Simultaneous Reduced Basis Approximation of Parameterized Eigenvalue Problems

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Reduced basis methods for parameterized partial differential equations have been studied for many problem classes like linear and non-linear equations, compliant and non-compliant outputs as well as static and time-dependent problems. They are also used in the context of component mode synthesis by static condensation reduced basis methods.

In many applications, e.g., in the field of vibro-acoustics during the planning process of large timber buildings, it is necessary to simulate the same large eigenvalue problem numerous times, using different material parameter values in each simulation. Furthermore, one is interested in approximating a certain number of the smallest eigenvalues and eingenvectors rather than only one eigenvalue or eigenvector and the eigenvalues of interest usually have multiplicities that depend on the parameters. One is interested in optaining the optimal parameter values for the components of the building. Reduced basis approximations allow to handle these problems in a fast way that is nevertheless accurate.

This talk is about a model reduction framework for parameterized eigenvalue problems by a reduced basis method [1], which, in contrast to the standard single output case, allows to approximate several outputs simultaneously. The outputs considered in this case are a certain number of the smallest eigenvalues with multiplicities. We analyze the corresponding a posteriori asymptotically error estimators for the eigenvalues, in order to achieve a fast and reliable evaluation of these input-output relations. Moreover, we present different greedy strategies and systematically study their performances, paying special attention to the multiple eigenvalues in the cases of the analysis of the estimator and the development of the greedy part of the algorithm.

We introduce a method to build a single reduced space for the simultaneous variational approximation of the eigenvalue problem and compare the performance of this space to the performance of a space built with a standard POD method.

Furthemore an extension of our reduced basis method to a component mode synthesis is shown, which allows to establish a component library that can be used to simulate large composed timber buildings.

References

[1] T. Dickopf, T. Horger, and B. Wohlmuth. Simultaneous reduced basis approximation of parameterized eigenvalue problems. *arXiv*, 2015.