Discrete empirical selection of indices algorithm for treatment of nonlinear terms in FEM Galerkin models for parameterized PDEs. Applications to parametric reduced order models.

R. Ştefănescu [1] , B.R. Noack [2], I.M. Navon [1*]

[1] *The Florida State University, Department of Scientific Computing, Tallahassee, Florida 32306, USA*
rstefanescu@fsu.edu, inavon@fsu.edu
[2] *Institut P' , CNRSUniversité de PoitiersENSMA, UPR 3346, Département Fluides, Thermique, Combustion, CEAT, 43 rue de lAérodrome, F-86036 Poitiers CEDEX, , France,*
Bernd.Noack_AT_univ – poitiers.fr

[*] Corresponding author

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Bernd.Noack_AT_univ – poitiers.fr

Abstract

We propose a new system reduction strategy for finite element Galerkin models for parameterized nonlinear partial differential equations that can be also applied in the framework of parametric reduced order models. The discrete empirical selection of indices algorithm (DESI) generalizes the discrete empirical interpolation method (DEIM) proposed by Sorrensen and Chaturantabut (2009) which reduces the complexity of the discretized nonlinear terms by approximating the underlying nonlinear functions in the framework of model reduction. The idea behind the DESI algorithm arose from the authors efforts to reduce the computational time of the pre-computed FEM proper orthogonal reduced order quadratic nonlinear models. The DESI algorithm approximates the tensor product representation of the discrete nonlinear term by selecting a subspace of indices using a greedy technique, thus leading to faster low-order surrogate models. A first proof-of-concept for DESI methodology is demonstrated for the full FEM 1D Burger model and its corresponding reduced order model where the DESI algorithm approximates a 2th-rank tensor.

*Corresponding author