Universitat Autònoma de Barcelona

2022/2023

Experimental Design

Code: 104862
ECTS Credits: 6

Degree	Type	Year	Semester
2503852 Applied Statistics	OB	2	2

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Prerequisites

Knowledge in:
• Calculus
• Descriptive Statistics
• Statistical Programming
• Statistical Inference
• Statistical sampling

Objectives and Contextualisation

The objectives of the subject are to learn to design and analyze experiments using the following techniques:
- Analysis of the variance of one and several factors.
- Analysis of the variance with blocks, nested factors, fractional designs with interaction
- Analysis of Covariance and other special designs.
The subject is also intended to familiarize students with the use of SAS software.

Competences

- Analyse data using statistical methods and techniques, working with data of different types.
- 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.
- Design a statistical or operational research study to solve a real problem.
- Formulate statistical hypotheses and develop strategies to confirm or refute them.
- Interpret results, draw conclusions and write up technical reports in the field of statistics.
- 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.
- Select statistical models or techniques for application in studies and real-world problems, and know the tools for validating them.
- 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.
- Summarise and discover behaviour patterns in data exploration.
- Use quality criteria to critically assess the work done.

Learning Outcomes

1. Analyse data through inference techniques using statistical software.
2. Analyse data using the model of block analysis of variance.
3. Analyse data using the model of covariance analysis.
4. Analyse data using the model of linear regression.
5. Analyse data using the model of variance analysis for one or more factors.
6. Analyse data using the model of variance analysis with nested factors.
7. Choose the relevant explanatory variables.
8. Critically assess the work done on the basis of quality criteria.
9. Establish the experimental hypotheses of modelling.
10. Identify response distributions with the analysis of residuals.
11. Identify the presence of interaction between variables by plotting means and interactions.
12. Identify the response, explanatory and control variables.
13. Identify the stages in problems of modelling.
14. Identify the statistical assumptions associated with each advanced procedure.
15. Make effective use of references and electronic resources to obtain information.
16. Make slight modifications to existing software if required by the statistical model proposed.
17. Prepare technical reports within the area of statistical modelling.
18. Reappraise one's own ideas and those of others through rigorous, critical reflection.
19. 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.
20. 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.
21. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
22. Use a range of statistical software to adjust and validate linear models and their generalisations.
23. Use specific packages for experimental design.
24. Validate the models used through suitable inference techniques.

Content

Principles of Experimental Design.
• Objective
• Hypothesis
• Variables
• Bias control.
• Common designs
• Calculate sample size

Review Inference 1 and 2 populations:
• 1 Sample, known sigma
• 1 Sample unknown sigma
• 2 independent samples known sigma
• 2 independent samples unknown sigma
• 2 paired samples

1: ANOVA 1 Fully Randomized Factor
• Variance decomposition
• Model and ANOVA Table
• Contrasts

• Separation of Means - LSD / Bonferroni / Scheffe / Tukey
• Verification of the model (Levene Test, Waste Chart, Normality)

2: ANOVA 1 Block
• Fixed / Random Factor
• Variance decomposition
• Model and ANOVA Table

3: ANOVA 1 Factor with Complete Blocks
• Model and ANOVA Table
• Verification of the model
• Cross-Over Studies

4: ANOVA 1 Factor Blocks InComplete
• Latin squares
• Model and ANOVA Table

5: ANOVA 2 Factors
• Model and ANOVA Table
• Separation of Means - SNK / Dunnet / Other methods

6: ANOVA 2 Factors with Interaction
• Model and ANOVA Table
• Interactions
• Separation of Means - SNK / Dunnet / Other methods

7: ANOVA with Sub-Replicates
• Model and ANOVA Table

8: ANCOVA
• Model and ANOVA Table

9: ANCOVA with Interactions
• Model and ANOVA Table
• Interactions

10: Other models
• Basic concepts of Screening Design
• Basic Concepts of Factorial Design 2k
• Basic concepts of the Surface Response method

Software
• R
• SAS System
• SAS Enterprise Guide

Methodology

There will be theoretical sessions where the concepts related to the design of studies and experiments will be exposed.
These sessions will be complemented by practical sessions in a computer room where dedistance will be done with Statistical software.
All the above concepts will be applied through a work that can be done in a group.

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			
Report	20	0.8	5, 4, 1, 18, 8, 9, 10, 11, 13, 14, 12, 16, 21, 19, 20, 7, 15, 22, 24
Theory	60	2.4	5, 1, 18, 8, 9, 13, 14, 16, 21, 19, 20, 7, 15, 22, 24
Type: Supervised			
Pràctiques	25	1	5, 1, 18, 8, 9, 13, 14, 16, 21, 19, 20, 7, 15, 22, 24

Assessment

Continuous evaluation:

Report 40%(Minimum grade 4)
Practices 15%
Partial Exam 45% (Minimum grade 4)

Reassessed:

Maximum between:

100% final exam
Report 40% + Exam 60% (Minimum grade 4)

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exam	45	15	0.6	5, 1, 18, 8, 9, 13, 14, 16, 21, 19, 20, 7, 15, 22, 24
Practical Sessions	15	15	0.6	5, 1, 18, 8, 9, 13, 14, 16, 21, 19, 20, 7, 15, 22, 24
Report	40	15	0.6	3, 2, 6, 5, 4, 1, 18, 8, 17, 9, 10, 11, 13, 14, 12, 16, 21, 19, 20, 7, 15, 23, 22, 24

Bibliography

References

- Estadística para investigadores - Box, Hunter, Hunter - Ed. Reverté
- Estadística. Modelos y Series Temporales. Daniel Peña - Ed. Alianza
- Principles and procedures of statistics, a biometrical approach 2nd Ed - Steel, Torrie - McGraw Hill
- Biostatistics: A foundation for analysis in the health sdciences. 4th Ed - Steel, Torrie - John Willey & Sons
- Design and Analysis of Experiments - Dean , Voss - Springer-Verlag New York, 1999
- Peña, D. (1998) Estadística. Modelos y Métodos. Tomo I: Fundamentos. Alianza Universidad Textos.
- Montgomery, DC. (2001). Design and Analysis of Experiments. John Willey and sons.

Software

SAS