Scalable parallel-in-time solvers for linear poroelasticty

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Efficiently solving coupled partial differential equations (PDEs) is a challenging task that requires the integration of time-parallel numerical methods and scalable linear solvers suited for high-performance computing (HPC) environments. This study presents a robust approach for the quasi-static Biot system, leveraging a multigrid-reduction-in-time (MGRIT) method (Falgout et al., 2014) integrating backward Euler time discretization and a highly scalable multigrid solver for the spatial domain. Solver robustness is achieved through fixed-stress smoothing (Gaspar and Rodrigo, 2017). We provide a theoretical convergence analysis of the proposed method and support our findings with empirical evaluations of its robustness and parallel scalability. Additionally, we address the potential advantages of incorporating linearly implicit extrapolation techniques and concurrent space-time coarsening.