Course guide
240335 - 240EO051 - Applied Statistics

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 715 - EIO - Department of Statistics and Operations Research.
Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN MANAGEMENT ENGINEERING (Syllabus 2021). (Compulsory subject).
Academic year: 2023
ECTS Credits: 5.0
Languages: English

LECTURER

Coordinating lecturer: Ginebra Molins, Josep
Others: Ginebra Molins, Josep

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. Acquire concepts and techniques related to descriptive and inferential statistics.
3. Apply concepts and techniques of descriptive and inferential statistics.
CEO3. Acquire concepts and techniques related to quantitative and experimental methods for analysis and decision making.

General:
1. Learn and master the analytical tools necessary for decision making in the organizational context more efficient.

Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

Basic:
CB7. (ENG) Que els estudiants sàpiguen aplicar els coneixements adquirits i la seva capacitat de resolució de problemes en entorns nous o poc coneguts dintre de contextos més amplis (o multidisciplinars) relacionats amb la seva àrea d'estudi.
CB8. (ENG) Que els estudiants siguin capaços de d'integrar coneixements i enfrontar-se a la complexitat de formular judicis a partir d'una informació que, essent incompleta o limitada, inclogui reflexions sobre les responsabilitats socials i ètiques vinculades a l'aplicació del seus coneixements i judicis.
CB9. (ENG) Que els estudiants sàpiguen comunicar les seves conclusions i coneixements (i darrers raonaments que els sostinent), a públics especialitzats i no especialitzats de manera clara i sense ambigüitats.

TEACHING METHODOLOGY

There are two types of sessions: main lectures and sessions in the computer lab. In the lectures (2 hours per week) the teacher explains the basics of the subject using examples.

In the hands-on sessions (2 hours every two weeks), practical problems will be solved using statistical packages.

Students will need to do a team project in which they will have to build a model to a set of data selected by them, and several smaller individual project that will be collected.
LEARNING OBJECTIVES OF THE SUBJECT

After the course the student will be able to:
1. Design how to collect data and how to convert these data into useful information for decision making in environments where there is variability.
2. Understand the concept of variability and how it is measured.
3. Know and apply some of the most common techniques of data collection and analysis.
4. Learn how to build statistical models to summarize information, make predictions, dimensionality reduction and classification.
5. Learn the use of statistical software to solve problems as close as possible to those in their future professional work.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>22.5</td>
<td>50.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>22.5</td>
<td>50.00</td>
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</tbody>
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Total learning time: 45 h

CONTENTS

Chapter 1: Probability and Statistics

Description:
1. Sample, population and the difference between statistics and probability. 2. Discrete probability models; Binomial and Poisson.
3. Continuous probability models; Normal model. 4. Point estimation of the population mean. 5. Confidence intervals and hypotheses tests for the population mean. 6. Statistical modeling and multivariate analysis.

Specific objectives:
Understand the concept of variability and how it can be modeled. Know how to use some probability models. Difference between probability and statistics. The concepts of confidence intervals and hypotheses tests.

Full-or-part-time: 9h
Theory classes: 2h
Laboratory classes: 2h
Self study: 5h

Chapter 2: Linear modeling

Description:
1. Theoretical versus fitted model. 2. Model fit by least squares and other model fit criteria. 3. ANOVA table and goodness of fit measures. 4. Statistical inference on the parameters of the model. 5. Prediction. 6. Model checking through residual analysis. 7. Cross validation and model selection. 8. Interpretation of the fitted model; Bias, colinearity and causality. 9. Use of categorical explanatory variables.

Specific objectives:
To learn how to build a linear model that relates one continuous response variable to a list of explanatory variables, to learn how to interpret that model and make predictions with it, and to learn how to design experiments statistically efficient.

Full-or-part-time: 45h
Theory classes: 10h
Laboratory classes: 10h
Self study: 25h
Chapter 3: Non-linear modeling

**Description:**

**Specific objectives:**
To learn how to build a non-linear model that relates one continuous response variable to a list of explanatory variables, to learn how to interpret that model and make predictions with it, and to check that the model is a good enough approximation of reality.

**Full-or-part-time:** 9h
- Theory classes: 2h
- Laboratory classes: 2h
- Self study: 5h

Chapter 4: Categorical and count response modeling

**Description:**

**Specific objectives:**
To learn how to build a linear model that relates one binary response variable to a list of explanatory variables and to learn how to interpret that model and make predictions with it.

**Full-or-part-time:** 18h
- Theory classes: 4h
- Laboratory classes: 4h
- Self study: 10h

Chapter 5: Time series modeling

**Description:**
1. Description of a time series; Stationarity and seasonality. 2. Autoregressive models, AR(p). 3. Moving average models, MA(q). 4. ARIMA(p,d,q) models. 5. Seasonal ARIMA models.

**Specific objectives:**
To learn how to build a time series model.

**Full-or-part-time:** 18h
- Theory classes: 4h
- Laboratory classes: 4h
- Self study: 10h

Chapter 6: Visualization of multivariate data (Dimensionality reduction)

**Description:**
1. Principal components analysis. 2. Correspondence Analysis

**Specific objectives:**
Learn about dimensionality reduction techniques both for continuous as well as discrete data.

**Full-or-part-time:** 9h
- Theory classes: 2h
- Laboratory classes: 2h
- Self study: 5h
Chapter 7: Unsupervised and supervised classification

Description:
1. Cluster analysis, 2. Discriminant analysis

Specific objectives:
To learn about unsupervised and supervised classification (learning).

Full-or-part-time: 9h
Theory classes: 2h
Laboratory classes: 2h
Self study: 5h

GRADING SYSTEM

The final course grade (NF) will be computed:

1) Assignments: NA
2) Group project: NT
3) Midterm exam: EP
4) Final exam: EF

The final course grade will be obtained through: \[ NF = 0.10*NA + 0.20*NT + 0.20*EP + 0.50*EF \]

BIBLIOGRAPHY

Basic: