

Degree	Type	Year
2500149 Mathematics	OT	4

Contact

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Teaching groups languages

You can view this information at the [end](#) of this document.

Prerequisites

The competencies in algebra, analysis and probability and statistics of the first cycle of mathematics are assumed.

Objectives and Contextualisation

The general objectives of this course in mathematical statistics, are:

1. Understanding the theoretical foundations of empirical processes and their limits.
2. Explore goodness-of-fit techniques to assess the adequacy of a statistical model to observed data.
3. Study the bootstrap method as a tool for statistical inference and estimating the distribution of an estimator.
4. Analyze extreme value theory and its application in modeling rare and extreme events.
5. Develop practical skills in implementing statistical methods related to the aforementioned topics.
6. Apply the acquired knowledge in solving real-world problems and interpreting statistical results appropriately.
7. Foster critical thinking and analytical ability to evaluate and question assumptions and findings in statistical analysis.
8. Promote effective communication of statistical concepts and obtained results through technical reports and presentations.

These general objectives will help students acquire a solid understanding of fundamental concepts and techniques in mathematical statistics and apply them effectively in problem-solving related to empirical processes, goodness of fit, bootstrap, and extreme value theory.

Competences

- Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
- Effectively use bibliographies and electronic resources to obtain information.
- Generate innovative and competitive proposals for research and professional activities.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.

- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Understand and use mathematical language.

Learning Outcomes

1. Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
2. Effectively use bibliographies and electronic resources to obtain information.
3. Generate innovative and competitive proposals for research and professional activities.
4. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
5. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
6. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
7. Understand abstract language and understand in-depth demonstrations of some advanced theorems of probability and statistics.

Content

1. Statistical models for structured data (linear models, time series, etc.) per a dades estructurades (models lineals, sèries temporals, etc.)
2. Nonparametric statistics: empirical processes, G-o-F theory, rank tests, Bootstrap.
3. Extreme value theory.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Computer work	24	0.96	1, 3, 4, 2
Problems sessions	6	0.24	7, 4, 2
Theoretical classes	30	1.2	7, 2
Type: Autonomous			
Personal work	80	3.2	3, 4, 2

The statistical models and their corresponding assumptions and properties are introduced in the theoretical sessions. Emphasis will be placed on rigor in the proofs as well as on the applicability and interpretation of the methods.

The discussion will be encouraged in the classroom and theoretical problems will be proposed to deepen the topics. Problems, and practical exercises to be performed with free software R will be proposed.

Some sections of the course could be developed by students in the form a written report and presented to the classmates.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First partial exam	0,2	4	0.16	7, 4, 2
Oral exposition of a report	0,2	1	0.04	1, 3, 6, 5, 4, 2
Second partial exam	0,3	4	0.16	1, 4, 2
Tasks delivery	0,3	1	0.04	3, 4, 2

$$NC = 0.25 \cdot P1 + 0.25 \cdot P2 + 0.5 \cdot Lli,$$

P1, P2: First and second partial exams, including theory, exercises, and practical component.

Lli: Grade for the proposed task submissions: solving theoretical and practical problems, and/or grade for autonomous work in which collateral topics or theory extensions will be developed and presented in written and oral form.

Students who do not pass the continuous evaluation, that is, if $NC < 5$ or $P_i < 3$, can take the 50% recovery exam corresponding to $P1 + P2$.

The single evaluation will consist of a comprehensive exam covering the 3 topics addressed in the course, including a computer-based part and an oral component.

Bibliography

Nonparametric Statistics:

1. Hollander, M., & Wolfe, D. A. (1999). Nonparametric Statistical Methods. Wiley.
2. Tsybakov, A. B. (2009). Introduction to Nonparametric Estimation. Springer.
3. Gibbons, J. D., & Chakraborti, S. (2010). Nonparametric Statistical Inference. CRC Press.

Empirical Processes:

1. "Empirical Processes: Theory and Applications" by Richard D. Pollard

2. "Weak Convergence and Empirical Processes: With Applications to Statistics" by Aad van der Vaart and Jon A. Wellner
3. "Empirical Processes in M-Estimation" by Vladimir Spokoiny

Extreme Value Theory:

1. "Extreme Value Theory: An Introduction" by Laurens de Haan and Ana Ferreira
2. "An Introduction to Statistical Modeling of Extreme Values" by Stuart Coles
3. "Extreme Value Theory: An Introduction" by F.G. Bosman, C.A.J. Klaassen, and A.J. Haan

Bootstrap:

1. "An Introduction to the Bootstrap" by Bradley Efron and Robert J. Tibshirani
2. "Bootstrap Methods and their Application" by A.C. Davison and D.V. Hinkley
3. "Bootstrap Techniques for Signal Processing" by Martin R. Cramer, Janice R. Eichenberger, and R. E. Hiorns

These books provide comprehensive coverage of their respective topics and are widely recognized as valuable resources in the field.

Software

Free software R and Rstudio and Python.

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Spanish	first semester	morning-mixed
(TE) Theory	1	Spanish	first semester	morning-mixed