Course guide
220557 - 220557 - Applied Statistics

Unit in charge:	Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit:	715 - EIO - Department of Statistics and Operations Research.

Degree: MASTER'S DEGREE IN MANAGEMENT ENGINEERING (Syllabus 2012). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Maria Albareda Sambola

Others:

Eulàlia Gríful Ponsati
MARIA ROSA MORERA RAVENTOS

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Acquire concepts and techniques related to descriptive and statistical inference.

Generical:
2. Ability to apply knowledge to solve problems in new environments or unfamiliar environments within broader contexts (or multidisciplinary) related to engineering.
3. Self-learning capacity to independent continuous training.
4. Ability to effectively communicate their findings, knowledge and concluding reasons to skilled and unskilled audiences, clearly and unambiguously.
5. Ability to integrate knowledge and formulate judgments with the aim of making decisions based on information that, with incomplete or limited include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgments.
6. Ability to understand the impact of engineering solutions in a global and social context .
7. Ability to operate and lead multidisciplinary and multicultural groups, with negotiation skills, group work, relationships in an international setting, and conflict resolution.

TEACHING METHODOLOGY

Three teaching modes are combined in this course:

Theory classes: Lectures in large groups to present the course contents.
Practical classes: Tutorials in medium size groups to discuss, debate and comment practical exercices and problems.
Independent learning: Self study and personal work in exericies and other activities.

In the lecturing sessions, teachers will introduce the theoretical basis of the concepts, methods and results and illustrate them with appropriate examples to facilitate their understanding.

In the practical classes, teachers will guide students in applying these theoretical concepts to solve problems, always encouraging a critical reasoning. Exercices will be proposed for the students to solve both, in the classroom and outside, to promote the use the basic tools needed to solve problems and put the students in contact with them.

Students, independently, need to work on the materials provided by teachers and the outcomes of the sessions of exercises/problems, in order to fix and assimilate the concepts.

The teachers will provide the syllabus (through the platform ATENEA).

Observation: This course might be taught in Spanish, if needed.

LEARNING OBJECTIVES OF THE SUBJECT

Applied Statistics, located in the first year of Master in Management, provides a range of advanced statistical tools that have been developed within the area of statistics in response to industrial and managerial problems.

Its contents are mainly quantitative and provide statistical tools that can support decision making based on collected data. In particular, forecasting techniques for time series are studied, as well as some multivariate analysis methods.

STUDY LOAD

Type	Hours	Percentage
Hours large group	8,0	6.40
Guided activities	22,0	17.60
Hours medium group	15,0	12.00
Self study	80,0	64.00

Total learning time: 125 h

CONTENTS

Module 1: Multivariate Analysis. Introduction

Description:
Multivariable Statistics is a wide knowledge area specialized in treating multidimensional observations. Thus, it is applicable to populations made by individuals on whiche two or more variables are measured simmultaneously.
By its nature, its study requires certain skills on matrix algebra and some concepts of basic statistics such as mathematical expectation, variance and standard deviation, their sample estimators and their extension to the notion of mathematical expectations vector and variance-covariance and correlation matrices.
All these concepts will be refreshed in this introduction.

Specific objectives:
Review concepts that will be necessary for following the course adequately.

Related competencies :
CE-A1. Acquire concepts and techniques related to descriptive and statistical inference.

Full-or-part-time: 8h 30m
Theory classes: 1h 20m
Guided activities: 2h 10m
Self study : 5h

Module 2: Multivariate Analysis. Principal Component Analysis

Description:
Principal components give a way to tackle situations where different variables that have been measured on a large group of individuals need to be analyzed. Specially when the size of the database makes its interpretation difficult and unefficient and correlations between variables reduce the efficacy of other study methods.

Graphical representation of individuals and variables in the principal components space allows to visualize relationships between variables, similarities among individuals and mutual associations. Principal components are nothing but a projection of the customers to a lower dimension subspace that minimizes the total information lost.

Specific objectives:
Give the student the hability to reduce the volume of data of quantitative data collected on a large sample, with the minimal information loss possible.

Full-or-part-time: 35h 20m
Theory classes: 2h
Practical classes: 6h 10m
Guided activities: 5h 10m
Self study : 22h

Module 3: Multivariate Analysis. Correspondence Analysis

Description:
The goal of correspondence analysis is to study contingency tables that collect data according to two modality sets (province and professional activity, for instance). It gives a geometrical representation, quite precise and simple, on a space of reduced dimension that exhibits associations within each set and among sets.

Specific objectives:
Give the student the capacity to identify possible relationships among the categories used to classify the sample individuals on a contingency table

Full-or-part-time: 16h 40m
Theory classes: 1h 30m
Practical classes: 1h 10m
Guided activities: 4h
Self study : 10h

Module 4: Time Series. Introduction

Description:
A time series is a set of observarions chronologically sorted, or the evolution of a phenomenon along the time. The objective of this module and the following ones is the analysis of the series to establish a pattern, validate its fit to data and forecast the future evolution

Specific objectives:
The objective of this specific module is to present the concept of time series and to review some preliminar concepts that are required in the following modules

Full-or-part-time: 4h 50m
Theory classes: 0h 30m
Guided activities: 1h 20m
Self study : 3h

Module 5: Time Series. Classical Decomposition

Description:
In this module we study the so called classical decomposition method, where the series is decomposed into trend, seasonality, cycles and residuals. To model the series and make forecasts it is necessary to stabilize it removing the seasonality and through the moving averages. Once decided their interaction (aditive or multiplicative) a final model is obtained that can be used to make forecasts.

Specific objectives:
Give the student the capability to identify aditive and multiplicative series and to model thiir main components: trend and seasonality.

Full-or-part-time: 11h 10m
Theory classes: 0h 40m
Practical classes: 1h 10m
Guided activities: 2h 20m
Self study : 7h

Module 6: Time Series. Modelling with categorical variables

Description:
The modelization of time series using categorical variables is an extension of the clasical method that allows to model jointly trend and seasonality. Moreover, it does not require to assume a predefined type of interaction between them, since the models used here include all possibilities and it is the method itself that determines what effects are relevant in a given time series. Thanks to this, modelization trhough categorical variables overcomes the main limitation of clasical decomposition since it allows to model adequately time series with a mixt behavior.

Specific objectives:
Give the students the capability of modeling series with trend and seasonality independently of their interaction.

Full-or-part-time: 14h 50m
Theory classes: 0h 30m
Practical classes: 2h 40m
Guided activities: 1h 40m
Self study : 10h

Module 7: Time Series. Autocorrelation

Description:
This module presents the correlogram, a graphical analysis tool where the autocorrelation function is represented for different lags. It indicates the number of admissible forecasts for a given time series. Additionally, it can give additional information to identify the period of the seasonality.

Specific objectives:
Give the student the capability to elaborate and interpret correlograms.

Full-or-part-time: 21h 10m
Theory classes: 1h
Practical classes: 3h 10m
Guided activities: 3h
Self study : 14h

Module 8: Time Series. Other forecasting techniques

Description:
In this block some methods based on exponential smoothing are presented. These methods allow, for instance, to model series that do not have a stable trend within the data collection time horizon and are also useful when the quantity of information is not too large.

Specific objectives:
The objective of this module is to study alternative tools to model time series without a strong structure given by a trend and a seasonality.

Full-or-part-time: 12h 30m
Theory classes: 0h 30m
Practical classes: 0h 40m
Guided activities: 2h 20m
Self study : 9h

GRADING SYSTEM

The coursework will be weighted as follows:

- Exam of modules 1-3, weight: 40%
- Exam of modules 4-8, weight: 40%
- Project of module 2, weight: 10%
- Project of modules 6 and 7, weight: 10%

Any student that cannot attend to one of the exams or wants to improve his/her grade will have an opportunity to do it in a final exam. The grade of a final exam will only be used in case it is better than the graid obtained in the corresponding exam during the course.

BIBLIOGRAPHY

Basic:
- Albareda, M.; Algaba, I.; Pepió, M. Series temporales y previsiones. Barcelona: OmniaScience, 2013. ISBN 9788494062469.
- Polo Miranda, C. Estadística multivariable [on line]. 4a ed. Barcelona: Edicions UPC, 2005 [Consultation: 22/06/2020]. Available on: http://hdl.handle.net/2099.3/36241. ISBN 8483018152.

Complementary:
- Pepió Viñals, M. Series temporales [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 22/06/2020]. Available on: http://hdl.handle.net/2099.3/36262. ISBN 8483016362.
- Johnson, Richard Arnold. Applied multivariate statistical analysis. 6th ed. Publicación Englewood Cliffs: Prentice-Hall, 2007. ISBN 9780131877153.
- Everitt, Brian. An R and S-PLUS companion to multivariate analysis [on line]. London: Springer, 2005 [Consultation: 10/06/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/b138954. ISBN 1852338822.
- Makridakis, Spyros G. [et al.]. Forecasting: methods and applications. 3rd ed. New York: John Wiley & Sons, 1998. ISBN 0471532339.
- Diebold, Francis X. Elementos de pronósticos. México: International Thomson, 1999. ISBN 9687529741.