Statistics > Methodology

Stable Estimation of a Covariance Matrix Guided by Nuclear Norm Penalties

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Estimation of covariance matrices or their inverses plays a central role in many statistical methods. For these methods to work reliably, estimated matrices must not only be invertible but also well-conditioned. In this paper we present an intuitive prior that shrinks the classic sample covariance estimator towards a stable target. We prove that our estimator is consistent and asymptotically efficient. Thus, it gracefully transitions towards the sample covariance matrix as the number of samples grows relative to the number of covariates. We demonstrate the utility of our estimator in four standard methods -- regression, canonical correlation analysis, discriminant analysis, and EM clustering -- when the number of samples is dominated by or comparable to the number of covariates.

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