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Performance Comparison of Binary Segmentation Method and Pruned Exact Linear Time Changepoint Detection Methods for AR (1) Model

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Changepoints are considered as the times at which abrupt changes occur in time series data. Binary Segmentation (BinSeg) and Pruned Exact Linear Time(PELT) methods are common changepoint methods. In this study, our objective is to evaluate the performance of the BinSeg Method and PELT method in the detection of changes of autocorrelation for Autoregression of order one (AR(1)) and White Noise(WN) using a simulation study. The simulation study was conducted in three stages, with 500 series for each stage. To choose penalties, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and modified BIC (mBIC) are used for model selection. First, we simulated the WN series and AR (1) with the autoregressive coefficient (φ =0.5) without any changes in mean or autocorrelations. The first stage was designed to evaluate the performance of both methods without any changes in the mean. In the WN series without mean shifts, no changepoints were detected. The presence of autocorrelation without mean shifts (AR(1)) detects changepoints for both methods for all penalties with an excessive number of changepoints, leading to poor performance of the methods. In the second stage, both the WN and AR(1) series were simulated with a mean shift. In autocorrelation with mean shifts, the detection of changepoints is low, less than 15% and 5% for PELT and BinSeg methods, respectively. In the third stage of the simulation, time series were simulated with the changes in autocorrelation with and without mean shifts at the true changepoints. For changes in autocorrelations with mean shifts (AR(1) model of ar(0.2, 0.5, 0.8)), the proportions of actual changepoint detection are very low, which is less than 1%, for both methods. Changepoints were not detected for any method for changes in autocorrelations without mean shifts. The PELT method is given a higher proportion of detecting changepoints with mBIC penalty than the BinSeg method in WN and AR(1) data with only mean changes. However, when autocorrelation shifts, the percentage of detecting true changepoints in AR (1) data is less than 1% with mean shift and without shift for both BinSeg and PELT methods. Therefore, developing a changepoint detection method is vital to identify the true changepoints at which autocorrelation changes.

Keywords: Autoregression, Binary segmentation, Pruned exact linear time, Simulations, Time series

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