Numerical Analysis and Scientific Computing Seminar

Experiences with Model Reduction and Interpolation

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Abstract: Modern physical simulations can be remarkably expensive, often requiring extensive time on massive supercomputers. The simulated models typically depend on a set of input parameters – e.g., material properties, boundary conditions, etc. Unfortunately, the cost of the simulations makes it difficult to study the effects of the parameters on model outputs; thorough sensitivity analysis, uncertainty quantification, and design optimization studies are often infeasible.

In this talk, I'll examine methods for constructing cheaper reduced order models (ROMs) with input/output relationships that are comparable to the full physical simulation. These ROMs can be used in place of the expensive simulation to study the effects of the input parameters on the model outputs.

The essential idea behind the construction of the ROM is to run a few expensive simulations, and to use their outputs to tune the parameters of the ROM. This tuning procedure involves a singular value decomposition (SVD) on the matrix of outputs from the expensive simulations, which may be very large. I will discuss a MapReduce implementation of the communication-avoiding QR factorization for tall matrices that allows us to scale the SVD computation to matrices with billions of rows.

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