

Simulation and Resampling

Code: 104868
ECTS Credits: 6

2024/2025

| Degree | Type | Year |
|----------------------------|------|------|
| 2503852 Applied Statistics | OB | 3 |

Contact

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Teachers

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Teaching groups languages

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

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.

Learning Outcomes

1. KM15 (Knowledge) Identify simulation and resampling algorithms and techniques, and models for complex situations, fostering innovation in the field of statistics.
2. KM15 (Knowledge) Identify simulation and resampling algorithms and techniques, and models for complex situations, fostering innovation in the field of statistics.
3. SM15 (Skill) Solve unconventional inference problems using simulation and resampling techniques.

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. Methods to compute confidence intervals. Applications (linear and generalised-linear models, hypothesis testing, time series, ...).
3. Resampling for machine learning: Bagging. Boosting.
4. Simulation: Simulation of random variables and vectors. Discrete Event Simulations. Output analysis. Input modelling. Generation of random numbers.

Activities and Methodology

| 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 | |

The methodology 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.

Assessment

Continous Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|--------------------------------|-----------|-------|------|-------------------|
| Exam of Resampling | 37.5% | 2 | 0.08 | KM15, SM15 |
| Exam of Simulation | 37.5% | 2 | 0.08 | KM15, SM15 |
| Resampling assignments hand in | 12.5% | 0 | 0 | KM15, SM15 |
| Simulation Assignments hand in | 12.5% | 0 | 0 | KM15, SM15 |

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 mean of at least 5.0/10 in the exams, with a minimum grade of 4.0/10 in each of them.
- 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 attendance 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 the grade.

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.

Language list

| Name | Group | Language | Semester | Turn |
|-------------------------------|-------|----------|-----------------|-----------|
| (PLAB) Practical laboratories | 1 | Catalan | second semester | afternoon |
| (TE) Theory | 1 | Catalan | second semester | afternoon |