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Machine learning to accelerate nonlinear solvers applied to multiphase porous media flow

Thursday, 2 June 2022 14:00 (15 minutes)

We present a machine learning strategy for accelerating the nonlinear solver convergence for multiphase porous media flow problems. The presented approach dynamically controls an acceleration method based on numerical relaxation. The methodology is implemented and demonstrated in a Picard iterative solver; however, it can also be used with other types of nonlinear solvers. The goal of the machine learning acceleration is to reduce the number of iterations required by the nonlinear solver by adjusting the value of the relaxation factor to the complexity/physics of the system. A set of dimensionless parameters is used to train and control the machine learning. In this way, a simple two-dimensional layered reservoir can be used for training while still exploring a large portion of the dimensionless parameter space. As a result, the training process is simplified, and the machine learning model can be applied to any type of reservoir models.

We demonstrate that the presented technique dramatically reduces the number of nonlinear iterations without sacrificing the quality of the results, even for models that are far more complex than the training case. The average reduction in the number of nonlinear iterations obtained due to the presented method is 24% and the reduction in runtime is 37%. It is worth noting that the optimum value of the relaxation factor is not known a-priori and it is problem specific. Hence, having an acceleration that adapts itself to the complexity/physics of the system throughout the numerical simulation is extremely valuable and has driven several publications in multiple fields.

The method presented here provides an easy way to deal with nonlinear system of equations that does not necessitate as much effort as a custom nonlinear solver while producing outstanding results. We believe that the machine learning acceleration is not limited to the multiphase porous media flow but extendable to any other system that can be studied based on dimensionless numbers, and that a relaxation technique can be used to stabilize the nonlinear solver.

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References

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

In person

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