Course guide STATISTICAL METHODS FOR BUSINESS

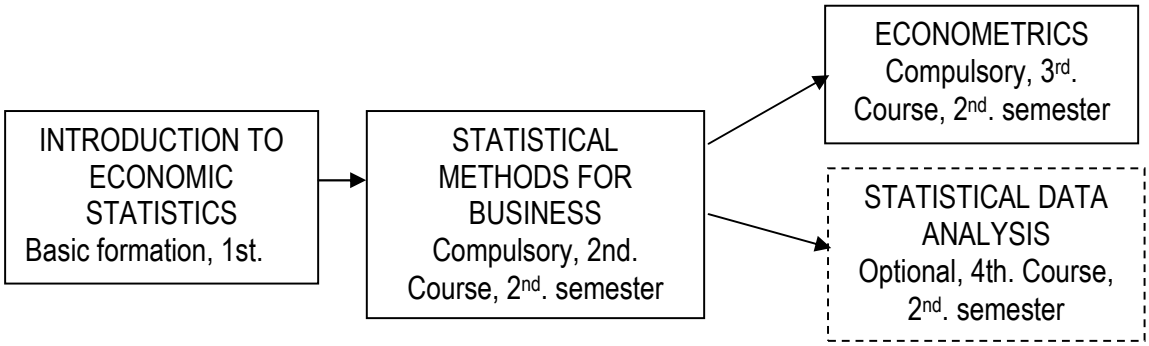
Introduction

Statistics plays an important role in the development of society. That is why it is included in degrees in Business Administration (EDA) of the Spanish and European universities.

Statistical studies are organized in the degree of Business Administration from the University of Oviedo through a set of basic training courses, compulsory and optional.

Thus, in the second half of 1st course we find the subject called *Introduction to Economic Statistics,* with an identical program in the degrees in Business Administration, Economics, Accounting and Finance, and Labor Relations and Human Resources. It presents the main tools of descriptive statistics and economic statistics.

In the second half of 2nd course we find *Statistical Methods for Business*, which studies contents of probability calculus and statistical inference.



As shown in the diagram, statistical studies continue in the third and fourth courses of the degree. In the third year it is included the subject *Econometrics,* devoted to estimate and test econometric models. In fourth course, the optional subject *Statistical Data Analysis*, examines a set of common statistical tools in the economic context, so students can solve real problems of data collection and analysis. Also, the course addresses a set of statistical techniques aimed at quality control and decision making in the economic /business areas.

In addition to the interplay between statistical subjects themselves, and as a natural consequence of its instrumental role in the subject curriculum, the skills that these subjects provide are used in other more specific degree subjects.

In this context, the overall objective of the course *Statistical Methods for Business* is to provide a set of statistical tools for solving problems through the use of sample information. The course will study probability models that are used in economics and business. It also discusses the fundamentals of statistical inference, with special emphasis on the construction of confidence intervals and hypothesis testing.

Prerequisites

- Basic statistical knowledge (e.g., averages, dispersion measures, two-dimensional distributions), discussed in the *Introduction to Economic Statistics* course.
- Mathematical knowledge to understand proofs.

Competences and learning outcomes

Upon completion of the course students should be able to acquire the following skills**:**

- Ability for analysis and synthesis.
- Learning ability.
- Ability to research and analyze information sources in the field of work.
- Ability to use computer and communication technologies.
- Ability to work independently.
- Self-critical ability.
- Ability to apply knowledge into practice.
- Concern for quality and a job well done.
- Ability to make decisions.

The **specific skills** developed in the course are:

- To identify and apply appropriate quantitative tools to analyze economic data.
- To manage and interpret specific software for data processing.
- To transmit information, ideas, problems and solutions in the field of business management to a general audience.

The former general and specific skills are specified in the following **learning outcomes:**

- To apply probability models to describe the behaviour of economic variables.
- Inferential statistical tools applied to solving problems in economics and business.
- To manage a spreadsheet to solve statistical problems.

Contents

The course guide is divided into 11 lessons, gathered into two blocks: the first block, corresponding to the items 1 to 5, focuses on the study of probability. The second block, which includes items from 6 to 11, is based on the analysis and study of the main tools of statistical inference, devoting particular attention to confidence intervals and statistical hypothesis testing.

Abbreviated Programme

Unit 1 .- Uncertainty and probability.

Item 2 .- Random magnitudes.

Item 3 .- Discrete probability models.

Item 4 .- Continuous probability models.

Unit 5 .- Joint analysis and limit theorems.

Item 6 .- Introduction to sampling. Estimators.

Item 7 .- Inferential tools. Distributions associated with sampling.

Item 8 .- Interval estimation.

Unit 9 .- Introduction to hypothesis testing.

Unit 10 .- Parametric tests.

Unit 11 .- Non-parametric tests.

Detailed program and learning objectives

Unit 1 .- Uncertainty and probability.

1.1 .- Probability. Concepts and quantification.

1.2 . Axiomatic definition of probability.

1.3 .- Conditional probability and independence.

1.4 .- Total Probability and Bayes theorem.

Objectives:

Specific learning objectives to be achieved by the student:

- To understand the various concepts of probability (classical, frequency and subjective).
- To distinguish the main terms used in combinatorial calculus.
- To properly interpret the concepts of complementary event, union and intersection of events, independent events and mutually exclusive events.
- To identify partitions of the sample space, and to apply the total probability and Bayes theorem.
- To properly interpret a priori and a posteriori probabilities and probability values.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapter 1.

DOWNING, D.; CLARK, J. (2010): *Business Statistics*. Barron's Educational Series.

NEWBOLD, P., CARLSON, W., THORNE, B. (2008): *Statistics for Management and Economics*. Ed. Prentice Hall.

Unit 2 .- Random magnitudes.

2.1 .- Random variable. Discrete and continuous variables.

2.2 .- Probability distribution of a random variable.

2.3 .- Characteristics of random variables. Expected value and dispersion.

2.4 .- Chebyshev Inequality.

Objectives:

The second topic introduces the concepts of random variable and probability distribution, which are of fundamental importance in this subject. At the end of the unit, students should be able to:

- Describe the concept of random variable, justifying the presence of uncertainty in the economic field.
- Distinguish between discrete and continuous variables.
- Calculate cumulative probabilities and probabilities for generic intervals, for both discrete and continuous variables.
- Calculate and interpret the expected value and variance of a random variable.
- Apply Chebyshev Inequality.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapters 2 and 3.

DOWNING, D.; CLARK, J. (2010): *Business Statistics*. Barron's Educational Series.

ANDERSON, D.R.; SWEENEY, D.J.; WILLIAMS, T.A. (2011): *Statistics for Business and Economics*. Thomson Press (India) Ltd.

Unit 3 .- Discrete probability models.

3.1 .- Bernoulli processes and related distributions.

3.1.1- Binomial model.

3.1.2- Geometric model.

3.2 .- Hypergeometric Model.

3.3 .- Poisson model.

Objectives:

This lesson is aimed at familiarizing students with the main discrete probability models and their economic and business applications, so they should be able to:

- Identify key discrete probability models, realizing the assumptions they are based on.
- Handle expressions of the expectation and the variance of the main models.
- Calculate probabilities for the main models.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapter 4.

WACKERLY, D.; MENDENHALL III, W.; SCHEAFFER, R.L. (2008): *Mathematical Statistics With Applications.* Ed. Thomson.

BREMNER, J.M.; MORGAN, B.J.T.; JOLLIFFE, I.T.; JONES, B.; NORTH, P.M.; E. E. BASSETT; E.E. (2000): *Statistics: Problems and Solutions*. World Scientific Publishers.

Unit 4 .- Continuous probability models.

4.1 .- Uniform model.

4.2 .- Normal model.

4.3 .- Other models.

Objectives:

This lesson tries to familiarize students with major continuous probability models, and especially with the Normal model and its economic and business applications, so they should be able to:

- Identify the uniform distribution and calculating probabilities.
- Describe the Normal model, its characteristics and apply the standardization process.
- Handle the tables of the Normal distribution in order to get probabilities or values.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapter 5.

OLSON OLTMAN, D.; LACKRITZ, J.R. (1991): *Statistics for Business and Economics*. Ed. Brooks/Cole Publishing Company.

CANAVOS, G.C. (1984): *Applied Probability and Statistical Methods*. Ed. Little, Brown and Company.

Unit 5 .- Joint analysis and limit theorems.

5.1 .- K-dimensional distributions.

5.2 .- Independent random variables. Properties.

5.3 .- Aggregates of random variables.

5.4 .- Central Limit Theorem and its applications.

Objectives:

- To apply the main properties derived from the independence of random variables.
- To calculate probabilities for the main aggregates of independent random variables.
- To apply and interpret the Central Limit Theorem.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapter 6.

CANAVOS, G.C. (1984): *Applied Probability and Statistical Methods*. Ed. Little, Brown and Company.

CHOU, Y.L. (1989): *Statistical Analysis for Business and Economics.* Ed. Elsevier.

Unit 6 .- Introduction to sampling. Estimators.

6.1 .- Sample surveys. Sample selection techniques.

6.2 .- Simple random sampling. Distribution of the sample.

6.3 .- Estimators and their properties.

6.4 .- Methods of obtaining estimators.

Objectives:

This unit lays out the basics of statistical sampling and presents the theory of estimation. Its objectives are:

- To present the basic ideas of sampling.
- To analyze the benefits and risks associated with the inferences carried out on samples.
- To study the concept of simple random sample.
- To describe the concept of estimator.
- To calculate and interpret the bias and mean square error of an estimator.
- To analyze the basic properties of estimators.
- To derive and interpret the maximum likehood estimator of a parameter.
- To derive and interpret estimators by the method of moments.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapters 6 and 7.

DOWNING, D.; CLARK, J. (2010): *Business Statistics*. Barron's Educational Series.

NEWBOLD, P., CARLSON, W., THORNE, B. (2008): *Statistics for Management and Economics*. Ed. Prentice Hall.

Unit 7 .- Inferential tools. Distributions associated with sampling.

7.1 .- Distributions associated with the sampling process.

7.2 .- Inferential processes and relevant distributions.

Objectives:

This topic introduces the main distributions used in statistical inference. The learning objectives for students are:

- To describe the chi-square and Student's t distributions.
- To calculate probabilities and quantiles.
- To apply the main pivotal statistics used in inferential processes on the mean, the proportion and variance.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapters 6 and 7.

WACKERLY, D.; MENDENHALL III, W.; SCHEAFFER, R.L. (2008): *Mathematical Statistics With Applications.* Ed. Thomson.

BREMNER, J.M.; MORGAN, B.J.T.; JOLLIFFE, I.T.; JONES, B.; NORTH, P.M.; E. E. BASSETT; E.E. (2000): *Statistics: Problems and Solutions*. World Scientific Publishers.

Unit 8 .- Interval Estimation.

8.1 .- Introduction to interval estimation.

8.2 .- Confidence intervals. Construction and characteristics.

8.3 .- Confidence intervals for the mean.

8.4 .- Confidence intervals for the proportion.

8.6 .- Confidence intervals for the variance.

Objectives:

This is one of the main units of the course and its purpose is to study interval estimation procedures, so that students are able to:

- Interpret the characteristics of precision and confidence of an estimator.
- Describe the respective advantages and limitations of point and interval estimation.
- Construct confidence intervals for the mean.
- Calculate the sample size required to estimate the mean.
- Build confidence intervals for the proportion and variance.
- Calculate the sample size required to estimate the proportion.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapter 7.

NEWBOLD, P., CARLSON, W., THORNE, B. (2008): *Statistics for Management and Economics*. Ed. Prentice Hall.

CANAVOS, G.C. (1984): *Applied Probability and Statistical Methods*. Ed. Little, Brown and Company.

Unit 9 .- Introduction to hypothesis testing.

9.1 .- Basics of statistical hypothesis testing.

9.2 .- Types of errors in hypothesis testing.

9.3 .- Methodology and implementation of statistical tests.

Objectives:

- To understand statistical hypothesis testing and distinguish the types of errors that can occur in a test.
- To interpret the p-value of a test.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapter 8.

DOWNING, D.; CLARK, J. (2010): *Business Statistics*. Barron's Educational Series.

NEWBOLD, P., CARLSON, W., THORNE, B. (2008): *Statistics for Management and Economics*. Ed. Prentice Hall.

Unit 10 .- Parametric tests.

10.1 .- Tests for the mean.

10.2 .- Tests for the proportion.

10.3 .- Tests for the variance.

Objectives:

- To resolve tests on the mean, the proportion and variance.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapter 8.

BREMNER, J.M.; MORGAN, B.J.T.; JOLLIFFE, I.T.; JONES, B.; NORTH, P.M.; E. E. BASSETT; E.E. (2000): *Statistics: Problems and Solutions*. World Scientific Publishers.

CANAVOS, G.C. (1984): *Applied Probability and Statistical Methods*. Ed. Little, Brown and Company.

Unit 11 - Non-parametric tests.

11.1- Runs test.

11.2 .- Normality testing.

11.3 .- Independence testing.

Objectives:

- To resolve tests on the randomness of the sample.
- To apply Normality tests.
- To test for independence between two characteristics in a given population.

Reference material:

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall. Chapters 8 and 14.

CANAVOS, G.C. (1984): *Applied Probability and Statistical Methods*. Ed. Little, Brown and Company.

CHOU, Y.L. (1989): *Statistical Analysis for Business and Economics.* Ed. Elsevier.

Methodology and working plan

The working plan for this course is structured as follows:

- Lectures, which present the overall motivation of the unit based on real situations in the economic sphere and give an overview of the theoretical part of each topic, with particular attention to key concepts and important developments.
- Practices, aimed at solving theoretical and practical issues and statistical exercises related to economic and business environment, supported by the tools and methods introduced in the lectures.
- Lab practices, with spreadsheet as the main working tool.

The following table presents an estimated schedule for students to follow the 11 lessons of the course over 15 weeks.

Week	Work
1	Unit 1.- Uncertainty and probability. 1st computer-aided practicum
2	Unit 2.- Random magnitudes
3	Unit 3.- Discrete probability models. 2nd computer-aided practicum
4	Unit 4.- Continuous probability models
5	Unit 5.- Joint analysis and limit theorems
6	Unit 5.- Joint analysis and limit theorems
7	Unit 6.- Introduction to sampling. Estimators.
8	Unit 7.- Inferential Tools. Distributions associated with sampling
9	Unit 8.- Interval estimation. 3rd computer-aided practicum
10	Unit 9.- Introduction to hypothesis testing
11	Unit 9.- Introduction to hypothesis testing
12	Unit 10.- Parametric tests
13	Unit 10.- Parametric tests
14	Unit 11.- Non-parametric tests
15	Unit 11.- Non-parametric tests. 4th computer-aided practicum

Assessment

The evaluation of the course is based on two elements:

1. **Continuous assessment** of the effort and the work developed by students throughout the course, through two tests (on the first and second parts of the course) that will allow students to know whether they have understood course content's.

2. **Final exam,** consisting of a test set, to assess the knowledge acquired by students and their ability to apply statistical tools to analyze and solve study problems in the economic and business fields.

Surfing on web course contents

For each lesson students should start by checking the corresponding lecture assisted by the reference material. Then, they should go to the practice section and carry out the proposed exercises for each lesson.

Once completed the first part of the course, students should check their assimilation of contents by doing Test 1 (doing the same at the end of the second part of the course with Test 2).

Finally, students should do the final exam in order to test whether they have successfully followed the course.

Resources, bibliography and additional documents

The following references are helpful for this subject:

Basic Bibliography

WALPOLE, R.E.; MYERS, R.H.; MYERS; S.L.; KEYING, E. (2011): *Probability and Statistics for Engineers and Scientists (9th Edition)*. Ed. Prentice Hall.

Complementary Bibliography

DOWNING, D.; CLARK, J. (2010): *Business Statistics*. Barron's Educational Series.

NEWBOLD, P., CARLSON, W., THORNE, B. (2008): *Statistics for Management and Economics*. Ed. Prentice Hall.

ANDERSON, D.R.; SWEENEY, D.J.; WILLIAMS, T.A. (2011): *Statistics for Business and Economics*. Thomson Press (India) Ltd.

WACKERLY, D.; MENDENHALL III, W.; SCHEAFFER, R.L. (2008): *Mathematical Statistics With Applications.* Ed. Thomson.

BREMNER, J.M.; MORGAN, B.J.T.; JOLLIFFE, I.T.; JONES, B.; NORTH, P.M.; E. E. BASSETT; E.E. (2000): *Statistics: Problems and Solutions*. World Scientific Publishers.

OLSON OLTMAN, D.; LACKRITZ, J.R. (1991): *Statistics for Business and Economics*. Ed. Brooks/Cole Publishing Company.

CANAVOS, G.C. (1984): Applied Probability and Statistical Methods. Ed. Little, Brown and Company.

CHOU, Y.L. (1989): Statistical Analysis for Business and Economics. Ed. Elsevier.