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Changepoint detection in case of step change and inhomogeneous segments (platform-like inhomogeneities)

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The quality of the time series homogenization is expected to be highly related to the previous changepoint detection phase, which is the subject of this contribution.
The changepoint detection is often performed applying statistical tests, most of them are originally suited to deal with a single changepoint and, for the application to series affected by multiple changepoints, a (hierarchic) binary tree splitting is usually implemented. It is the case of SNHT, probably the most applied homogeneity test, that is well known for its power, robustness and simplicity.
The optimal segmentation methods, as the one defined in Caussinus-Mestre (2004), are a completely different group of techniques especially developed for the identification of many changepoints at the same time and, even if numerically burdensome, they can correctly handle also a non-hierarchic pattern of changepoints.

In our opinion, an important case of non-hierarchic pattern is the inhomogeneous segment, also known as platform-like inhomogeneity, that can be defined as a piece of series that has a mean value different from the rest of the series, in other words, two abrupt changes of equal amplitude and different sign. This type of inhomogeneity can arise in a number of practical cases.
Indeed, any accident, or event, that produces a stable variation in the mean value of the recorded variable, will be followed after a while (that can go from a few days to some years) by a correction taking back the mean value to that before the accident: the two changes will produce an inhomogeneous segment anomaly. This correction could follow the identification of the anomaly but it can be accidental as well. To detect easily this inhomogeneity, the simultaneous detection of two changepoints is needed.

In a set of Monte Carlo experiments, focused on different patterns containing inhomogeneous segments and step changes, the detection skills of SNHT (alpha = 0.01) and the Caussinus-Mestre method were compared: the latter showed to be significantly better in the case of many changepoints while SNHT proved to be slightly better in the case of monotone stair wise pattern (including the single step change). SNHT showed its limits in case of inhomogeneous segments, especially when the segment is placed near to the middle of the series. Moreover, a random changepoint position is returned by SNHT when the series includes two inhomogeneous segments laying on different sides of the main series.
On the same series some other methods were also compared:
1) the semi-hierarchic implementation of SNHT, which showed a behavior close to the classical implementation of SNHT;
2) the SNH2T, which is a test (based on the SNHT statistics) especially suited to deal with inhomogeneous segments, showed accurate performance only in case of pure inhomogeneous segments;
3) the Standard Normal Composite Method (SNHCM), which represents a combination of SNHT and SNH2T, showed always a good detection skill, avoiding the behavior of SNHT in case of inhomogeneous segments. Moreover, the numerical complexity of SNHCM is smaller then the one of the Caussinus-Mestre method.