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STRUCTURE-PRESERVING HYPER-REDUCTION OF PARAMETRIC HAMILTONIAN SYSTEMS

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Conservative processes are ubiquitous in a wide range of phenomena in engineering and natural sciences, and can be modeled as Hamiltonian systems. These are differential equations whose dynamics is described by a scalar function, the Hamiltonian, typically representing the total energy, that is preserved over time. The complexity of accurately solving such systems scales with the number of degrees of freedom of the problem, which is typically very large. This leads to unbearable computational costs, especially when the problem has to be repeatedly solved for many instances of input parameters. To address this issue, model order reduction techniques replace the original problem by a problem of lower complexity, called reduced model. In this talk, we focus on projection-based methods where the reduced model is obtained by projecting the full order dynamics onto a subspace of reduced dimension. In the framework of non-linear problems, this step is usually not sufficient to obtain a substantial computational gain, since the evaluation of the non-linearities requires a lifting to the full dimensional space. To overcome this bottleneck, a further step of reduction is required. Hyper-reduction techniques, such as the Discrete Empirical Interpolation Method (DEIM), have been introduced to efficiently handle non-linear quantities in the governing equations. However, hyper-reduction is in general not structure-preserving: if classical DEIM is applied to a Hamiltonian system, the resulting hyper-reduced system is no longer Hamiltonian. In this talk, we will discuss hyper-reduction techniques based on a DEIM approach that aim at reducing the complexity of the original problem while preserving its Hamiltonian structure.