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Group-Sparse Model Selection: Hardness and Relaxations

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Group-based sparsity models are proven instrumental in linear regression problems for recovering signals from much fewer measurements than standard compressive sensing. The main promise of these models is the recovery of "interpretable" signals along with the identification of their constituent groups. To this end, we establish a combinatorial framework for group-model selection problems and highlight the underlying tractability issues revolving around such notions of interpretability when the regression matrix is simply the identity operator. We show that, in general, claims of correctly identifying the groups with convex relaxations would lead to polynomial time solution algorithms for a well-known NP-hard problem, called the weighted maximum cover problem. Instead, leveraging a graph-based understanding of group models, we describe group structures which enable correct model identification in polynomial time via dynamic programming. We also show that group structures that lead to totally unimodular constraints have tractable discrete as well as convex relaxations. Finally, we study the Pareto frontier of budgeted group-sparse approximations for the tree-based sparsity model and illustrate identification and computation trade-offs between our framework and the existing convex relaxations.

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