Explicit parametric solutions using an algebraic PGD solver

P. Díez, S. Zlotnik, A. Huerta

Laboratori de Càlcul Numèric (LaCàN),
ETS de Ingenieros de Caminos, Canales y Puertos,
Universitat Politècnica de Catalunya, BarcelonaTech, Spain
pedro.diez@upc.edu

Separable approximations efficiently deal with high-dimensional data. In particular, the Proper Generalized Decomposition (PGD) provides separable functions as solutions of boundary value problems. The general PGD framework contains a large family of methodologies, all of them providing solutions in for of separable objects, that is a sum of terms, being each term a product of 1D functions (or arrays). Some of the PGD methodologies have been conceived to tackle nonlinear problems.

We present a general methodology to perform basic operations (sum, product, division, exponentiation…) for this type of objects. The idea is based on the principle of the PGD compression, that is a separable least squares approximation of any multidimensional function. The PGD compression is extensively used in practice to compact the separable solution in less terms without loss of accuracy. Here, this concept is applied to both algebraic tensor structures and functions in multidimensional Cartesian domains. Moreover, a straightforward extension of this concept is devised to operate with multidimensional objects stored in the separable format. That allows creating a toolbox of PGD arithmetic operators. Thus, the toolbox is used to perform elemental operations with PGD type objects. This is of particular interest to solve nonlinear problems with PGD techniques by simply replicating the iterative algebraic solvers that are used in the standard Finite Element framework.