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Physics-informed neural networks applied to two-phase flow in porous media problems

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Physics-informed Neural Networks (PINN) has been proven to be an efficient tool to solve forward and inverse problems governed by partial differential equations [1]. In this work, PINN is utilized to solve two-phase flow in porous media problems. Collocation points sampling is refined using the adaptivity algorithm introduced in [2] by adding training points based on the local value of validation residuals. PINN provided accurate results in several 2D examples as compared to existing analytical solutions and to FEM reference solutions.

Furthermore, PINN is assessed to build parametric solvers for such problems. This is done through training the model offline with collocation points that cover the spatio-temporal and parametric space. After the model is sufficiently trained, predictions can be done quickly online for any parameter. The solved problems include injection with changing gate location, injection with different domain permeability and a combination of both parameters in one parametric solver. It is concluded that PINN offers a simple flexible way to build parametric models for two-phase flow in porous media problems.

REFERENCES

[1] Raissi, M., Perdikaris, P., Karniadakis, G. E, *Physics-informed neural networks: A deep learning framework for solving forward and inverse problems involving nonlinear partial differential equations*. Journal of Computational Physics, 378, 686-70, 2019.

[2] Hanna, J., Aguado, J. V., Comas-Cardona, S., Askri, R., Borzacchiello, D, *Residual-based adaptivity for two-phase flow simulation in porous media using Physics-informed Neural Networks*. arXiv e-prints, arXiv-2109, 2021.