Universitat Autònoma de Barcelona

2023/2024

Simulation and Resampling

Code: 104868
ECTS Credits: 6

Degree	Type	Year	Semester
2503852 Applied Statistics	OB	3	2

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

Roger Borràs Amoraga

External teachers

Aureli Alabert

Prerequisites

It is assumed that the student has acquired the competences of the previous courses in Statistics Inference, Probability, and Stochastic Processes, and that they has a good level with the R programming language.

Objectives and Contextualisation

To learn how to produce random samples with a computer and how to apply it to the analysis of complex systems, the process optimisation.

To learn the resampling techniques in statistical inference and machine learning.

Competences

- Correctly use a wide range of statistical software and programming languages, choosing the best one for each analysis, and adapting it to new necessities.

- Critically and rigorously assess one's own work as well as that of others.
- Make efficient use of the literature and digital resources to obtain information.
- Select and apply the most suitable procedures for statistical modelling and analysis of complex data.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- 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.
- Use quality criteria to critically assess the work done.
- Work cooperatively in a multidisciplinary context, respecting the roles of the different members of the team.

Learning Outcomes

1. Critically assess the work done on the basis of quality criteria.
2. Describe the advantages and disadvantages of algorithmic methods compared to the conventional methods of statistical inference.
3. Identify the statistical assumptions associated with each advanced procedure.
4. Identify, use and interpret the criteria for evaluating compliance with the requisites for applying each advanced procedure.
5. Implement bootstrap methods.
6. Make effective use of references and electronic resources to obtain information.
7. Reappraise one's own ideas and those of others through rigorous, critical reflection.
8. Solve inference problems through simulations.
9. Solve problems in calculating probabilities and stochastic processes through simulation.
10. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
11. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
12. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
13. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
14. Work cooperatively in a multidisciplinary context, accepting and respecting the roles of the different team members.

Content

1. Permutation tests: Two-sample tests. Test with paired data. Correlation tests. Advanced examples.
2. Bootstrap and other resampling methods: Basic concepts. Estimations of standard error and bias. Parametric bootstrap. Non-parametric bootstrap. Mehtods to compute confidence intervals. Applications (linear and generalised-linear models, hyothesis testing, time series, ...).
3. Resampling for machine learning: Bagging. Boosting.
4. Simulation: Simulation of random variables and vectors. Discrete Event Simulations. Output analysis. Imput modelling. Generation of random numbers.

Methodology

The metodology will combine classroom lectures delivered by the teachers and practical work of the student with computers.

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Classroom lectures (theoretical and practical)	50	2	
Type: Autonomous			
Assignments	48	1.92	
Personal study of the subject	48	1.92	

Assessment

The evaluation is based on:

- Homework deliveries (25% of the final grade).
- Exams (75% of the final grade).

To pass the course you must:

- Get a minimum grade of 4.0/10 in each of the exams.
- Get a global mean of 5.0/10, which will be the final grade.

Grades not satisfying these conditions can be studied case by case.

Each exam will have a second call ("recuperació" in the official terminology of UAB). The attendamce to the second call shall automatically invalidate the grade of the first one. There is no second call for the homework deliveries.

The student that have attended exams or hand-in homework for a total of 50% or more of the course, according to the weight that appears in the Avaluation Activities table, will be evaluated. Otherwise will be considered "not evauable".

For the eventual award of Special Honours ("Matricula de Honor" in the official terminology) the grades of second exam calls will not be taken into account.

The plagiarism in the homework deliveries will be considered an offense as serious as any kind of cheating in and exam, and shall be penalised with an automatic course failure.

UNIQUE EVALUATION: Students opting for the so-called "Unique Evaluation" will be evaluated in one only exam covering the whole course, including the matter relative to homework. There will not be homework deliveries. One piece of the exam can be oral. In case of passing the first call there will not be an option to a second one to improve thegrade.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exam of Resampling	37.5%	2	0.08	2, 3, 5, 13, 10, 8, 9
Exam of Simulation	37.5%	2	0.08	2, 3, 5, 13, 10, 8, 9
Resampling assignments hand in	12.5%	0	0	7, 1, 3, 4, 5, 12, 10, 11, 8, 9, 14, 6
Simulation Assignments hand in	12.5%	0	0	7, 1, 3, 4, 5, 12, 10, 11, 8, 9, 14, 6

Bibliography

- Ross, Sheldon (2013) Simulation. Elsevier (Recurs electrònic UAB).
- Law (2014) Simulation. Modelling and Analysis.
- James - Witten - Hastie - Tibshirani (2013) An introduction to Statistical Learning: with applications in R. Springer (Recurs electrònic UAB).
- Efron - Hastie (2016) Computer Age Statistical Inference. Cambridge University Press.

Software

During the course the relevant installation instructions for the software to be used will be given, at the appropriate time.