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Physics-enhanced Convolutional Neural Networks for Predicting Effective Dispersion in Porous Media

Wednesday, 1 June 2022 11:00 (15 minutes)

The effective dispersion coefficient is a key parameter for characterizing the transport capability of porous media. This coefficient depends not only on the pore-scale geometry but also the macroscale flow conditions and is traditionally expensive to compute as it requires the solution to a partial differential equation (PDE). In this work, a physics-enhanced Convolutional Neural Network (CNN) is developed to estimate effective dispersion given an image of the microstructural geometry and a Peclet number describing the flow condition. The CNN is trained with 100,000 computer-generated images of porous media, on which a PDE closure problem is solved to calculate the effective dispersion coefficient for various Peclet numbers. The CNN is enhanced by including Minkowski functionals and tensors as inputs, which are powerful morphological descriptors for porous media. Results demonstrate that enhancing the CNN with physics-based Minkowski functionals not only speeds up training time but also increases accuracy. This CNN dramatically reduces the computational cost of characterizing porous media while improving on the accuracy of frequently-used relationships and can have benefits in multiple fields including energy and energy storage.

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Participation

Unsure

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