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Regeneration of Geological Models Using Support Vector Machine Assisted by Principal Component Analysis

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Abstract : History matching is a crucial procedure for predicting reservoir performances and making future decisions. However, it is difficult due to uncertainties of initial reservoir models. Therefore, it is important to have reliable initial models for successful history matching of highly heterogeneous reservoirs such as channel reservoirs. In this paper, we proposed a novel scheme for regenerating geological models using support vector machine (SVM) and principal component analysis (PCA). First, we perform PCA for figuring out main geological characteristics of models. Through the procedure, permeability values of each model are transformed to new parameters by principal components, which have eigenvalues of large magnitude. Secondly, the parameters are projected into two-dimensional plane by multi-dimensional scaling (MDS) based on Euclidean distances. Finally, we train an SVM classifier using 20% models which show the most similar or dissimilar well oil production rates (WOPR) with the true values (10% for each). Then, the other 80% models are classified by trained SVM. We select models on side of low WOPR errors. One hundred channel reservoir models are initially generated by single normal equation simulation. By repeating the classification process, we can select models which have similar geological trend with the true reservoir model. The average field of the selected models is utilized as a probability map for regeneration. Newly generated models can preserve correct channel features and exclude wrong geological properties maintaining suitable uncertainty ranges. History matching with the initial models cannot provide trustworthy results. It fails to find out correct geological features of the true model. However, history matching with the regenerated ensemble offers reliable characterization results by figuring out proper channel trend. Furthermore, it gives dependable prediction of future performances with reduced uncertainties. We propose a novel classification scheme which integrates PCA, MDS, and SVM for regenerating reservoir models. The scheme can easily sort out reliable models which have similar channel trend with the reference in lowered dimension space.

Keywords : history matching, principal component analysis, reservoir modelling, support vector machine
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