Sequential Low-rank Change Detection

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Detecting emergence of a low-rank signal from high-dimensional data is an important problem arising from many applications such as camera surveillance and sensor network monitoring. We consider a procedure based on the largest eigenvalue of the sample covariance matrix to detect the change. To achieve dimensionality reduction, we present a sketching-based approach for rank change detection using the low-dimensional linear sketching vectors of the original high-dimensional observations. The premise of this approach is that, when the sketching matrix is a random Gaussian matrix, and the dimension of the sketching vector is sufficiently large, the rank of sample covariance matrix for these sketches is identical to the sample covariance matrix of the original data vectors. Hence, we may be able to detect the rank change using sample covariance matrices of the sketches without having to recover the original covariance matrix. We character the performance of the largest eigenvalue statistic and the sketching procedure, and demonstrated their good performance.