Chapter 1

An introduction to the (postponed) 5th edition of the International Workshop on Functional and Operatorial Statistics

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Abstract This volume is composed by a set of short papers corresponding to some of the contributions that were sent to be presented at the fifth edition of the International Workshop on Functional and Operatorial Statistics (IWFOS). This fifth edition was to be held in June 2020 in Brno (Czech Republic), but had to be postponed as a consequence of the health crisis caused by the COVID-19 pandemic. The aim of this introduction is to make a fast presentation of these contributions by putting them into the recent trends in Functional Data Analysis and related fields.

1.1 IWFOS and Functional Data Analysis

The meetings IWFOS has played a major role along the last twelve years to promote Functional Data Analysis (FDA) ideas. The first edition took place in Toulouse, France (June 2008), at a moment when FDA ideas were not so much developed as they can be nowadays. Then this meeting took place each three years (Santander, Spain, 2011; Stresa, Italy, 2014; A Coruña, Spain, 2017), and each issue was the opportunity for active researchers in the field to share their recent advances and to start new collaborations. During these twelve years, all the leaders in research on FDA have participate in some way in these events (either as member of the

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Programs Committee or as contributor, or both of them). The fifth edition of IWFOS was to be held in June 2020 in Brno (Czech Republic), but had to be postponed as a consequence of the health crisis caused by the COVID-19 pandemic. As can be noted from the short papers included in this volume (which had been accepted for such fifth edition), the IWFOS planned for 2020 maintained the high quality standards of the other four past editions.

From a methodological point of view, one can say that FDA's ideas have been of influence on almost all the fields of Statistics, including: linear, semiparametric and nonparametric modelling, as well as regression, clustering and classification problems, or independent, time series and spatial datasets, ... Also, from an applied point of view, FDA's ideas have been used to analyse scopes of real data coming from most of applied scientific fields, including medicine, econometrics, environmetrics, physics, spectrometry, and many other ones ... This wide degree of interest of FDA's ideas is attested by the recent bibliographical studies (see for instance, [3], [4], [6], [7], [5], [1], [2], ...).

Since the third edition in 2014, and because of the wide set of links existing between FDA and High-Dimensional Statistics (HDS), the topics of IWFOS meetings have been extended to HDS (see [4] and [1]). The (postponed) 2020's edition had followed this opening strategy, that has been nicely appreciated by the participants of past editions, and extended it as well to HDS as to other related fields.

1.2 Presentation of the various chapters

This volume contains contributions on several topics in functional and high-dimensional Statistics and related fields, including:

- Classification: see Chapter **28** for a proposal, based on distance correlation, for selecting optimum scales for supervised classification of 3D point clouds.
- Confidence bands: see Chapter **21**, which focuses on a new approach, based on random field theory, for constructing simultaneous confidence bands in the case of the function-on-scalar linear regression model.
- Density estimation: see Chapter **11** for a proposal of a nonparametric method for density estimation over two-dimensional domains.
- Depth: see Chapter **25**, where the depth in finite-dimensional spaces is introduced, and it is outlined particular difficulties one faces when attempting to generalize depths to the situation of functional or other infinite-dimensional data.
- Diagnostic tests: see Chapter **10**, where a diagnostic test is constructed by using a novel procedure that allows to indicate if one functional data precedes to another one.
- Dimension reduction: see Chapter **6** for a reconstitution, based on PCA, of a cyclostationary random function; and Chapter **19** for FPCA combined with the survival Cox regression model.

- Estimation on manifolds: see Chapter **7** for some asymptotic properties related to an estimator of the level sets of a density; and Chapter **16** for stringing via manifold learning.
- High- and infinite-dimensional Statistics: see Chapter **26** for an algorithm to select impact points in a new sparse semiparametric functional model.
- Inference on functional data: see Chapter **18** for discussion related to some results (very useful in econometrics) on functional data whose mean and covariance are expanded in certain particular basis.
- Networks: see Chapter **13** for an approach to extend network analytical tools to the functional data setting; and Chapter **20** for robust neural networks.
- Operatorial Statistics: see Chapter **24** for distances between covariance operators associated with functional random processes.
- Prediction: see Chapter **12** for an algorithm to generate nonparametric prediction bands for a functional-on-scalar linear regression model.
- Regression: see Chapter **8**, where the behaviour of a cross-validation approach to select the pseudo-metric is studied by means a simulation study; Chapter **22** for estimation of the functional single index regression model with responses missing at random for strong mixing time series data; and Chapter **29** for rates of convergence and asymptotic distribution of estimators in generalized functional partially linear single-index models.
- Robustness: see Chapter **30** for functional outlier detection.
- Sequential learning: see Chapter **4**, where a novel signature approach is discussed, focusing in its use in machine learning.
- Small-ball probability: see Chapter **5** for an overview on asymptotic results related to a factorization of the small-ball probability, as well as illustrations of new results.
- Smoothing: see Chapter **14** for a proposal to retrieve functional data from the corresponding observed discretized valued, considering a factor model on the measurement error term.
- Spatial data: see Chapter **2** for an application of space-time regression; Chapter **3** for a simulation study related to spatial regression with partial differential equation regularization; and Chapter **23** for an overview, including application, on object oriented spatial Statistics focused on the problem of kriging prediction.
- Testing: see Chapter **9**, where a test procedure for checking the validity of the single functional index model is introduced and its performance is analyzed by means of Monte Carlo experiments; Chapter **15** for a goodness-of-fit test for the functional linear model with functional response, the corresponding statistics being calibrated through a wild bootstrap on the residuals; Chapter **17** for two-sample tests based on empirical characteristic functionals; Chapter **27** for local inference controlling the false discovery rate; and Chapter **32** for adjusted p-values based on envelope tests.
- Topological object data analysis: see Chapter **31**, where it is presented methodology to study distributions on object spaces.

Finally, it is worth being noted that some of these chapters include, in addition to methodology and/or asymptotics and/or simulation studies and/or overviews on some topic, interesting applications to real data, concerning the areas of:

- Automobile engineering: see Chapter **20**.
- Criminology: see Chapter **20**.
- Drawing recognition: see Chapter **4**.
- Econometrics: see Chapters **20** and **21**.
- Environmetrics: see Chapters **12**, **13**, **15**, **23** and **27**.
- Medicine: see Chapters **19**, **31** and **32**.
- Mobile phone: see Chapter **2**.
- Spectrometrics: see Chapter **26**.
- Urban environment: see Chapter **28**.

References

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