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Characterization of multiphase flow in fractured reservoirs using hidden physics models

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We consider a two-phase oil-water flow in matrix-fracture system and choose a specific parametrized form of multiphase flow functions in matrix and in fractures. First, we assume that all parameters are known. We run simulations of this system using a conventional hydrodynamic simulator with a fixed set of parameters and use the obtained saturation field as a ground truth. Then, we represent the discretization of the governing equations as a Gaussian process and estimate its covariance function by minimizing the negative log marginal likelihood. The obtained parameters of the covariance function are used to close the system of governing equations.

We start with estimating the parameters of the Brooks-Corey relative permeability functions in the Buckley-Leverett equation. Next, we present results for a core flooding experiment, where the injected water is displaced in high permeability fracture and simultaneously imbibes into adjacent matrix blocks. We generate the ground truth solutions for various values of residual saturations, Brooks-Corey exponent, and capillary entry pressure at several time instants and estimate the parameters of fracture relative permeabilities and capillary pressure. Finally, we estimate how much does the accuracy of predictions deteriorate in case of a noisy training data.