Non-Intrusive Reduced Basis two-grid method with parabolic equations

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Reduced Basis Methods (RBMs) are used to solve parametric problems for a large number of parameter values, and they aim at reducing the complexity of high fidelity (HF) codes. They are appealing in the industrial framework as they conserve the accuracy of classical simulation tools such as finite element, finite volume or spectral discretizations while reducing the computational costs. Usually, they employ an offline/online decomposition. The efficiency of the RBM relies on the ability, offline, to prepare the online step. One drawback of these approaches is the fact that their implementation is intrusive, in the sense that some elementary RBM bricks of the approximation needs to be assembled offline from the original code and this requires to modify lines in the HF code. Thus, non intrusive versions are interesting if the user does not have access to the original code.
The "Non Intrusive Reduced Basis" (NIRB) two-grid method, developed in [1], combines the concept of RBM (i.e. being able to approximate accurately the state by a linear combination of very few elements in the reduced basis) and the non intrusive aspect by post-processing a coarse approximation (e.g. obtained by using the reference code on a coarse finite element grid) computed in a short time. This method has been developed in the context of elliptic equations. We extend the NIRB two-grid method to parabolic equations. To the best of our knowledge, the two-grid method has not already been studied in the context of time-dependent problems. We demonstrate that it may be used on such problems with a model problem which is the heat equation. The parameter is the diffusion coefficient. We recover optimal estimates in $L^\infty(0,T;H^1(\Omega))$, and present numerical results.

Références

[1] R. Chakir and Y. Maday, *Une méthode combinée d'éléments finis à deux grilles/bases réduites pour l'approximation des solutions d'une E.D.P. paramétrique.*, C. R. Acad. Sci. Paris, Ser. I Vol 347, p435-440, 2009.

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