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Physics informed neural networks based on sequential training for CO_2 utilization and storage in subsurface reservoir

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Simulation of CO_2 utilization and storage (CCUS) in subsurface reservoirs with complex heterogeneous structures requires a model that captures multiphase compositional flow and transport. Accurate simulation of these processes necessitates the use of stable numerical methods that are based on an implicit treatment of the flux term in the conservation equation. Due to the complicated thermodynamic phase behavior, including the appearance and disappearance of multiple phases, the discrete approximation of the governing equations is highly nonlinear. Consequently, robust and efficient techniques are needed to solve the resulting nonlinear system of algebraic equations. Machine learning (ML) techniques have recently been applied to a wide range of nonlinear computational problems. Recently, Physics informed neural network (PINNs) has been proposed for solving partial differential equations. Unlike typical ML algorithms that require a large dataset for training, PINNs can train the network with unlabelled data. The applicability of this method has been explored for the flow and transport of multiphase in porous media. However, for strongly nonlinear hyperbolic transport equations, the solution degrades significantly. In this work, we propose a sequential training PINNs to simulate two-phase transport in porous media. The main concept is to retrain neural network to solve the PDE over successive time segments rather than train for the entire time domain at once. We observe that sequential training can capture the solution more accurately concerning the standard training method. Furthermore, we extend the sequential training approach for compositional problems in which nonlinearity is more significant due to the complex phase transition.

Participation

In-Person

References

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