Assessing the uncertainty in change point detection with confidence curves

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Abstract

Statistical tools are very popular in hydrological time series analysis, and change point detection is a typical application. The traditional way to conduct change point detection is on the basis of Null-Hypothesis Significance Testing (NHST), which tests a null hypothesis (there is no significant change in the statistical characteristics of a time series) for a preselected significance level. NHST can provide a point estimate of a change point, but no information about the probability that the point estimate is the true change point. Confidence curves can be used to represent the uncertainty of change point detection graphically. Two parametric methods to construct confidence curves are considered. 'Method B' from Cunen (2018)[1] constructs confidence curves based on maximum likelihood parameter estimation. The variation proposed here uses pseudo maximum likelihood instead and constructs confidence curves based on L-Moment parameter estimation. From synthetic experiments and real data analysis, the pseudo likelihood based method is much less computationally expensive, while the two methods have comparable performance. An uncertainty measure linked to the confidence curve is proposed to serve as a basis for conclusions about the existence of a change point.

Keywords: Change point detection; hydrological time series; confidence curves; pseudo maximum likelihood method; uncertainty

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[1] Cunen, C.; Hermansen, G. & Hjort, N. L. Confidence distributions for change-points and regime shifts Journal of Statistical Planning and Inference, 2018, 195, 14-34