Autoscaling Localized Reduced Basis Methods With pyMOR and EXA-DUNE

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Abstract

The mathematical models of complex flows, arising for example in reservoir engineering or water pollution dispersion prediction, are naturally of multi-scale and parametric character. They combine effects on multiple scales of space, ie. microscopic material features like porosity with macroscopic influences like external pressures or well placement. It is often impossible to know the exact material properties at every given point in the computational domain, but rather a statistical distribution needs to be assumed.

Localized RB methods are well suited for the computational efficiency requirements arising from multi-query scenario like uncertainty quantification or optimization. Both scenarios typically incur a huge number of forward solves, making model reduction with RB methods very attractive to reduce time-to-solution.

The blending of accuracy enhancing multi-scale and parametric forward-solve accelerating reduced basis methods achieved in our Localized Reduced Basis Multi-Scale Method (LRBMS) make it particularly useful in these problem domains. Adaptive online enrichment enables us to start with relatively coarse approximation spaces and only expend more computational effort where either problem specific knowledge or error indicators dictate.

As a part of the German Science Foundation's Strategic Priority Programme 1648 "Software for Exascale Computing (SPPEXA)" project EXA-DUNE we are developing a dual software stack in Python and C++. In this contribution we will show how using pyMOR as the driver for the model reduction, we will be able to dynamically and efficiently allocate and free available computing resources as needed, spanning high-dimensional solves across changing pools of MPI-Parallel discretizations powered by EXA-DUNE, with very little input from the user.

References

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