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Compressed sensing with partial support information

Compressed sensing is a powerful "non-adaptive" signal acquisition paradigm. After making the initial assumption that the high-dimensional signals to be acquired are sparse or compressible, one constructs a universal sampling method (i.e., a measurement matrix) that will provide sufficient information to recover exactly or approximately the underlying signal. Typically, the reconstruction algorithm (e.g., ℓ_1-minimization) is also non-adaptive—i.e., it does not utilize any additional information about the signal and can be used to estimate any sufficiently sparse or compressible signal. In various applications, however, there is prior information that can be exploited to improve the recovery quality (this is the basis of various approaches that fall under the term "model-based compressed sensing"). In this talk, we present such a method that improves signal reconstruction from compressed sensing measurements when partial support information is available. We propose to use a certain weighted ℓ_1-minimization algorithm in this setting. We prove that if at least 50% of the (partial) support information is accurate, then weighted ℓ_1-minimization is stable and robust under weaker conditions than those for standard ℓ_1 minimization. Moreover, weighted ℓ_1-minimization provides better bounds on the reconstruction error in terms of the measurement noise and the compressibility of the signal to be recovered. We illustrate our results with extensive numerical experiments on synthetic data and real audio and video signals. We also propose an iterative algorithm that is based on a "support estimate" stage followed by a weighted ℓ_1-minimization algorithm. This is joint work with Hassan Mansour, Rayan Saab, and Michael Friedlander.