Dissertation Defense

Scale Inverse Problems: Low-Rank Approximations and Optimization

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Abstract: Inverse problems can be found in a variety of scientific applications, and the development of efficient and reliable methods remain an essential and challenging task. In this thesis, we introduce novel low-rank solvers for linear systems that arise from large scale inverse problems, which are usually ill-posed and require the use of regularization to obtain meaningful solutions. The new methods are developed around the concept of regularization: i) the low-rank, Kronecker product based forward model approximation method involves the approximation of a truncated singular value decomposition; and ii) the low-rank Krylov subspace methods are based on nuclear norm regularization. We explore the performance of these novel low-rank methods in various imaging applications such as image deblurring, inpainting and computer tomography. Besides applications where the forward model is known and fixed, we also consider an extended application, where the forward model is not exactly known and requires calibration. In this context, we are able to not only apply our new low-rank methods, but also propose a new hybrid machine learning and block coordinate descent algorithm that effectively improves solution accuracy.

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