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Lasso-Inspired Variants of Weighted Orthogonal Matching Pursuit with Applications to Sparse High-Dimensional Approximation

Motivated by recent developments in sparse high-dimensional approximation from Monte Carlo sampling, we propose new weighted generalizations of the Orthogonal Matching Pursuit (OMP) algorithm. Greedy algorithms of this type are more computationally efficient than convex optimization-based methods for small values of the target sparsity and offer a promising way to mitigate the curse of dimensionality. In this work, we propose new theoretically-justified greedy selection criteria that are inspired by variants of the LASSO optimization program. A key issue is the robustness of the optimal choice of the tuning parameter with respect to the measurement noise, which is realized by the square-root LASSO program in the context of convex optimization. We investigate how this property is carried over into the context of LASSO-based OMP methods. Conducting numerical experiments in high-dimensional polynomial approximation, we show the efficacy of the proposed algorithms by studying the recovery error as a function of the algorithm iterations. Moreover, we illustrate settings where the optimal choice of the tuning parameter is more robust against the noise.