Online Precision Matrix Changepoint Detection with Localization to Groups of Dimensions

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Abstract

Changepoint detection methods for precision matrices, especially in higher dimensions, fall into two extremes. At one extreme, global changepoint detection methods identify when precision matrices differ in terms of overall properties, such as their L-infinity norms. This global approach is very coarse-grained in terms of dimensions and may not identify the locations of the changes if they take place on a subset of the dimensions. On the other extreme, local changepoint detection methods inspect individual pairwise components of a precision matrix. These methods can identify changes in individual dimensions, but they are generally computationally expensive in higher dimensions, require careful handling of a large number of hypothesis tests simultaneously, and do not identify subsets in which a change takes place. Our work aims to fill a gap in the middle of these two extremes by efficiently detecting and localizing changepoints caused by changes to a subset of dimensions within a precision matrix. Our approach, which we refer to as LD-CPD (Linear Decomposition Changepoint Detection), uses a linear decomposition of the precision matrix and tests for changes to the components of this decomposition, where these components correspond to a group of dimensions. We benchmark our algorithm on several simulation studies with changes involving groups of dimensions, as well as on real-world sensor networks and

stock market data. We show that our approach is effective at identifying changepoints in both regimes in a computationally efficient manner while providing a convenient interpretation of the changes through this linear framework.

Keywords: Changepoint Localization, Anomaly Detection, Precision Matrix, Graphical Models