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An integrated tool for digital rock physics: benchmark results for flow simulations

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Because of the current low oil price, the Oil and Gas industry needs to optimize their workflows. Digital rock physics (DRP) is the to determine physical rock properties by performing numerical simulations on 3D scans of rock samples. This innovative technique saves time and money in comparison to conventional lab experiments. Besides the increase in efficiency, DRP also allows insights into the actual processes occurring in the rock samples. It is, therefore, considered a game changer for the oil and gas industry.
Imaging and calculation are the basis of DRP. They aim to determine the 3D geometry of pore spaces and mineral phases, and to subsequently simulate various physical processes in these digital objects. To obtain macroscopic rock properties such as permeability, electrical conductivity, diffusivity, and elastic moduli, different steps are involved: the image acquisition with well resolved pore throats (CT-scan, FIB-SEM images, etc.); image processing for noise reduction, smoothing, and segmentation; setting up the numerical experiment; and numerically solving the Stokes equations. For each of these DRP steps, there is more than one method and implementation. For quality control of the DRP solutions, benchmark tests are needed to validate the property estimations. The benchmark results in [1] compare different solvers with analytical models and empirical models for flow computations on the microstructures ranging from idealized pipes to digital rocks.
The innovative and easy-to-use DRP simulator GeoDict® [2] allows to conveniently quantify the impact of numerical solvers, boundary conditions, simulation platforms, etc. on macroscopic rock properties. GeoDict reports the permeability, as well as the runtime and memory consumption. Local or remote servers, as well as cloud services (e.g. MS Azure) can be tested for performances and quality benchmarks. Automatic result reports and PowerPoint presentation generation are possible. We were able to improve the speed of our flow solvers. This is demonstrated by reproducing the predicted permeabilities from the benchmarks in [1] requiring much shorter run-times.

References

[1] Saxena, N. et al.: References and benchmarks for pore-scale flow simulated using micro-CT images of porous media and digital rocks. Advances in Water Resources, Volume 109, (2017) p. 211-235.
[2] GeoDict, the Digital Material Laboratory, www.geodict.com.

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