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WEIGHTED CONDITIONAL NETWORK TESTING FOR MULTIPLE HIGH-DIMENSIONAL CORRELATED DATA SETS

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Abstract: Gaussian graphical models (GGMs) have been investigated to infer dependence (or network) structure among high-dimensional data by estimating a precision matrix. However, while many estimation methods for GGM have been developed, methods for testing the equality of two precision matrices are still limited. Because testing the equality of the precision matrix depends on other given precision matrices, we develop a weighted conditional network testing for considering other given precision matrices information and also provide theoretical properties. None of the existing methods can be applied to test conditional differences when other networks are conditionally given and different. We demonstrate the advantage of our approach using a simulation study and genetic pathway analysis.

Key words and phrases: Conditional difference, Gaussian graphical model, precision matrix.

1. Introduction

Graphical models (Friedman, Hastie and Tibshirani, 2008; Qiao, Guo and James, 2019) have become popular for investigating networks in various scientific fields, such as social science, neuroscience, precision medicine, and omics.

Most graphical models have been developed for multiple estimations of precision matrices but not for testing their equality. Precision matrices play a fundamental role in many high-dimensional inference problems. In the Gaussian graphical model (GGM) framework, the difference between two precision matrices characterizes the differential network, which measures the amount of change in the network between two groups. Xia, Cai and Cai (2015) proposed testing the differential networks of two precision matrices and applied this test to the detection of gene-gene interaction under a GGM. Cai (2017) provided a substantive review paper summarizing recent developments in hypothesis testing for high-dimensional covariance structures, including global testing for the overall pattern of covariance structures and simultaneous testing of a large collection of hypotheses with false discovery proportion (FDP) and false discovery rate (FDR)

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