

Efficient Algebraic Multigrid Preconditioners on Clusters of GPUs

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Abstract. Many scientific applications require the solution of large and sparse linear systems of equations using iterative methods, this operation accounting for a large percentage of the computing time. In these cases, the choice of the preconditioner is crucial for the convergence of the iterative method. Given the broad range of applications, great effort has been put in the development of efficient preconditioners ensuring algorithmic scalability: in this sense, multigrid methods have been proved to be particularly promising. Additionally, the advent of GPUs, now found in many of the fastest supercomputers, poses the problem of implementing efficiently these algorithms on highly parallel architectures; this is made more difficult by the fact that the solution of sparse triangular systems, a common kernel in many types of preconditioners, is extremely inefficient on GPUs.

In this paper, we use the PSBLAS and MLD2P4 libraries to explore various issues that affect the efficiency of multilevel preconditioners on GPUs, both in terms of execution speed and exploitation of computational cores, as well as the algorithmic efficiency in guaranteeing convergence to solution in a number of iterations independent of the parallelism degree. We investigate these issues in the context of linear systems arising from groundwater modeling application of the filtration of 3D incompressible single-phase flows through porous media.

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