Dynamic Time Warping for Well-to-Well Geological Connectivity Characterization

J. L. Hernandez Mejia, J. Pisel, and M. Pyrcz

ABSTRACT

For reservoir waterfloods, injection and production data provide valuable information about well-to-well geological connectivity to augment stratigraphic interpretation and modeling, and geophysical inversion. This connectivity information may be applied to optimize well locations and injection and production rates to maximize the recovery of important energy resources. Several techniques are used to evaluate the connectivity between injection and production wells, such as correlation coefficients, linear regression models, and capacitance resistance models. However, such methods rely on simplified flow physics and are based on various simplifying assumptions about the data, geological, and engineering setting. We propose a novel, intuitive machine learning method for physics-constrained dynamic time warping algorithm (PCDTW) to detect the influence of water injection wells on oil production response by mapping the input water injection signal on the output oil production signal. The proposed signal mapping PCDTW method can efficiently determine the lag time between water injection and oil production response, which is needed to characterize the reservoir formation connectivity and heterogeneity between paired injection and production wells. Our proposed method is based on an enhanced physics-based model with constraints for subsurface flow through porous media to improve accuracy, avoid incorrect signal matches or non-physical results, inconsistent with geology and to reduce uncertainty. Our proposed method is a data-driven, domain and physics informed model to support subsurface engineering data science.

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