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Relative permeability curve prediction directly from 3D digital rocks based on AI approaches

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The relative permeability curve is one of the key features to evaluate the flow property of a porous medium, which is important in many subsurface engineering problems such as underground energy storage and recovery. Recently, rapid developments in the technology of artificial intelligence (AI) have offered new views to revisit the acquisition of relative permeabilities. Here, we present our systematic work on the developments of AI models for the predictions of relative permeability curves directly from 3D digital rock images. The training and testing data are generated from pore-network simulations and core-flood experiments. It avoids the use of indirect geometrical parameters as inputs in previous AI methods. It is able to cover 3D digital rocks with variable sizes and further equiped to have the upscaling capability. The results show that the AI models have high prediction accuracies over 95%, with scale information being the most important physics feature accounting for 51%, and the upscaling prediction of relative permeability curve is in good agreement with macroscopic experiment data. The new framework is also flexible and can be easily extended for the prediction of other rock physical properties according to practical demands.

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