Model reduction approach for parametric quasi-static nonlinear mechanics problems in an industrial code

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We present our work on parametric model order reduction (pROM) for a generic class of parametric mechanical problems with internal variables in a non-linear quasi-static framework. This work is the result of a collaboration between the MEMPHIS team of Inria Bordeaux Sud-Ouest and the R&D departments of EDF.

Within the engineering studies performed by EDF, it may be necessary to evaluate a mechanical model repeatedly for slightly different configurations, which are associated with different physical or geometric model parameters (parametric study). However, successive evaluations for non-linear mechanical problems can lead to prohibitive computational costs.

We implement an hyper-reduced reduced-order model (ROM) based on an industrial FEM code (Code Aster). We develop an adaptive algorithm based on a POD-Greedy strategy [2]. Since the differential operator is nonlinear, we develop an hyper-reduction strategy based on empirical quadrature ([1], [3]) : our approach relies on the construction of a reduced mesh to speed up online assembly costs of the ROM. Moreover, we introduce an error indicator correlated to the approximation error, whose evaluation is cost-efficient in terms of computational time.

As an illustration and validation of our methodology, we present numerical results for a case of linear mechanics (isotropic linear elasticity) and non-linear mechanics (elasto-plasticity).

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