



FACULTE DES SCIENCES SOCIALES  
Méthodes quantitatives en sciences sociales  
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**Topic** Review of the habilitation thesis of David KRAUS, PhD  
entitled *Topics in Functional Data Analysis*

This habilitation thesis is a compilation of five research papers by Dr David Kraus on functional data analysis from a statistician viewpoint.

These papers all appeared in top-ranked journals in methodological statistics, with Dr Kraus as first author in four of them.

The introductory paper, written with Prof. Panaretos and Maddocks during the postdoctoral stay of Dr Kraus at EPFL (Lausanne) and published in 2010 in JASA, is motivated by the study of the mechanical properties of DNA in molecular biology. The methodological contribution focuses on a two-sample comparison of Gaussian processes based on their covariance structure with a test constructed using a Karhunen-Loève representation of the pooled data and the asymptotic representation of the test function.

The second paper, again with Prof. Panaretos and published in 2012 in Biometrika, focuses on the comparison of the second-order structure of functional data with a M-test that is robust to the presence of outliers and to non-normality. Its performances and robustness to data contamination are studied using a simulation study and illustrated on biological data similar to the ones used in the first paper.

The third paper published in 2014 in JRSS-B with Dr Kraus as single author during his stay as a statistician at the University hospital of Lausanne, focuses on functional data where individual recordings such as heart rate measurements can be partly missing due to recording issues. Like in the preceding papers, it relies on second-order properties and the Karhunen-Loève theorem suggesting a decomposition of the observed functionals on a basis of orthonormal eigenfunctions of the covariance operator. The consistency of the obtained estimators is proved in this missing data framework after a specific methodological handling of this common practical feature.

The fourth paper, co-authored with Marco Stefanucci and published in 2019 in Biometrika, is devoted to functional classification in two possible groups from partially observed curves and using the conjugate gradient method. The methodology is illustrated with the analysis of the radius of the internal carotid artery in patients with two possible types of aneurysm.

The final paper selected for the habilitation thesis published by Dr Kraus as a single au-

thor in 2019 in the Journal of Multivariate Analysis, pursues the development of inferential methods for the mean function, covariance operator and eigenlements from partially observed functional data. Practical aspects related to the possible vast amount of data following from discretization are explicitly discussed and handled with a bootstrap-based strategy.

This selection of papers is a coherent testimony of the high-quality expertise developed by Dr Kraus in functional data analysis after his PhD in Charles University in 2008. The methodological developments are always motivated and illustrated on data from natural sciences, thereby immediately showing the relevance of that research for other science areas. Dr Kraus is also a quality partner for research teams outside statistics or data science, as shown by several of his recent co-publications in epidemiology.

In conclusion, there is no doubt that Dr Kraus is a brilliant researcher and that his submitted text entitled *Topics in Functional Data Analysis* fully meets the expectations of a habilitation thesis in the field of mathematics or Applied Mathematics.

Sincerely,

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