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A Robust Matrix-Free SQP Method for Large-Scale Optimization

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Optimal design, optimal control, parameter estimation and inverse problems are ubiquitous in science and engineering. Their mathematical models often involve large-scale PDE-constrained optimization problems that can be solved numerically using sequential quadratic programming (SQP) methods. For this class of problems, however, the inexactness in the iterative solution of linear systems, typically due to the need for matrix-free linear algebra, severely limits the effectiveness of a conventional SQP approach. Recently, several strategies have been proposed that aim at rigorous control of inexactness via a dynamic management of stopping tolerances for linear solvers, based on the overall progress of the optimization algorithm.

In this talk, we revisit an inexact matrix-free trust-region SQP algorithm for equality-constrained optimization, and demonstrate its effectiveness on several classes of problems for which conventional SQP methods fail to converge. In addition, we investigate subtle yet important algorithmic differences between the inexact trust-region approach and a recently introduced line-search technique and identify possible areas of improvement in both cases. Finally, we briefly examine the challenges in extending the inexactness-control mechanisms of the trust-region approach to the case of inequality constraints.