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Permeability estimation using a hierarchical Markov tree (HMT) model

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Simulation of transport processes in porous media flow requires the permeability of the medium as an input. Nevertheless, the permeability of most media such as the one of a geo-engineering system is usually not directly attainable and needs to be estimated from related well or seismic data. A hierarchical Markov tree (HMT)-based Bayesian computational approach is presented herein for estimating heterogeneous permeability of a porous medium at different length scales [1-3]. A two-layer HMT model is used to model the random permeability at both the data-collection scale and another much finer scale. Hierarchical Bayesian analysis is used to derive the posterior distributions of logarithms of the unknown permeability at different length scales. A hybrid MCMC algorithm is developed to explore the posterior distributions [4]. This Bayesian computational approach is rather general and applicable to various parameter estimation problems. As a demonstration, we consider a permeability estimation problem where the distributions of unknown permeability at different length scales are computed from pressure and fluid concentration data at the wells.

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