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Globally Adaptive Quantile Regression with High Dimensional Data

Quantile regression has become a valuable tool to analyze heterogeneous covaraite-response associations that are often encountered in practice. The development of quantile regression methodology for high dimensional covariates primarily focuses on examination of model sparsity at a single or multiple quantile levels, which are typically prespecified ad hoc by the users. The resulting models may be sensitive to the specific choices of the quantile levels, leading to conceptual difficulties in identifying relevant variables of interest. We propose a new penalization framework for quantile regression in the high dimensional setting. We employ adaptive L1 penalties, and more importantly, propose a uniform selector of the tuning parameter for a set of quantile levels to avoid potential problems with model selection at individual quantile levels. Our proposed approach achieves consistent shrinkage of regression quantile estimates across a continuous range of quantiles levels, enhancing the flexibility and robustness of the existing penalized quantile regression methods. Our theoretical results include the oracle rate of uniform convergence and weak convergence of the parameter estimators. We also use numerical studies to confirm our theoretical findings and illustrate the practical utility of our proposal.