INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This thesis documents investigations on developing the better spectral shrinkage functions for matrix estimation. It proposes two effective spectral shrinkage estimators. The first estimator exploits the correlation present in the data matrix by decoupling the shrinkage and the truncation of singular values. It employs a logistic function based shrinkage of singular values and shows better rank estimation than the existing methods. The parameters of this estimator are tuned by grid-search solution of a SURE formulation. However, the method is computationally expensive and the applicability of this estimator is limited. The second estimator addresses this problem. It expresses the thresholding function as a linear combination of the derivatives of a Gaussian so that the corresponding SURE admits a closed form solution for the optimal parameters of the shrinkage function. Hence, it avoids the huge computational cost involved in the first method in parameter search. In addition, this linearization of thresholding function allows to increase the number of parameters arbitrarily, providing a sufficient flexibility in the shape of the shrinkage function. The estimator performs better matrix estimation than the state-of-the art methods.

The thesis further investigates the effectiveness of the proposed estimators in signal denoising applications in a collaborative filtering framework. In this framework, the noisy signals under investigation are rearranged in the form of several data matrices. The denoising of electrocardiogram (ECG) signal is presented as the first application. For this purpose, the data matrices are formed by grouping similar blocks from the noisy ECG signal. These data matrices are then denoised by the proposed matrix estimation methods. The denoised signal is obtained by inverse operation of the matrix formation. The quality of the denoised signal is measured using different performance metrics and it is found to be better than that of the existing methods. Following that the denoising of two-dimensional photographic images and three-dimensional magnetic resonance images are also explored. On applying the proposed matrix estimation methods in collaborative filtering framework the competitive denoising performances are achieved in both the applications.