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Title: Testing high-dimensional general linear hypotheses through spectral shrinkage

Abstract: We consider the problem of testing linear hypotheses associated with a high-dimensional multivariate linear regression model under the setting where the dimensionality of the response is comparable to the sample size, and the dimensionality of the predictors is finite. Classical solutions involving likelihood ratio tests for such problems suffer from significant loss of power within this asymptotic framework. We propose regularization schemes that modify the likelihood ratio statistics by applying nonlinear shrinkage to the eigenvalues of the empirical covariance matrix of the regression residuals. We propose two different classes of regularized tests to deal with different types of structural assumptions on the covariance matrix of the noise in the linear regression model: (a) the spectral measure of the noise covariance converges to a nontrivial limit; and (b) the noise covariance has a spiked covariance structure. We show that in each case, the proposed tests significantly improve on the performance of the likelihood ratio test. We also address the problem of finding the optimal regularization parameter within a decision-theoretic framework by adopting a probabilistic formulation of the alternatives. As an application, we consider the problem of detecting possible associations among human behavioral measurements and volumetric measurements for various brain regions.

(This is a joint work with Haoran Li, Alexander Aue and Jie Peng).