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Title: Limit of the Smallest Eigenvalue of a Large Dimensional Sample Covariance Matrix

Abstract:

In this paper, the authors show that the smallest (if \( p \leq n \)) or the \((pn + 1)\)-th smallest (if \( p > n \)) eigenvalue of a sample covariance matrix of the form \((1/n)XX^T\) tends almost surely to the limit \((1/\sqrt{y})^2\) as \(n \to \infty\) and \(p/n \to y \in (0, \infty)\), where \(X\) is a \(p \times n\) matrix with iid entries with mean zero, variance 1 and fourth moment finite. Also, as a by-product, it is shown that the almost sure limit of the largest eigenvalue is \((1 + \sqrt{y})^2\), a known result obtained by Yin, Bai and Krishnaiah. The present approach gives a unified treatment for both the extreme eigenvalues of large sample covariance matrices.