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funcharts: An R package for the statistical process monitoring of multivariate functional data

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2nd floor - AULA E

Abstract In many statistical process control applications data acquired from multiple sensors are provided as profiles, also known as functional data. Building control charts to quickly report shifts in the process parameters or to identify single anomalous observations is one of the key aims in these circumstances. In this work, the R package funcharts is introduced, which implements new methodologies on statistical process control for multivariate functional data developed in the recent literature, in both unsupervised and supervised learning scenarios. In the unsupervised setting, multivariate functional data are the quality characteristic of interest to be monitored. In the supervised setting, the quality characteristic a scalar or functional quantity, influenced by multivariate functional covariates, then functional regression is used to model the relationship between the quality characteristic and the variables to increase the capacity to assess anomalies in the process. The major focus of funcharts is on Phase II monitoring, in which one wants to monitor a data set of new observations to signal anomalous observations, given a reference data set of in-control data used to estimate the model and control chart limits. Furthermore, in all the considered scenarios, the R package offers functions for real-time monitoring for functional data with a temporal domain, i.e. for monitoring the section of profiles partially observed only up to an intermediate domain point.

This research activity is a joint work with Biagio Palumbo, Antonio Lepore and Fabio Centofanti from the Department of Industrial Engineering of the University of Naples Federico II, and Alessandra Menafoglio and Simone Vantini from Politecnico di Milano.

Christian Capezza is a researcher in Statistics for experimental and technological research at the Department of Industrial Engineering of the University of Naples Federico II. The scientific coordinator of his research activity is prof. Biagio Palumbo. He works on advanced statistical methodologies for engineering applications and his research project regards the development of interpretable statistical methods for the analysis of complex systems in Industry 4.0, with particular focus on statistical process monitoring, functional data analysis and generalized additive models. He graduated from the University of Naples Federico II in 2016 with a MSc in Engineering Management. In 2020, he obtained a PhD in Industrial Engineering from the same University, supervised by prof. Biagio Palumbo and Antonio Lepore. During the PhD, he was visiting scholar in the PhD course in Statistics at the Department of Statistics of the University of Padova, moreover he was visiting postgraduate research student at the School of Mathematics of the University of Bristol. Finally, in 2021, he was post-doc researcher (Assegnista di Ricerca) at the University of Naples Federico II.