T3B: Modern First-Order Optimization Methods for Imaging Problems
Speaker: Wotao Yin (UCLA, USA)

Abstract

Optimization is playing an increasingly important role in computational imaging, where many problems reduce to large-scale optimization with structures. The huge number of variables in imaging problems often preclude the use of off-the-shelf, sophisticated algorithms such as the interior-point methods because they exceed memory limits. Scalable optimization algorithms with small memory footprints, low per-iteration costs, and excellent parallelization properties have become the popular choices. Algorithms for structure optimization have recently received significant improvements due to the revival of numerical techniques such as operator splitting, stochastic sampling, and coordinate update. Favorable structures in imaging problems can reduce a problem with a huge number of variables and data to simple, small, parallel subproblems. Developing and adapting such algorithms can potentially revolutionize the solution to many imaging problems. However, exploiting structures in large-scale optimization is not an easy task as one needs to recognize those structures to generate simple subproblems, and then combine them into fast and scalable algorithms. This is harder than applying ADMM or block coordinate descent right out of the box.

This tutorial focuses on latest first-order algorithms and the techniques of exploiting problem structures. It will provide a high-level overview of operator splitting and coordinate update methods (which include proximal, ADMM, primal-dual, and coordinate descent methods as special cases) in the context of computational imaging, along with concrete examples in image reconstruction, optical flow, segmentation, and others. Emphasis will be given to exploiting problem structures and the fundamental mechanism of building first-order algorithms with fast convergence. Some key results will be "proved" in simplified settings and through graphical illustrations. Stochastic approximating algorithms and recent nonconvex optimization results will also be included.

Speaker Bio:

Wotao Yin is a professor in the Department of Mathematics of UCLA. His research interests lie in computational optimization and its applications in image processing, machine learning, and other data science problems. He received his B.S. in Mathematics from Nanjing University in 2001, and then M.S. and Ph.D. in Operations Research from Columbia University in 2003 and 2006, respectively. During 2006-2013, he was with Rice University. He won NSF CAREER award in 2008, Alfred P. Sloan Research Fellowship in 2009, Morningside Gold Medal in 2016. He invented fast algorithms for sparse optimization and has been leading the research of optimization algorithms for large-scale problems. His methods and algorithms have found very broad applications across different fields of science and engineering. Google Scholar recorded his 90 papers, out of which 27

have been cited at least 100 times, and 3 have had over 1000 citations. He also co-authored 20 open-source software packages and 2 review articles.