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A framework for upscaling and modelling fluid flow for discrete fractures using conditional generative adversarial networks

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This work follows up the adaptation and application of conditional generative adversarial networks (CGAN) to the solution of partial differential equations, for the scaling up of highly heterogeneous aperture distributions of fractures into equivalent permeability tensors. The upscaled equivalent tensor enables a substantial reduction in the computational cost of simulating fluid flow in fractured porous media by allowing the employment of coarser grids while keeping the accuracy of an explicit model. However, this procedure becomes expensive in case multiple fractures are observed, which is the case of naturally fractured rocks. To accelerate the scaling-up, this work proposes the employment of CGAN for the solution of the fluid flow inside the fracture. CGAN have previously shown to handle well the parametrization of heterogeneous material properties and providing accurate solutions. Three different types of aperture distributions are used as input in this work: layered media, Zinn & Harvey transformation and self-affine fractal. As output, the model predicts the pressure inside the fracture which is used for calculation of the equivalent permeability tensor. Our results show that the framework employing CGAN provides equivalent tensors that are highly accurate, compared to the ones obtained via a traditional framework.

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