**Physics Informed Neural Networks for Fluid Flow in Porous Media**

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**Abstract**

Physics Informed Neural-Networks (PINNs) is an emerging field that is gaining credence among the scientific computing community. By embedding domain knowledge into machine learning models, PINNs allow for long-term, accurate, consistent, and generalizable spatiotemporal predictions that are rooted in physics while leaving room for data assimilation. In addition, the PINNs approach is mesh-free, avoids truncation errors, and can solve inverse problems as easily as it can solve forward problems. In this work, we present a PINNs approach for the simulation of fluid displacement in porous media. Specifically, we solve the non-linear hyperbolic Buckley-Leverett (B-L) problem with a nonconvex flux function, and we extend the PINNs solution to a 2D heterogeneous problem. The contributions of our work are threefold. First, we present a PINNs approach to solving the hyperbolic B-L problem by regularizing the neural network residual with more physics. Second, we show that it is possible to obtain extremely accurate solutions using the Adam optimizer with a residual-based adaptive refinement (RAR) algorithm that achieves an ultra-low loss. Our solution method can accurately capture the shock-front. Third, we extend the PINNs application to stratified and heterogeneous porous media in a 2D setting.