Effective Permutation Tests for Differences Across Multiple High-Dimensional Correlation Matrices

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Room BENVENUTI

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Testing the equality of two or multiple correlation or covariance matrices is an important problem in biology, finance and many other areas. High dimensionality, where the number of features is much larger than the sample size, causes conventional procedures to perform poorly, as they are often based on limiting distributions of test statistics in the classical large sample size setting. Moreover, their performance is often contingent on whether the matrix of differences is sparse or dense, while such information is rarely available. In this article, we develop a new family of permutation testing procedures to tackle these challenges. The introduced tests are demonstrated to outperform many other competing procedures in terms of size control and power under various settings. In particular, using our variance-stabilizing transformation, the proposed methods provide the best performance for testing correlation or covariance matrix differences in both sparse and dense settings. We establish non-asymptotic guarantees on the power of our test, which ensure its reliability for sparse and dense differential correlation matrices. Through the analysis of gene-expression and brain imaging data, we showcase the high power and accurate size control of our test in high-dimensional statistical applications.

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