Real-time monitoring of functional data

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Recent improvements in data acquisition technologies have produced data-rich environments in every field. Particularly relevant is the case where data are apt to be modelled as functions defined on multidimensional domain, which are referred to as functional data. A typical problem in industrial applications deals with evaluating the stability over time of some functional quality characteristics of interest. To this end, profile monitoring is the suite of statistical process control (SPC) methods that deal with quality characteristics that are functional data. While the main aim of the profile monitoring methods is to assess the stability of the functional quality characteristic, in some applications, the interest relies in understanding if the process is working properly before its completion, i.e., in the real-time monitoring of a functional quality characteristic. This work presents a new solution to this task, based on the idea of real-time alignment and simultaneous monitoring of phase and amplitude variations. The proposal is to iteratively apply at each time point a procedure consisting of three main steps: i) alignment of the partially observed functional data to the reference observation through a registration procedure; ii) dimensionality reduction through a modification of the functional principal component analysis (FPCA) specifically designed to consider the phase variability; iii) monitoring of the resulting coefficients. The effectiveness of the proposed method is demonstrated through both an extensive Monte Carlo simulation and a real-data example.

Keywords

profile monitoring; functional data analysis; curve registration

Special/invited session

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