Applied & Computational Math Seminar

Alexander Howse, M. Sc.
University of Waterloo

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Nonlinear Preconditioning and Matrix Manifold Optimization: Applications to Tensor Approximation Problems

Abstract:

Nonlinear preconditioning is a strategy by which nonlinear algebraic solvers can be combined to improve convergence when solving a nonlinear system F(x)=0. In particular, we consider nonlinear left(right)-preconditioning, which are generalizations of left(right)-preconditioning strategies for solving linear systems. We discuss how these strategies can be applied to the nonlinear conjugate gradient and nonlinear GMRES (a.k.a. Anderson acceleration) algorithms.

Matrix manifold optimization is a framework for optimization problems where the set of feasible solutions is a set of matrices with specific properties, such as orthonormality, symmetry, or positive-definiteness. We highlight the changes required for an algorithm to use matrix manifold optimization.

We illustrate how nonlinear preconditioning and matrix manifold optimization can be used in tandem to solve the Tucker tensor approximation problem. A tensor is a multidimensional array, which in Tucker format is represented by a multilinear product of a core tensor and a set of matrices, one for each dimension. Numerical results show that the proposed methods converge faster and more robustly than all other methods considered, including the standard workhorse algorithm for computing Tucker approximations, as well as several other popular optimization algorithms.