Adaptivity concepts for POD reduced-order modeling

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In this talk, we consider model order reduction using proper orthogonal decomposition (POD-MOR) in order to replace high-fidelity systems by low-order surrogates. In order to construct the reduced-order approximation, snapshots of the underlying dynamical system are generated by performing numerical simulations of the high-fidelity model. A crucial challenge within POD-MOR lies in its input dependency: if a physical property is not identified within the snapshot set, it will also be missing in the reduced-order model. Thus, it is not guaranteed automatically that the reduced-order approximation delivers a sufficiently accurate solution w.r.t. the (unknown) true solution. In order to avoid (too) fine discretizations in space and time, we utilize adaptivity concepts which generate 'good' snapshots efficiently. Moreover, non-uniform discretizations are highly relevant in many practical applications in order to make implementations feasible. In particular, we propose a residual-based adaptive time discretization for POD-MOR in optimal control which is based on a reformulation of the optimality system into an elliptic equation. On the other hand, we combine space-adapted snapshots with the usual POD framework and address the challenges arising such as snapshot vectors with different lengths and a violation of a weak divergence-free property in the context of flow problems. We illustrate the concepts with numerical examples including simulation and control of phase field models and incompressible flow.

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