OUT-OF-SAMPLE ERROR ESTIMATE FOR ROBUST M-ESTIMATORS WITH CONVEX PENALTY

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Abstract: A generic out-of-sample error estimate is proposed for robust M-estimators regularized with a convex penalty in high-dimensional linear regression where (X,y) is observed and p,n are of the same order. The out-of-sample error estimate enjoys a relative error of order 1/sqrt(n) in a linear model with Gaussian covariates and independent noise, when $p/n \to \gamma' \in (0,\infty)$. General differentiable loss functions ρ are allowed provided the derivative of ρ is 1-Lipschitz, which includes the Huber loss and its smooth variants. The validity of the out-of-sample error estimate holds either under a strong convexity assumption, or for the $\ell 1$-penalized Huber M-estimator if the number of corrupted observations and sparsity of the true β are bounded from above by a small enough constant times n.
For the square loss and in the absence of corruption in the response, the results additionally yield 1/sqrt(n)-consistent estimates of the noise variance and of the generalization error. This generalizes, to arbitrary convex penalty, estimates that were previously known for the Lasso.
The reference for this work is https://arxiv.org/abs/2008.11840

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