

Optimal nonparametric change point detection and localization

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Abstract: We study change point detection and localization for univariate data in fully nonparametric settings in which, at each time point, we acquire an i.i.d. sample from an unknown distribution. We quantify the magnitude of the distributional changes at the change points using the Kolmogorov–Smirnov distance. We allow all the relevant parameters – the minimal spacing between two consecutive change points, the minimal magnitude of the changes in the Kolmogorov–Smirnov distance, and the number of sample points collected at each time point – to change with the length of time series. We generalize the renowned binary segmentation (e.g. Scott and Knott, 1974) algorithm and its variant, the wild binary segmentation of Fryzlewicz (2014), both originally designed for univariate mean change point detection problems, to our nonparametric settings and exhibit rates of consistency for both of them. In particular, we prove that the procedure based on wild binary segmentation is nearly minimax rate-optimal. We further demonstrate a phase transition in the space of model parameters that separates parameter combinations for which consistent localization is possible from the ones for which this task is statistical unfeasible. Finally, we provide extensive numerical experiments to support our theory. R code is available at <https://github.com/hernanmp/NWBS>.