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Multilevel Algorithms for L_1 Minimization 2: Convex Optimization with Application to Covariance Selection

(Joint work with Eran Treister, Javier Turek, Aviva Herman)

We extend our multilevel optimization algorithm recently developed for the LASSO problem to general convex optimization problems with L_1 regularization and sparse solutions. Such problems are very common in the fields of signal processing and machine learning. Taking advantage of the (typical) sparseness of the solution, we create a multilevel hierarchy of similar problems, which are traversed back and forth in order to accelerate the optimization process. This framework is applied for solving the Covariance Selection Problem, where the inverse of an unknown covariance matrix of a multivariate normal distribution is estimated, assuming that it is sparse. This problem serves numerous applications (not discussed in this talk), including brain activity analysis (fMRI), analysis of gene expressions (for genetic characterization of diseases), adaptation of personalized contents on websites, and analysis of correlations in stocks. To estimate the unknown covariance, an L_1 regularized log-determinant optimization is solved efficiently with our multilevel algorithm. This task is especially challenging for large-scale data sets because of time and memory limitations. Our numerical experiments demonstrate the efficiency of the multilevel framework for solving both medium and large scale instances of this problem.