Course Unit	Experimental Design and Multivariate Analysis			Field of study	Mathematics and statistics		
Master in	Biotechnological Engineering			School	School of Agriculture		
Academic Year	2021/2022	Year of study	1	Level	2-1	ECTS credits	6.0
Type	Semestral	Semester	1	Code	5010-509-1102-00-21		

Workload (hours)	162	Contact hours	T	-	TP	60	PL	-	TC	-	S	-	E	-	OT	4	O	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Luís Filipe de Sousa Teixeira Nunes

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Recognise the importance of an adequate experimental methodology and know how to design experiments.
2. Distinguish between different experimental designs and improve the capacity to choose the best options in accordance to the objectives.
3. Identify the adequate sampling procedures and statistical tests.
4. Distinguish different techniques of multivariate data analysis.
5. Interpret software output results and acquire criticising capacity.

Prerequisites

Before the course unit the learner is expected to be able to:
1. Basic knowledge in informatics.
2. Algebra: determinants, eigenvalues and matrices.
3. Basic concepts of descriptive statistics; confidence intervals and hypotesis tests.
4. Minimum knowledge about analysis of variance and linear regression.

Course contents

Data sampling and transformations of variables. Design and layout of experiments with and without randomization restrictions. Regression analysis. Classification of multivariate data analysis techniques: models, assumptions, validation of data/results, interpretation and restrictions. Multivariate analysis applications: multivariate analysis of variance (MANOVA); principal components and factor analysis; discriminant analysis; cluster analysis. Data analysis with statistical software.

Course contents (extended version)

1. Sampling, confidence intervals and hypothesis tests
   - 1. 1. Data sampling and transformation of variables
   - 1. 2. Confidence intervals
   - 1. 3. Parametric tests (means, proportions and variances)
2. Simple and multiple linear regression
3. Analysis of Variance (ANOVA)
4. Robust methods, resampling and non-parametric tests
   - 4. 1. Trimmed means, winsorization and M estimators
   - 4. 2. Resampling with replacement (bootstrap)
   - 4. 3. Resampling without replacement (permutation tests)
   - 4. 4. Non-parametric tests
5. Experimental design
   - 5. 1. Completely randomized single-factor design
   - 5. 2. Randomized complete block design, latin squares and related designs
   - 5. 3. Factorial designs
   - 5. 4. Experiments with nested factors and hard-to-change factors (split-plots)
6. Introduction to multivariate analysis
   - 6. 1. Concepts of multivariate analysis
   - 6. 2. Multivariate analysis of variance (MANOVA)
7. Multivariate analysis techniques
   - 7. 1. Principal components analysis
   - 7. 2. Exploratory factor analysis
   - 7. 3. Cluster analysis
   - 7. 4. Discriminant analysis and other classification methods

Recommended reading

1. Hoshmand, A. R. , 2006. Design of experiments for agriculture and natural sciences, 2nd edition, Chapman &Hall/CRC.
2. Montgomery, D. C. , 2013. Design and Analysis of Experiments, 8th edition, John Wiley & Sons.
3. Dalgaard, P. , 2008. Introductory Statistics with R, 2nd edition, Springer.
4. Wehrens, R. , 2020. Chemometrics with R. Multivariate Data Analysis in the Natural Sciences and Life Sciences, 2nd edition, Springer.
5. Hair, J. F. , Babin, B. J. , Anderson, R. E. , 2018. Multivariate Data Analysis, 8th edition, CENGAGE.

Teaching and learning methods

Presentation of the theoretical concepts using audiovisual and multimedia equipment. Problem solving and applications of theoretical concepts using a statistical software. Practical assignments to integrate and apply the learned concepts. Availability of documents and examples of application in virtual. ipb platform to support the self-study and the preparation of the practical assignments.

Assessment methods

1. Students - (Regular) (Final, Supplementary, Special)
   - Practical Work - 50%
   - Final Written Exam - 50%
2. Students - (Student Worker) (Final, Supplementary, Special)
   - Practical Work - 50% ((Alternativelly should make final practical exam (50%)))
   - Final Written Exam - 50%

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Luís Filipe de Sousa Teixeira Nunes	Carlos Manuel Mesquita Morais	Paula Cristina Azevedo Rodrigues	Paula Sofia Alves do Cabo
01-12-2021	01-12-2021	01-12-2021	02-12-2021