MODEL ORDER REDUCTION IN SUPPORT OF THE VIRTUAL ELEMENT METHOD

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Virtual elements (VEM) are a family of numerical methods for the approximation of PDEs which can easily handle complex geometries and their discretization by means of arbitrarily-shaped polygons/polyhedra. Since the basis functions of the VEM space are themselves solutions of PDEs, their explicit evaluation is not required, and several quantities are not computed exactly. For instance, the nonpolynomial contribution is handled by a stabilization term when constructing the bilinear form and neglected when computing the error.

We propose a Reduced Basis (RB) approach for efficiently solving the equation associated to each virtual basis function. The idea is to replace the stabilization term with an actual approximation of the nonpolynomial contribution. We show that this operation produces good results even if done in a very rough way. This novel approach improves the convergence properties of VEM when applied, for instance, to anisotropic second order diffusion equations, when standard stabilization recipes show poor performance. In post-processing framework, it is well known that, when a PDE is solved with VEM, the degrees of freedom of the discrete solution allow only the computation of projections onto discontinuous polynomial spaces, so that the solution is not conforming. The RB approximation of the virtual functions can also be exploited for reconstructing conforming solution in the VEM space. This task can be useful to carry out operations such as visualization, reconstruction in subdomains, pointwise evaluation and evaluation of the conforming error when benchmarking the method.

References

[1] Fabio Credali, Silvia Bertoluzza, and Daniele Prada. Reduced basis stabilization and post-processing for the virtual element method. *Computer Methods in Applied Mechanics and Engineering 420:116693*, 2024.