

Enhanced SSA-HJ-biplots for time series with complex structure

Alberto Silva¹, Adelaide Freitas²

1 – CIDMA, University of Aveiro.

2 – CIDMA & Department of Mathematics, University of Aveiro.

FIGURE 1

The distance graph (right) suggests a structural break at iteration 17 (1966) in the global temperature series (1945–2019, left panel).

The biplot method is a multivariate technique that, when combined with Singular Spectrum Analysis (SSA), aids in visualizing and identifying patterns in univariate time series. We recently proposed the SSA-HJ-biplot, a graphical tool that simultaneously represents the rows and columns of the time series trajectory matrix with maximum quality on the same factorial axes. This enables exploratory visual analysis of time series components such as trends and periodicities. The position of points, as well as the size and direction of arrows in the SSA-HJ-biplot, can reveal key structural features of the time series.

However, complex structures in the time series may blur the biplot, making visual interpretation challenging. A time series is defined as heterogeneous when a structural break occurs at a specific change point, interrupting the governing linear recurrent relation; then, after a short transition phase, a new recurrence regime governs the series. In this work, we propose a new structural change detection method for

heterogeneous time series, aiming to segment them into homogeneous subseries and thereby improve the performance of the SSA-HJ-biplot. Some existing procedures based on SSA detect structural changes by comparing a single decomposition method applied on two trajectory matrices (base and test). In each iteration of the procedure, distances between selected eigenvectors and a suitable subspace are computed. In our approach, the comparison – and the resulting distance – is based on applying two different decomposition methods (one robust and the other ordinary, both using the NIPALS algorithm) to the same trajectory matrix. These distances become more pronounced when there is a change in the direction of certain eigenvectors due to a disruption in the linear recurrent formula. Examples with synthetic and real datasets are presented.

This work received an honorable mention from the Portuguese Association for Data Classification and Analysis.

