MoRePaS 2015

Optimal local approximation spaces for component-based static condensation procedures

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In this talk we introduce local approximation spaces for component-based static condensation (sc) procedures that are optimal in the sense of Kolmogorov [2].

To facilitate simulations for large structures such as aircraft or ships it is crucial to decrease the number of degrees of freedom on the interfaces, or "ports", in order to reduce the size of the statically condensed system. To construct optimal port spaces we consider a (compact) transfer operator that acts on the space of harmonic extensions on the component pair associated with the respective port and maps the traces (of the harmonic extensions) on the boundary ports to the trace on the shared port. Solving the "transfer eigenproblem" for the composition of the transfer operator and its adjoint yields the optimal space. For a related work in the context of the generalized finite element method we refer to [1]. Next we introduce a spectral greedy algorithm to generalize the transfer eigenproblem procedure to the parameter dependent setting and construct a quasi optimal parameter independent port space. Moreover, we show that given a certain tolerance and an upper bound for the ports in the system, the spectral greedy constructs a port space that yields a sc approximation error on a system of arbitrary configuration which is smaller than this tolerance for all parameters in a rich train set. Numerical experiments demonstrate the very rapid and exponential convergence both of the eigenvalues and the sc approximation based on spectral modes also for non-separable and irregular geometries.

References

[1] I. Babuska and R. Lipton. Optimal local approximation spaces for generalized finite element methods with application to multiscale problems. *Multiscale Modeling & Simulation*, 9(1):373–406, 2011.

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