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Active learning for multiple change point detection in non-stationary time series with deep gaussian processes

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Detecting multiple change points (MCPs) in non-stationary time series is a significant challenge, as the underlying data can exhibit diverse properties. Traditional MCP detection approaches often rely on fixed sliding windows, exhaustive searches, or restrictive assumptions, making them less effective in complex dynamic scenarios. To address these issues, we propose a novel algorithm that integrates Active Learning (AL) with Deep Gaussian Processes (DGPs) to effectively detect MCPs in non-stationary time series data. Our method begins with spectral analysis to identify frequency-domain features indicative of potential change points. Specifically, a designed spectral metric locates the regions where significant spectral variations occur. Then, guided by this spectral metric and the uncertainty estimates provided by the DGP model, the algorithm strategically selects the most informative sampling points at each iteration. This combined approach enables the algorithm to concentrate sampling efforts precisely in areas where changes are most likely to occur, significantly improving detection accuracy and sampling efficiency. The hierarchical and flexible modeling structure of DGPs further allows our approach to capture various change patterns, including subtle or abrupt shifts, without overly restrictive modeling assumptions. We evaluate our algorithm comprehensively using simulated datasets designed to mimic real-world complexity, as well as actual datasets exhibiting different forms of non-stationarity and noise levels. Experimental results consistently demonstrate that our method outperforms existing state-of-the-art techniques in terms of detection accuracy, robustness against noise, and the number of samples required, making it particularly valuable in practical applications where data collection is expensive or limited.

Biography

Emily Wu is currently a student at Lexington High School in Massachusetts, USA. She has a strong interest in data science, and machine learning research. Her recent work focuses on time-series analysis and change-point detection using probabilistic models and active learning methods. Emily contributed to the development and evaluation of algorithms that integrate spectral analysis with deep Gaussian processes to identify structural changes in complex datasets. Her work has been applied to both simulated and real-world data, demonstrating strong performance in both accuracy and efficiency. Emily aims to pursue further research in statistical learning and applied machine learning.