Parametric Model Order Reduction of Dynamical Systems: Survey and Recent Advances

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Abstract: Model reduction has become an ubiquitous tool in simulation and control for dynamical systems arising in various engineering disciplines. Often, models of physical processes contain parameters describing material properties and geometry variations, or arising from changing boundary conditions. These parameters may vary with time or be stochastic when modeling the uncertain knowledge about them. For purposes of design, optimization, and uncertainty quantification, it is often desirable to preserve these parameters as symbolic quantities in the reduced-order model (ROM). This allows the re-use of the ROM after changing the parameter so that the repeated computation of reduced-order models can be avoided. Significant savings in simulation times for full parameter sweeps, within optimization algorithms and Monte Carlo simulations can be achieved this way.

In this talk, we survey several approaches for computing ROMs for linear and nonlinear parametric systems. Parameter dependencies can be linear, polynomial, or nonlinear in general. The considered methods construct the ROMs in different way, using system-theoretic concepts, rational interpolation, and/or greedy-type sampling approaches. We discuss the state-of-the-art of these methods and present recent advances. We illustrate the performance of the available methods using numerical examples, often in the context of industrially relevant applications.