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Multilevel Algorithms for L_1 Minimization 1: The LASSO Problem and Sparse Representation of Signals

(Joint work with Eran Treister)

The area of sparse representation of signals is drawing tremendous attention in recent years in diverse fields of science and engineering. The idea behind the model is that a signal can be approximated as a linear combination of a few "atoms" from a pre-specified and over-complete "dictionary" (typically represented by columns from a matrix with more columns than rows). The sparse representation of a signal is often achieved by minimizing an L_1 penalized least squares functional. Various iterative-shrinkage algorithms have recently been developed and are quite effective for handling these problems, often surpassing traditional optimization techniques. Here we introduce a new iterative multilevel approach that reduces the computational cost of existing solvers for these inverse problems. Our method takes advantage of the sparseness of the solution, and, at each iteration, it adaptively creates and processes a hierarchy of lower-dimensional problems employing well-known iterated shrinkage methods. Analytical observations suggest, and numerical results confirm, that this new approach may significantly enhance the performance of existing iterative shrinkage algorithms in cases where the dictionary is an explicit matrix.