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Functional data analysis

Academic Year: (2023 / 2024)   **Review date: 20-04-2023**

Department assigned to the subject: Statistics Department

Coordinating teacher: GALEANO SAN MIGUEL, PEDRO

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Introduction to Data Science
Probability and Data Analysis
Introduction to Statistical Modeling
Statistical Learning
Predictive Modeling
Bayesian Data Analysis

OBJECTIVES

1. Possess and understand knowledge that provides foundations for the development and / or application of this knowledge, often, in a research context.
2. Apply the acquired knowledge to solve problems in new or unfamiliar environments within multidisciplinary contexts related to their area of study.
3. Integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, should include reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.
4. Possess learning skills that allow them to continue studying in a way that will be self-directed or autonomous.

1. Apply the theoretical foundations of the techniques for the collection, storage, treatment and presentation of information as a basis for the development and adaptation of these techniques to specific problems.
2. Identify the most appropriate data analysis techniques for each problem and apply them for the analysis, design and resolution of these problems.
3. Obtain practical and efficient solutions for problems of treatment of data sets, both individually and as a team.
4. Synthesize the conclusions obtained from these analyzes and present them clearly and convincingly, both in writing and orally.
5. Be able to generate new ideas (creativity) and anticipate new situations, in the contexts of data analysis and decision making.
6. Use skills for teamwork and to relate to others autonomously.

Specific Competences:
1. Use the basic results of statistical inference and regression as a basis for prediction methods.
2. Identify and select the appropriate software tools for the treatment of functional data.
3. Use advanced statistical procedures for the treatment of functional data in areas such as modeling, inference and prediction.
4. Design systems for the processing of functional data, from the initial collection and filtering of them, their statistical analysis, to the presentation of the final results.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to the functional data analysis.
2. Tools for exploring functional data:
a. Functional mean and variance.
b. Covariance and correlation functions.
c. Cross-covariance and cross-correlation functions.
3. From functional data to smooth functions:
a. Basis functions.
b. Smoothing functional data by least-squares.
c. Smoothing functional data with a roughness penalty.

4. Principal component analysis for functional data:
a. Defining functional PCA.
b. Visualizing the results.
c. Computational methods for functional PCA.
d. Regularized PCA.
5. Regression for functional data:
a. Functional linear models with scalar responses.
b. Functional linear models with functional responses.
6. Supervised classification for functional data:
a. k-nearest neighbors.
7. Unsupervised classification for functional data
1. k-means.

LEARNING ACTIVITIES AND METHODOLOGY

AF1: THEORETICAL-PRACTICAL CLASSES. They will present the knowledge that students should acquire. They will receive the class notes and will have basic texts of reference to facilitate the follow-up of the classes and the development of the subsequent work. Exercises, practical problems on the part of the student will be solved and workshops and evaluation test will be held to acquire the necessary skills.
AF2: Updated to allegation
AF3: INDIVIDUAL OR GROUP WORK OF THE STUDENT.
AF9: FINAL EXAMINATION In which the knowledge, skills and abilities acquired throughout the course will be assessed globally.
MD1: CLASS THEORY. Exhibitions in the teacher's class with support of computer and audiovisual media, in which the main concepts of the subject are developed and the materials and bibliography are provided to complement the students' learning.
MD2: PRACTICES. Resolution of practical cases, problems, etc. raised by the teacher individually or in groups.
MD3: TUTORIES. Individualized assistance (individual tutorials) or group (collective tutorials) to students by the teacher.

ASSESSMENT SYSTEM

Final exam (50%). More than 4 out of 10 is required in the final exam to pass the course.
Midterm exam (30%)
Resolution of exercises and labs (20%)

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

BASIC BIBLIOGRAPHY

- Horváth, L. and Kokoszka, P. Inference for Functional Data with Applications, Springer, 2012

- Kokoszka, P. and Reimherr, M. Introduction to Functional Data Analysis, CRC Press, 2017

- Ramsay, J. and Silverman, B. Functional Data Analysis, Springer, 2005