Reduced Basis and Instantaneous Control Preconditioners for the Solution of Time-Dependent Optimization Problems

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Many physical phenomena can be modeled by linear or nonlinear time-dependent partial differential equations (PDEs). Optimization of such systems in the context of parameter estimation, optimal control, or optimal design plays an important role in science and engineering. Algorithms for the solution of time-dependent PDEs typically involve marching in time, starting from an initial condition. In optimization, however, the values of the solution of the time-dependent PDE at later times feed into the optimization at early times. This coupling in time makes the practical solution of these very large-scale optimization problems challenging. Storage management techniques, reduced bases approaches, and instantaneous control techniques have been devised to address the computational complexity of these problems. However, theoretical convergence properties of the latter two technqiues are not yet completely understood.

In this talk we propose to use reduced basis approaches and instantaneous control techniques as linear or nonlinear preconditioners in the solution of time-dependent optimization problems. Information contained in reduced bases and instantaneous control is incorporated into the optimization while convergence of the overall scheme is ensured by the outer iteration. We present theoretical and numerical justifications for this approach.