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Reduced-Order Models for Parametrized PDE Models with Constraints

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Various phenomena simulated using partial differential equations (PDEs) give rise to constrained systems of equations. These include models of optimal control with constraints given by elliptic PDEs, as well as fundamental models of fluid dynamics such as the Stokes equations where the constraints correspond to the incompressibility (divergence-free) condition. If these models also depend on random (parametrized) input data, than it is important to develop reduced-order models (ROMs) to reduce the computational costs associated with multiple solutions of the large-scale algebraic systems that arise from discretization. Several approaches have been developed to construct ROMs for constrained problems. These approaches supplement greedy search strategies [4] with methods that augment the spaces obtained from searching in order to enforce inf-sup stability, which otherwise does not hold in the reduced spaces. In this work, we present two sets of results. The first is a comparison of the effectiveness of two such methods for augmentation, known as aggregation methods [3] and supremizing methods [1, 2]. The second is an introduction of a new approach that avoids the difficulties caused by lack of inf-sup stabiity by forcing the reduced model to have a simpler structure not of saddle-point form.

References

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