


CHARLES UNIVERSITY
Faculty of mathematics
and physics

Masaryk University
Faculty of Science
Department of Mathematics and Statistics
Kotlářská 267/2
611 37 Brno

February 1, 2022

Review on Habilitation Thesis

Please, find on the consequent pages my report on the habilitation thesis “Topics in Functional Data Analysis” written by Mgr. David Kraus, Ph.D.

Yours faithfully,

Michal Pešta

Department of Probability
and Mathematical Statistics
Sokolovská 49/83
186 75 Prague 8, Czechia
tel: +420-221-913-287
fax: +420-222-323-316

doc. RNDr. Michal Pešta, Ph.D.
Associate Professor
Charles University
Faculty of Mathematics and Physics
tel: +420-608-427-147
e-mail: michal.pesta@mff.cuni.cz

Review on

Topics in Functional Data Analysis

Habilitation thesis by Mgr. David Kraus, Ph.D.

The text of the thesis conveys an impressive research program of the candidate, the program that does not limit itself to extensions and improvements of existing statistical procedures, but rather aims at scientific breakthroughs in statistical methodology relevant for the functional data, with further outreach into a broader area of data science. Rather than cultivating well-established academic topics, Kraus dares to venture into yet uncharted territories. Such an ambitious program may not be initially always fully recognized and appreciated by all the members of the scientific community, especially by those in habit to think within the established paradigms; nonetheless however, the collection of the attached publications witnesses also the fact that the candidate has already mastered the craft of the dissemination of scientific results, that very important skill for a young researcher at this stage of his or her career. I was happy to realize that Kraus is able to get his results published in respected international publication outlets (for instance, "Journal of the American Statistical Association" and "Journal of the Royal Statistical Society: Series B (Statistical Methodology)" are premier journals in their field).

Regarding the thesis per se, there are several recurrent themes: covariance operators and, more generally, dependence patterns in the functional data; the hunt for missing data; and two-sample problems motivated by the need of applications. The technologies themselves are diverse as well: Hilbert-Schmidt operators, Karhunen-Loève expansion, eigenfunction-eigenvalue decomposition, principal component analysis, classification, conjugate gradient, regularization, empirical processes, bootstrap, and others. Given that your faculty is that of Faculty of Science, I feel it important to mention that his treatment of the investigated problems is not in the style of some simplified "bio-statistics" approach, but he employs sophisticated mathematical tools to achieve deeper theoretical understanding of the proposed methods: the use of asymptotic probability theorems for stochastic processes is widespread. On the other hand, the attached papers care about the applied impact of the pursued research, and make an effort to attract users with less mathematical background by including computer experiments and real-data examples.

The thesis is organized in the chapters according to the type of the problems and subsequent data structures studied. After the introduction and summary in Chapter 1, Paper A addresses statistical inference on the covariance structure of random functions. Paper B then deals with the the second-order structure of a random function, which is key to understanding the nature of the functional observations that it induces, as it is inextricably linked with the smoothness properties of the stochastic fluctuations of the function.

Paper C focuses on the methods of analysis for functional data that are observed incompletely in the sense that each function might be observed only on a subset of the domain, whereas no information about the curve is available on the complement of this subset. Classification of a functional observation into one of two groups is covered in Paper D. Finally, Paper E is devoted to the asymptotic distribution of estimators of the mean function and covariance operator, K-sample tests of equal means or covariances, and confidence intervals for eigenvalues and eigenfunctions in the setting of incomplete functions. In this way, the thesis is thus not merely a collection of vaguely related published papers, but constitutes a coherent, unified treatise. (The brief online search revealed that to achieve this character, the candidate deliberately made a sacrifice of not including all his publications, some of which are of independent interest and would be definitely worth showcasing.)

The text is a pleasure to read, and the author exercised the utmost care in presenting the results; the whole package, and also the choice of co-authors (few, but selected, and rather peers than subordinates or superiors) reveals a strong and independent research personality (I would like to note that some papers are single-authored), with very well-developed mathematical, statistical, and other culture. Truly a person deserving to be granted “venia docendi”.

I do not have an access to the complete Curriculum Vitae of the candidate, but based on this habilitation and on his online publication record, I can responsibly assert that he will be a strong and unambiguous case should he apply for the tenure and the promotion to the Associate Professor rank at my own institution, Faculty of Mathematics and Physics of the Charles University. In view of all said and done, I thus recommend, strongly and unreservedly, Dr. David Kraus for the promotion to the Associate Professor rank at the Masaryk University, based on the Habilitation Thesis my task was to review.

The Habilitation Thesis entitled “Topics in Functional Data Analysis” by Dr. David Kraus fulfils requirements expected of a habilitation thesis in the field of Mathematics – Applied Mathematics.

Sincerely yours,

Michal Pešta