DOCTORAL (PHD) STUDIES
COURSE DESCRIPTION

Course title	Field of science	Faculty	Institute
Functional Data Analysis	Mathematics (N 001)	Faculty of Mathematics and Informatics	Institute of Applied Mathematics
Study method	Number of credits	Study method	Number of credits
Lectures	1	Consultations	0
Individual work	3	Seminars	1

Course summary

Functional data analysis (FDA) is a branch of statistics that analyses data providing information about curves, surfaces or anything else varying over a continuum. In its most general form, under an FDA framework, each sample element of functional data is considered to be a random function. For example: air temperature; stock prices; medical image (EEG, fMRI, etc.); emotion curve; growth curve, etc.

This course introduces methods for analysing functional data using the R package, with emphasis on practical problems and applications.

The course is devoted for PhD students in the Natural Sciences (Physics /Chemistry /Biology /Geology /Informatics/ Biochemistry/ Biophysics/ Ecology and Environmental Science), Technological Sciences (Computer Engineering), Medical and Health Sciences (Medicine), Social Sciences (Management /Economics /Sociology /Psychology), Natural Sciences (Mathematics, for those PhD students, where statistics is not the main field).

Prerequisites: PhD students should have attended a basic statistics course.

Course topics:

1. Introduction to R
2. Introduction to functional data
3. Functional data with R
4. Case studies from different scientific fields.
5. Case studies with R

Contact hours: 48 academic hours.

Exam: a case study project with data of your choice and presentation (2 academic hours)

Self-study hours: 75 academic hours

Language of delivery: English.

Main literature

1. Ramsay, J. O. and Silverman B.W. *Applied Functional Data Analysis: Methods and Case Studies*. Springer, New York, 2002.

2. Ramsay, J. O., Giles Hooker, and Spencer Graves. *Introduction to functional data analysis*. *Functional data analysis with R and MATLAB*. Springer, New York, 2009.

3. Rob J. Hyndman & Han Lin Shang. Rainbow Plots, Bagplots, and Boxplots for Functional Data, Journal of Computational and Graphical Statistics, 2010, 19:1, 29-45

Optional literature

4. Ramsay, J. O. and Silverman B.W. *Functional Data Analysis*. Springer Science+Business, 2002.

5. Zhang, J. *Analysis of variance for functional data*. Taylor & Francis Group, 2014

6. Laura M. Sangalli, Piercesare Secchi, Simone Vantini & Alessandro Veneziani (2009) A Case Study in Exploratory Functional Data Analysis: Geometrical Features of the Internal Carotid Artery, Journal of the American Statistical Association, 104:485, 37-48
7. Laura Ferreira & David B. Hitchcock (2009) A Comparison of Hierarchical Methods for Clustering Functional Data, Communications in Statistics - Simulation and Computation, 38:9, 1925-1949
8. Xiaoyan Leng, Hans-Georg Müller, Classification using functional data analysis for temporal gene expression data, *Bioinformatics*, Volume 22, Issue 1, 1 January 2006, Pages 68–76.
9. Febrero, Manuel, Pedro Galeano, and Wenceslao González-Manteiga. "Outlier detection in functional data by depth measures, with application to identify abnormal NOx levels." *Environmetrics: The official journal of the International Environmetrics Society* 19.4 (2008): 331-345
10. Febrero-Bande, M., & de la Fuente, M. O. (2012). Statistical Computing in Functional Data Analysis: The R Package fda.usc. *Journal of Statistical Software*, *51*(4), 1–28.
11. Jacques, Julien, and Cristian Preda. "Functional data clustering: a survey." *Advances in Data Analysis and Classification* 8.3 (2014): 231-255
12. Viviani, R., Grön, G. and Spitzer, M. (2005), Functional principal component analysis of fMRI data. Hum. Brain Mapp., 24: 109-129
13.Jane-Ling Wang, Jeng-Min Chiou, Hans-Georg Müller. Annual Review of Statistics and Its Application 2016 3:1, 257-295
14. Sørensen, H., Goldsmith, J. and Sangalli, L.M. (2013), An introduction with medical applications to functional data analysis. Statist. Med., 32: 5222-5240
15. Manteiga, Wenceslao González, and Philippe Vieu. "Statistics for functional data." *Computational Statistics & Data Analysis* 51.10 (2007): 4788-4792

Consulting teacher	Scientific degree	Pedagogical name	Main publications in the field of science of the last 5 year period
Jurgita Markevičiūtė	Dr.	Assoc. prof.	1. Markevičiūtė, Jurgita; Bernatavičienė, Jolita; Levulienė, Rūta; Medvedev, Viktor; Treigys, Povilas; Venskus, Julius. Impact of COVID-19-related lockdown measures on economic and social outcomes in Lithuania // Mathematics. Basel : MPDI. eISSN 2227-7390. 2022, vol. 10, no. 15, art. no. 2734, p. [1-20] 2. Markevičiūtė, Jurgita; Bernatavičienė, Jolita; Levulienė, Rūta; Medvedev, Viktor; Treigys, Povilas; Venskus, Julius. Attention-based and time series models for short-term forecasting of COVID-19 spread // CMC-Computers, materials & continua. Henderson, NV : TECH Science Press. ISSN 1546-2218. eISSN 1546-2226. 2022, vol. 70, no. 1, p. 695-714. 3. Venskus, Julius; Treigys, Povilas; Markevičiūtė, Jurgita. Unsupervised marine vessel trajectory prediction using LSTM network and wild bootstrapping techniques // Nonlinear analysis : modelling and control. Vilnius : Vilniaus universiteto leidykla. ISSN 1392-5113. eISSN 2335-8963. 2021, vol. 26, no. 4, p. 718-737. 4. Norkus, Zenonas; Markevičiūtė, Jurgita. New estimation of the gross domestic product in Baltic countries in 1913–1938 // Cliometrica. Heidelberg : Springer. ISSN 1863-2505. eISSN 1863-2513. 2021, vol. 15, iss. 3, p. 565-674. 5. Norkus, Zenonas; Grytten, Ola; Markevičiūtė, Jurgita; Šiliņš, Jānis. Can the economic growth of interwar Latvia be estimated by contemporary national accounts? // Baltic journal of economics. Abingdon : Routledge Taylor & Francis Group. ISSN 1406-099X. eISSN 2334-4385. 2022, vol. 22, no. 2, p. 90-109.

			6. Norkus, Zenonas; Ambrulevičiūtė, Aelita; Markevičiūtė, Jurgita. The population size of Lithuania (within contemporary borders) between 1897 and 1914 // Journal of Baltic studies. Portland : Francis & Taylor. ISSN 0162-9778. eISSN 1751-7877. 2020, vol. 51, iss. 4, p. 587-609.

Approved by Mathematics and Informatics Faculty board ...../2021. Protocol No. .....
Board Chairman –