A ``Tuning-free" multi-field reduced basis method with application to multiscale modelling.

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P. Kerfriden*, K.C. Hoang* and S.P.A. Bordas*†

* Cardiff University School of Engineering
The Parade, CF24 3AA Cardiff, United Kingdom
e-mail: pierre.kerfriden@gmail.com

† Faculte des Sciences, de la Technologie et de la Communication,
University of Luxembourg,
6 rue Richard Coudenhove-Kalergi, L-1359 Luxembourg

ABSTRACT

The reduced basis method [1,2] is an increasingly popular reduced order modeling technique for parameterized partial differential equations. In this talk, we will present a new reduced reduced basis method for affinely parametrised elliptic PDEs based on the concept of two-field surrogates [2].

The main idea is to construct separate reduced bases approximations for the primal variable and for the flux of the elliptic PDE. The primal surrogate is constructed in such a way that it satisfies the Dirichlet conditions exactly, while the flux surrogate satisfies the balance equation of this field. In this context, the Constitutive Relation Error permits to compute a certain measure of the exact error that is made when solving these surrogates [3]. We use this error as a guide to construct an efficient reduced basis, through a greedy sampling of the parameter domain.

In a second step, we make this strategy goal-oriented, by minimising the error in the outputs of the reduced model, using the well-known adjoint methodology.

We show that the proposed strategy is significantly more efficient than state-of-the art alternatives in terms of computational costs, for a given level of accuracy. In addition, we show that the goal-oriented setting allows for the algorithm to be ``tuning-free": the only input parameter that is required from the engineer is the tolerance on the output of the computation. Finally, we show that this new reduced basis paradigm is easy to use and implement.

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