

DISSERTATION
DEFENSE

*Low-Rank Exploiting Optimization Methods for Inverse
Problems and Machine Learning*

Kelvin Kan
Emory University

Abstract: Due to rapid technological development, datasets of enormous size have emerged in various domains, including inverse problems and machine learning. Many important applications in these domains, e.g. PDE parameter estimation, data classification and regression, are formulated as optimization problems. These problems are often of large-scale and can be computationally intractable to solve. Fortunately, it has been empirically observed that large datasets can be accurately estimated by low-rank approximation. Specifically, they can be approximately expressed using a relatively compact representation whose computation is less demanding. Therefore, an effective way to circumvent the computational obstacle is to exploit the low-rank approximation. In addition, low-rank approximation can serve as a regularization technique to filter out irrelevant features (e.g. noise) from the data since it can capture essential features while discarding less pertinent ones.

This dissertation presents three applications of low-rank exploiting optimization methods for inverse problems and optimization. The first application is a projected Newton-Krylov method which efficiently exploits the low-rank approximation to the Hessian matrix to compute the projection for bound-constrained optimization problems. The second application is a modified Newton-Krylov method geared toward log-sum-exp minimization. It is scalable to large problem sizes thanks to its utilization of the low-rank approximation to the Hessian. In the third application, we apply hybrid regularization, which synergistically combines iterative low-rank approximation schemes and Tikhonov regularization, to effectively and automatically avoid an undesirable phenomenon in machine learning.

Wednesday, March 22, 2023, 12:00 pm
Mathematics and Science Center: MSC E308A

Advisors: Lars Ruthotto and James Nagy

MATHEMATICS
EMORY UNIVERSITY