ArbiLoMod: Communication Avoiding Localized Reduced Basis Methods for Problems with Arbitrary Local Modifications

A. Buhr[1], M. Ohlberger[1], and S. Rave[1]

[1]Institute for Computational and Applied Mathematics, University of Münster, Münster, Germany

During the development of today's computer architectures in the last decade, communication capabilities did not grow at the same speed as computation capabilities. This trend was accelerated by the rise of accelerator devices, multiplying the available computing power in each node of a cluster. Cloud environments pushed this trend to the extreme, allowing any user to request a high number of workstations, connected to the user by an internet connection capable of transferring usually only a few megabytes per second. To leverage these computing potentials for engineers working with finite element based simulation software, we designed the localized reduced basis method "ArbiLoMod" which is tailored to this computing environment. In all design decisions, avoiding of communication was the primary goal, often trading computation in for less communication.

ArbiLoMod employs reduced basis techniques to find problem adapted low dimensional spaces in which the solutions of a given parametrized partial differential equation can be quickly approximated for arbitrary parameters. The reduced space is localized by a decomposition of the solution space into overlapping local subspaces. Elements of other existing localized reduction methods are incorporated [4, 5, 1, 2]. The use of localized reduced spaces not only allows for a good parallelization, but also for a fast recomputation of the solution after arbitrary local modifications of the underlying problem, a situation often occurring in engineering environments, hence the name "ArbiLoMod". To guarantee the quality of the solution, a localized a-posteriori error estimator is employed, based on the global residual of the problem. When necessary, the reduced local spaces are enriched adaptively.

We will show numerical results, obtained by an implementation of the method in our model reduction framework pyMOR [3], for elliptic model problems.

References

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