Accuracy assessment of generalized parametric solutions for optimization and uncer-tainty quantification

Pedro Díez*, Sergio Zlotnik, Raquel García-Blanco

Universitat Politècnica de Catalunya (UPC BarcelonaTech)
Laboratori de Càlcul Numèric (LaCàN)
E.T.S. d'Enginyers de Camins, Canals i Ports de Barcelona
pedro.diez@upc.edu

ABSTRACT

Keywords: Reduced Order Models, Proper Generalized Decomposition, Error Assessment

Optimization of design and manufacturing is a real need of Industry and requires sampling repeatedly the computational models in different points of the multidimensional parametric design space. This undergoes an important computational effort and, in practice, a large time lapses before obtaining a reliable answer. The problem is similar in the framework of Uncertainty Quantification: characterizing a stochastic model requires solving a large number of deterministic instances, browsing a multidimensional space in which the input random variables play the same role as the free design parameters play in the optimization context.

Reduced Order Models (ROM) constitute a realistic approach to obtain affordable solutions in this framework. The idea is building a model less general but accurate enough to accurately represent the solutions in the manifold mapped from the parametric space. In particular, Proper Generalized Decomposition (PGD) provides an explicit expression for the parametric dependence of the solution, optimally stored using a separable approximation. Thus, the optimization process is a simple and computationally costless post-process of the PGD solution. The PGD solution includes also the possibility of computing sensitivities (derivatives with respect to the parameters). This work reports on new strategies to assess the accuracy of the PGD (and other ROM) to control the accuracy within the optimization process. The estimates proposed are based on residual techniques and aim to assess the error measured in general Quantities of Interest (QoI). Goal-oriented strategies are essential in optimization because the QoI is precisely the objective (cost) function to be minimized.