Change point estimation for Gaussian time series data with copula-based Markov chain models

Li-Hsien Sun[1], Yu-Kai Wang[1], Lien-Hsi Liu[1], Takeshi Emura[2], and Chi-Yang Chiu[3]

[1]Graduate Institute of Statistics, National Central University, Taoyuan City 320317, Taiwan

[2]Institute of Statistical Mathematics, Tokyo, Japan

[3]Division of Biostatistics, Department of Preventive Medicine, University of Tennessee Health Science Center, Memphis, TN 38163, USA

Abstract

This paper proposes a method for change-point estimation, focusing on detecting structural shifts within time series data. Traditional maximum likelihood estimation (MLE) methods assume either independence or linear dependence via autoregressive models. To address this limitation, the paper introduces copula-based Markov chain models, offering more flexible dependence modeling. These models treat a Gaussian time series as a Markov chain and utilize copula functions to handle serial dependence. The profile MLE procedure is then employed to estimate the changepoint and other model parameters, with the Newton-Raphson algorithm facilitating numerical calculations for the estimators. The proposed approach is evaluated through simulations and real stock return data, considering two distinct periods: the 2008 financial crisis and the COVID-19 pandemic in 2020.

Keywords: Change point, Copula, Serial dependence, Sequential analysis, Gaussian time series, Markov chain