Smoothed Sparse Optimization

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Abstract

Sparse optimization has found interesting applications in many areas such as machine learning, signal processing, compressive sensing, medical imaging, finance, etc. Sparse optimization involves minimizing the 1-norm or 1-like functions, which are non-differentiable. In order to apply the classic methods such as gradient descent and quasi Newton, a traditional trick is to consider smoothed approximates of the 1-norm such as the Huber-norm, (1+eps)-norm, and the sum of sqrt(x_i^2 + eps), where eps>0 is a small parameter. They cause a (slight) loss in solution sparsity and often require tuning eps. This talk introduces an alternative “smoothing” approach that does not directly generate a smooth function but produces an unconstrained dual problem whose objective is differentiable and enjoys a “restricted” strongly convex property. Not only can one apply a rich set of classic techniques such as gradient descent, line search, and quasi-Newton methods to this dual problem, global linear convergence is guaranteed. In particular, this gives the first global linear convergence result among the gradient-based algorithms for sparse optimization, including the recent algorithms based on operator splitting (ISTA/FISTA), variable splitting (Bregman/ADMM), and/or coordinate descent, which converge sublinearly in the global sense. In addition, our "smoothing" approach produces exactly sparse solutions with recovery guarantees. Numerical examples are presented on problems in compressive sensing, medical imaging, feature selection, video decomposition, and distributed LASSO with big data.

Biography

Wotao Yin is an Associate Professor with the Department of Computational and Applied Mathematics of Rice University. His research interests lie in computational optimization and its applications in image processing, machine learning, medical imaging, and other inverse 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. Since 2006, he has been with Rice University. He won the NSF CAREER award in 2008 and Alfred P. Sloan Research Fellowship in 2009. His recent work has been in optimization algorithms for large-scale signal processing and machine learning problems.