Time domain decomposition methods for large-scale optimal control problems

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I will introduce two approaches to solve time domain decomposition formulations of large-scale optimal control problems. The first approach is an extension of the classical gradient method, the other approach is based on Newton's method but uses a reduced order approximation of the Hessian.

Time domain decomposition or direct multiple shooting formulations of optimal control problems decompose the underlying differential equations into equations on shorter time subintervals and couple these at the time interval boundaries. These coupling conditions must be satisfied at the solution, but not during the iteration of an optimization algorithm. This is exploited to achieve substantial improvements in the numerical solution of such problems through superior stability properties of sub-problems, enhanced convergence properties of solution algorithms, and introduction of parallelism. However, time domain decomposition formulations have a price: The auxiliary initial data at time interval boundaries are additional optimization variables and the coupling conditions are additional constraints. For problems governed by (discretized) PDEs this leads to huge increases in optimization variables and constraints, and the new approaches discussed in this talk are designed to tackle such problems.

I will introduce the two approaches, present convergence results, illustrate their performance on applications, and sketch several open problems.

This talk is based on joint work with my former students Xiaodi Deng and Caleb Magruder, and with Dr. Doerte Jando (Uni Heidelberg).