Interpolatory Reduction Methods for Parameter-dependent Dynamic Control Systems

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Abstract: In this talk, we will discuss reduction strategies for complex dynamical processes that are subject to certain variations in material properties and geometries, respectively. In the context of parameter optimization, this inevitably leads to the need for accurate and fast simulation of the underlying systems. While some methods like proper orthogonal decomposition and reduced basis methods directly work on the PDE formulation of the problem, here we will first perform a semi-discretization in space by e.g. finite elements before we obtain a large-scale linear parameter-varying ODE of the form

$$E\dot{x}(t) = Ax(t) + \sum_{i=1}^{d} p_i(t)A_i\,x(t) + Bu(t), \quad y(t) = Cx(t)$$

with $E, A, A_i \in \mathbb{R}^{n\times n}$, $B \in \mathbb{R}^{n\times m}$ and $C \in \mathbb{R}^{q\times n}$. We will point out a link between the above type of systems and a special class of nonlinear control systems for which we will present some powerful extensions of successful linear reduction strategies. One of the main advantages is the fact that by this means we can completely preserve the parametric structure of the original model even if the p_i vary in time which usually is a nontrivial task. We will test our methods on some real-life applications arising in e.g. micro-mechanical and electrochemical systems.

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