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CONFIDENCE DISTRIBUTIONS FOR CHANGE-POINTS AND REGIME SHIFTS

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ABSTRACT. Suppose observations $y_1, \ldots, y_n$ stem from a parametric model $f(y, \theta)$, with the parameter taking one value θ_L for $y_1, \ldots, y_\tau$ and another value θ_R for $y_{\tau+1}, \ldots, y_n$. This article provides and examines two different general strategies for not merely estimating the break point τ but also to complement such an estimate with full confidence distributions, both for the change-point τ and for associated measures of differences between the two levels of θ. The first idea worked with involves testing homogeneity for the two segments to the left and the right of a candidate change-point value at a fine-tuned level of significance. Carrying out such a scheme requires having a goodness-of-fit test for constancy of the θ parameter over a segment of indices, and we also develop classes of such tests. These also have some independent interest. The second general method uses the log-likelihood function, profiled over the other parameters, and we show how this may lead to confidence inference for τ. Our methods are illustrated for four real data stories, with these meeting different types of challenges.

Key words: change-points, confidence distributions, homogeneity testing, log-likelihood profiling, monitoring bridges, regime shifts, Tirant lo Blanch

1. Introduction and summary

Many types of processes and natural phenomena experience change-points, sometimes via a jump in mean level and on other occasions via different and perhaps more subtle changes of behaviour. Such changes and discontinuities, when parameters of a model change from one state to another, are variously called break-points, tipping points, paradigm or regime shifts, structural changes or critical transitions, depending on the type or school of application. There is naturally a vast literature inside several areas of application, from engineering (see e.g. Frick et al. (2014)), economics and finance, to biology (e.g. Gould & Eldredge (1977)), meteorology, geology, climate, sociology and history (cf. Spengler (1918), Fukuyama (1992)). As Gladwell (2000) writes in *The Tipping Point*, "the tipping point is that magic moment when an idea, trend, or social behavior crosses a threshold, tips, and spreads like wildfire". There is similarly a large literature regarding aspects of estimation and assessment of change-points inside statistical methodology. The present paper is

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