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Simulation of multi-physics porous-media applications using partitioned black-box methods

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Many real-world applications involve porous-media multi-physics problems. Examples are (1) the hydromechanical coupling of liquid in a fracture under high pressure and the resulting deformation of the surrounding porous medium [3] or (2) the coupling free and porous-medium flow [2].

In the presented work, we avoid the ill-conditioned systems of equations that normally arise when solving such problem monolithically. Instead, we use partitioned schemes that solve the problems on the subdomains individually. This allows us to reuse existing solvers for the resulting linear systems of equations. The coupling of the subdomains is achieved by appropriate exchange of information over the sharp interface separating the subdomains and incorporating this information in coupling conditions.

Our focus is on "black-box" coupling methods. These black-box methods approximate the interface problem via information exchanged over the coupling interface. This allows us to reuse existing methods for the linear systems of equations and even to reuse existing software packages, like CFD solvers, with little adaption. The couplings are carried out via the open-source coupling library preCICE [1] that has many useful features such as data mapping, data communication, parallelization, etc. already implemented. We study the behavior of different coupling schemes for hydromechanical coupled problems and coupled free and porous-medium flow problems.

REFERENCES

[1] H.-J. Bungartz et al. "preCICE – A fully parallel library for multi-physics surface coupling". In: *Computers and Fluids* 141 (2016). Advances in Fluid-Structure Interaction, pp. 250–258.

[2] A. Jaust, K. Weishaupt, M. Mehl, and B. Flemisch. "Partitioned Coupling Schemes for Free-Flow and Porous-Media Applications with Sharp Interfaces". In: *Finite Volumes for Complex Applications IX - Methods, Theoretical Aspects, Examples*. 2020, pp. 605–613.

[3] P. Schmidt, A. Jaust, H. Steeb, and M. Schulte. *Simulation of flow in deformable fractures using a quasi-Newton based partitioned coupling approach*. 2021. arXiv: 2104.05815.