities and unrealistic structural features. And MPS-based inversion is relatively slow and characterization of posterior probability is incomplete. To address this problem, an effective method about how to capture information content of complex priors become a largely important research question. Deep learning (DL) is the most state-of-the-art invention in image recognition. The capacity of data reconstruction of DL may make some problem of geological modeling problem addressed. In this paper, Convolutional Generative Adversarial Neural Network (CGAN) is introduced to learn parametric representation from TI and characterize the spatial structure of geometry. CGAN expresses complex and raw data in simpler representations by stacking a number of convolutional layers. After several training of CGAN, competition between Generator and Discriminator of CGAN generates a lot of 3-D unconditional geostatistical models in a matter of seconds. The effectiveness result shows that these unconditional models fit the multipoint statistical features of TI. And the low-dimensional parameterization of CGAN can be incorporated within the inversion. The trained neural network directly applies the prior information of TI to conditional iterative inversion, which greatly improves calculation speed of the prior probability and maximum likelihood function. This makes inversion simulate many geological conditional models with relatively low computational consumption. The inversion results of different standard deviation show that CGAN-based inversion reproduces geological

structures of conditional data with less uncertainty by the comparison with MPS.