Inference and Uncertainty Quantification for Noisy Matrix Completion

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Abstract: Noisy matrix completion aims at estimating a low-rank matrix given only partial and corrupted entries. Despite substantial progress in designing efficient estimation algorithms, it remains largely unclear how to assess the uncertainty of the obtained estimates and how to perform statistical inference on the unknown matrix (e.g. constructing a valid and short confidence interval for an unseen entry).

This paper takes a step towards inference and uncertainty quantification for noisy matrix completion. We develop a simple procedure to compensate for the bias of the widely used convex and nonconvex estimators. The resulting de-biased estimators admit nearly precise non-asymptotic distributional characterizations, which in turn enable optimal construction of confidence intervals for, say, the missing entries and the low-rank factors. Our inferential procedures do not rely on sample splitting, thus avoiding unnecessary loss of data efficiency. As a byproduct, we obtain a sharp characterization of the estimation accuracy of our de-biased estimators, which, to the best of our knowledge, are the first tractable algorithms that provably achieve full statistical efficiency (including both the rates and the pre-constants). The analysis herein is built upon an intimate link between convex and nonconvex optimization.