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COMPOUND SEQUENTIAL CHANGE-POINT DETECTION IN PARALLEL DATA STREAMS

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Abstract: We consider sequential change-point detection in parallel data streams, where each stream has its own change point. Once a change is detected in a data stream, this stream is deactivated permanently. The goal is to maximize the normal operation of the pre-change streams, while controlling the proportion of the post-change streams among the active streams at all time points. Using a Bayesian formulation, we develop a compound decision framework for this problem. A procedure is proposed that is uniformly optimal among all sequential procedures that control the expected proportion of post-change streams at all time points. We also investigate the asymptotic behavior of the proposed method when the number of data streams grows large. Numerical examples are provided to illustrate the use and performance of the proposed method.

Key words and phrases: Change-point detection, compound decision, false non-discovery rate, large-scale inference, sequential analysis.

1. Introduction

Sequential change-point detection, which dates back to the pioneering work of Page (1954, 1955), focuses on the early detection of distributional changes in sequentially observed data. Methods for sequential change-point detection have been applied widely in various fields, including engineering, education, medical diagnostics, and finance, among others, where a change point typically corresponds to a deviation of a data stream from its "normal" state. The classical methods for sequential change-point detection focus on detecting one or multiple changes in a single data stream (Lorden (1971); Page (1954); Roberts (1966); Shewhart (1931); Shiryaev (1963)). With advances in information technology, large-scale streaming data have become more common, and many recent developments tend to focus on change-point detection in multiple data streams (Chan (2017); Chen and Zhang (2015); Chen (2019); Mei (2010); Xie and Siegmund (2013); Fellouris and Sokolov (2016)).

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