FUNDAMENTALS OF PROBABILITY AND STATISTICS

Grado en Comportamiento y Ciencias Sociales BBSS SEP-2023 FPS-BS.1.S.A

Area Data Science

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Degree course: FIRST

Number of credits: 6.0

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Category: BASIC

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Luis Vivanco is an Adjunct Professor of Operations and Supply Chain Management and of Decision Making at IE Business School.

He started his career as a SCM Engineer in 1989 after receiving a BSc in Industrial and Systems Engineering at Tec de Monterrey in Mexico and an MSc in Information Management from the University of Lancaster in the UK. In his role he was the in-site representative for a US range control manufacturer with their largest customer in Mexico, an alliance between GE Appliances and Mexico's MABE, dealing with logistics, production planning and quality issues.

In 1993 he did a Master in Business Administration at the International Institute for Management Development (IMD) in Switzerland. Following his MBA he worked in several strategy and business development roles with service MNCs. In parallel, since 1996, he has collaborated in research and consulting projects in SCM with companies like LEGO, Unilever, Harley-Davidson or Philips, writing cases on the subject, including one on Numico that deserved the Best Case recognition in the SCM category in the EFMD Case Writing Competition. He was also a participant in the Value Chain 2020 Forum organized by IMD with the sponsoring of companies like Nestle, Philips, GSK, Shell, LEGO or Grundfos, among other. The Forum looked at the value chain challenges facing companies over the next decade. He is the co-author of "The Value Chain Shift", which was published as the result of this forum.

Academic Background

- Master in Business Administration, IMD International, Switzerland

- MSc in Information Management, Lancaster University, UK

- BSc in Industrial Engineering, Tecnológico de Monterrey, Mexico

- Strategic Negotiations Program, Harvard Business School, USA

Academic Experience

Edited by Documentation
31th August 2023

Since 1996, Research Associate (external), IMD International. Over 15 written cases on Value Chain Management, Strategy and Change Management. Co-Author of "The Value Chain Shift" with focus on managing resource scarcity and on corporate social responsibility through the value chain.

Corporate Experience

- Consultant on Strategic development, decision making processes and value

  chain management. Clients include The LEGO Group, Unilever, Sigma Alimentos (owner

  of Campofrio) and MABE Appliances.

- Director of Strategy and International Business at British Telecom. SCM Specialist at

  GE Appliances.

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SUBJECT DESCRIPTION

Statistics is the science of data. It uses mathematical tools to collect, organize, process, and summarize data; make estimates using probability rules; and draw inferences that will affect decision-making in uncertain environments. In the social sciences, statistics help identify interesting questions, explore data sets, and correctly interpret results to make solid, evidence-based conclusions. Students enrolled in this course will learn how to examine, organize, and read data and how to make informed decisions. In addition, this course provides the theoretical and practical bases for other courses in the bachelor in Behavior and Social Sciences, such as Fundamentals of Data Analysis, Simulating and Modelling to Understand Change, and Quantitative Tools for Studying People.

LEARNING OBJECTIVES

The objective of this course is to provide students with the tools to delve into data sets and to make use of this information in business, social and behavioral applications. At the end of each module, students should be able to:

Module 1:

- Describe data by means of graphs or numbers, and understand in whichcontext each of these descriptive tools are useful.

Module 2:

- Understand patterns of randomness and relate them to known probabilitydistributions.

Module 3:

- Identify the differences between population and sample distributions.

- Calculate through software the probabilities associated to common probabilitydistributions.

Additionally, the course will focus on the acquisition or reinforcement of generic skills:

- The ability to clean and organize datasets in order to analyze them.

- The ability to summarize and present information in a meaningful way.

- The ability to build an abstract model to address a research problem.

- The ability to quickly identify the tools that need to be used in businesssituations.

TEACHING METHODOLOGY

IE University teaching method is defined by its collaborative, active, and applied nature. Students actively participate in the whole process to build their knowledge and sharpen their skills. Professor's main role is to lead and guide students to achieve the learning objectives of the course. This is done by engaging in a diverse range of teaching techniques and different types of learning activities such as the following:

Learning Activity	Weighting	Estimated time a student should dedicate to prepare for and participate in
Lectures	20.0 %	30.0 hours
Discussions	10.0 %	15.0 hours
Exercises in class, Asynchronous sessions, Field Work	20.0 %	30.0 hours
Group work	30.0 %	45.0 hours
Individual studying	20.0 %	30.0 hours
TOTAL	100.0 %	150.0 hours

PROGRAM

CONTENT

The theoretical content of this course consists of three parts, each of them divided into several modules. The first part covers descriptive statistics and focuses on the graphical and numerical procedures that are used to summarize, organize, and process data. The second part discusses probability axioms and basic discrete and continuous probability distributions. The third part consists in an introduction to sampling distributions. In the lab sessions, students will work in groups solving exercises related to the theoretical sessions.

All the required readings are from the compulsory textbook "Statistics for Business and Economics", Macclave, Benson & Sincich, 13th global edition. Prior to all sessions, you should read assigned textbook sections. Reading the textbook in advance will allow you to get the most out of each lecture. Supplementary reading from the online (free) book OpenIntro Statistics (https://www.openintro.org/) is recommended (but not required) if students have difficulties understanding some concepts.

Note: The following description of the material covered is tentative. An attempt will be made to cover all listed topics. However, the pace of the course will depend on the group performance.

SESSION 1 (LIVE IN-PERSON)

Topics: Introduction to the course

Activities: Lecture, practical examples, class discussion Content:

-Introduction and presentation of the course syllabus and objectives. -Basic statistical concepts. Variables and levels of measurement.

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 1, Sections 1.1. – 1.3.

Supplementary Reading (optional)

·Book "Statistics for Business and Economics": Chapter 1, Sections 1.6., 1.7.

SESSION 2 (LIVE IN-PERSON)

Topics: Introduction to statistics

Activities: Lecture, practical examples, exercises.

Content:

-Presentation of some graphical tools to summarize different types of data.

-Organizing data into tables and charts. Frequency distribution tables. Using graphs to summarize data (bar graph, pareto diagram and histograms).

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 1, Section 1.5.; Chapter 2, Section 2.1., 2.2.

Supplementary Reading (optional)

·Book "Statistics for Business and Economics": Chapter 1, Sections 1.6., 1.7.

SESSION 3 (ASYNCHRONOUS)

Topics: Describing data using numerical measures

Activities: Video lectures, practical cases after each video lecture, forum discussion, final test.

Content:

- Measures of central location: Mean, mode, median.

- Measures of dispersion: range, variance, and standard deviation.- Chebyshev's Rule and Empirical rule

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 2, Sections 2.3- 2.5.

Supplementary Reading (optional)

·Book "OpenIntro Statistics": Chapter 2

SESSION 4 (ASYNCHRONOUS)

Topics: Describing data using numerical measures (cont.)

Activities: Video lectures, practical cases after each video lecture, forum discussion, final test.

Content:

- Measures of relative standing

- Boxplots

- Relationship between two variables: Scatterplots

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 2, Sections 2.7- 2.8, 2.10

Supplementary Reading (optional)

·Book "OpenIntro Statistics": Chapter 2

SESSION 5 (LIVE IN-PERSON)

LABS: Working on exercises and problems to practice what was learnt in Session 1, 2, 3 and 4.

Activities: (Work in groups) Homework and problem sets from MyStatLabs, in-class discussion.

SESSION 6 (LIVE IN-PERSON)

Using Technology: R software

Activities: video lectures explaining R studio, short exercises in R Studio to practice the commands shown in the video lectures, forum discussion, and individual assignment.

Content: Basic introduction to R studio.

-Install R and R studio

-Explanation of R Studio interface -Types of objects

Required Reading (to be done in advance)

From the book of Danielle Navarro (Learning Statistics with R): Chapter 3.

SESSION 7 (LIVE IN-PERSON)

Using Technology: R software (cont.)

Activities: Lecture, short exercises in R Studio to practice the commands, class discussion.

Content: Basic introduction to R

-Importing dataset

-Install packages

-Manipulating objects

Required Reading (to be done in advance)

From the book of Danielle Navarro (Learning Statistics with R): Chapter 4

SESSION 8 (ASYNCHRONOUS)

Topics: Probability and its postulates (Part 1)

Activities: Video lectures, study cases using a visualization tool, problem set, final test.

Content:

- Basic terminology.

- Probability axioms: addition and multiplication rules.

- Computing the probabilities of processes of interest.

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 3, Sections 3.1 – 3.4. From section 3.1, skip combination rule section)

Supplementary Reading (optional)

·Book "OpenIntro Statistics": Chapter 3

SESSION 9 (ASYNCHRONOUS)

Topics: Probability and its postulates (Part 2)

Activities: Video lectures, study cases using a visualization tool, problem set, final test.

Content:

- Probabilities of joint and marginal events - Conditional probabilities

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 3, Sections 3.5-3.7.

Supplementary Reading (optional)

·Book "OpenIntro Statistics": Chapter 3

SESSION 10 (LIVE IN-PERSON)

LABS: Working on exercises and problems to practice what was learnt in Session 8-9.

Activities: Work in groups: Homework and problem sets from MyStatLabs, class discussion

SESSION 11 (LIVE IN-PERSON)

Topics: Random variables

Activities: Lecture, demonstration of how to solve different exercises (manually and using R studio, 20'), exercises in groups with R Studio and MyStatLab.

Content:

- Definition of random variables: Expected value, variance. - Discrete and continuous random variables.

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 4, Sections 4.1.

SESSION 12 (ASYNCHRONOUS)

Topics: Discrete random variables

Activities: Video lectures, study cases, individual exercises (MyStatLab).

Content:

- Discrete random variables.
- Probability functions and properties (expected value and variance)
- Chebyshev's Rule
- Cumulative probabilities

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 4, Sections 4.2.

SESSION 13 (LIVE IN-PERSON)

Topics: Discrete probability distributions (cont.)

Activities: Lecture, practical examples, problem sets in groups (to solve manually and using R studio).

Content:

- Discrete probability distribution (small review) - Binomial probability distribution

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 4, Sections 4.3 and 4.4

Supplementary Reading (optional)

·Book "OpenIntro Statistics": Chapter 4, Section 4.3., 4.5.

SESSION 14 (LIVE IN-PERSON)

Topics: Discrete probability distributions (cont.)

Activities: Lecture, practical examples, problem sets in groups (to solve manually and using R studio).

Content:

- Binomial probability distribution (cont.)
- Mean and variance of Binomial probability distribution

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 4, Sections 4.3.

SESSION 15 (LIVE IN-PERSON)

Topics: Discrete probability distributions (cont.)

Activities: Lecture, practical examples, problem sets in groups (to solve manually and using R studio).

Content:

- Other discrete probability distributions: The Poisson distribution

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 4, Sections 4.1.

SESSION 16 (LIVE IN-PERSON)

LABS: Working on exercises and problems to practice what was learnt in Session 11-15.

Activities: (Individual) Homework and problem sets from MyStatLabs and forum discussion.

SESSION 17 (LIVE IN-PERSON)

REVIEW SESSION: In this session, we will review the content of the previous sessions and work on exercises to prepare for the midterm exam.

SESSION 18 (LIVE IN-PERSON)

MIDTERM EXAM

SESSION 19 (ASYNCHRONOUS)

Topics: Continuous random variables and important continuous distributions.

Activities: Lecture, practical examples, problem sets (to solve manually and using R studio).

Content:

-Definitions and properties of a continuous distribution -The Normal distribution

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 4, Sections 4.5 – 4.6.

Supplementary Reading (optional)

·Book "OpenIntro Statistics": Chapter 4, Section 4.1.

SESSION 20 (LIVE IN-PERSON)

Topics: Continuous random variables and important continuous distributions (cont.) Activities: Lecture, practical exercises (manually and in R studio), class discussion.

Content:

- Learning how to derive probabilities from a normal distribution using tables and using R. - Assessing normality in continuous random variables.

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics": Chapter 4, Section 4.7

SESSION 21 (LIVE IN-PERSON)

LABS: Working on exercises and problems to practice what was learnt in Session 19-20.

Activities: (Individual) Homework and problem sets from MyStatLabs, forum discussion.

SESSION 22 (LIVE IN-PERSON)

Topics: Continuous random variables and important continuous distributions (cont.) Activities: Lecture, practical exercises (manually and in R studio), class discussion.

Content:

- Other continuous probability distributions: t-Student distribution and Chi-square distribution.

Required Reading (to be done in advance):

There is no required reading for this session, only the material provided by the professor.

SESSION 23 (LIVE IN-PERSON)

Topics: Continuous random variables and important continuous distributions (cont.) Activities: Lecture, practical exercises (manually and in R studio), class discussion.

Content:

- Other continuous probability distributions: F-Snedecor distribution.

Required Reading (to be done in advance)

There is not required reading for this session, only the material provided by the professor.

SESSION 24 (LIVE IN-PERSON)

LABS: Working on exercises and problems to practice what was learnt in Session 22-23

Activities: (Individual) Homework and problem sets from MyStatLabs, forum discussion.

SESSION 25 (LIVE IN-PERSON)

Topics: Sampling, sampling distribution of sample means and proportions.

Activities: Lecture, practical exercises (in groups) with visualization tools, R Studio and MyStatLab.

Content:

- Brief introduction to sampling methods
- Random samples
- Distribution of sample means

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics", Chapter 5: Sections 5.1 – 5.2.

SESSION 26 (LIVE IN-PERSON)

Topics: Sampling, sampling distribution of sample means and proportions (cont.)

Activities: Video lecture, practical exercises (in groups) using a visualization tool for Central Limit Theorem, individual exercises in MyStatLab, final test.

Content:

- Central Limit Theorem
- Sampling distributions of sample proportions

Required Reading (to be done in advance)

·Book "Statistics for Business and Economics", Chapter 5: Sections 5.3 and 5.4.

SESSION 27 (LIVE IN-PERSON)

LABS: Working on exercises and problems to practice what was learnt in Session 25-26.

Activities: Work in groups: Homework and problem sets from MyStatLabs, in-class discussion

SESSION 28 (LIVE IN-PERSON)

Presentation of group projects (more information below) and general review

SESSION 29 (LIVE IN-PERSON)

Presentation of group projects (more information below) and general review

SESSION 30 (LIVE IN-PERSON)

FINAL EXAM

EVALUATION CRITERIA

criteria	percentage	Learning Objectives	Comments
Final Exam	35 %		
Intermediate tests	20 %		Midterm exam
Individual work	10 %		Quizzes
Group Presentation	20 %		Group project
Class Participation	15 %		

RE-SIT / RE-TAKE POLICY

A. Exams (20% and 35%)

There will be one midterm and one final exam. For these exams, you must bring your own simple calculator (phones, tablets, laptops, and other electronic devices are not allowed). You are also allowed to bring up one-sided A4 SHEET paper for the midterm (two sides in the final exam) with any formulae that you think could be helpful. THE CHEAT-SHEET ALONG WITH ANY SCRAP PAPER WILL BE COLLECTED AND STAPLED TO YOUR EXAMS. In order to pass the course,

you need a minimum grade of 6 in the final exam (in a scale from 1 to 10). If your grade in the final exam does not reach the threshold value of 6, you will fail the course, even in the case in which your weighted average (computed using the table above) exceeds 5.0. In conclusion, to pass the course, the average grade should be at least 5 (this grade is obtained using the weights described on the Evaluation Criteria table) and the score on the final exam has to be at least 6. This rule does not apply for the midterm exam. Notice that the date of the midterm could change and need to be considered with flexibility. The precise date will be communicated to students two weeks ahead of time. The retake exam will take place in June 2022, and students will be evaluated of all the contents of the course.

B. Group report and presentation (20%)

The group project is an integral part of this course. It consists of the identification of a real-world problem, the formulation of appropriate hypotheses, the collection and statistical analysis of data, and the presentation and interpretation of obtained results. More information about this project will be available at Campus Online.

Throughout the semester, each group (composed of 5-6 students) will be asked to submit three sections. Dates for these submissions will be announced in the beginning of the course. These sections will be corrected by the professor and returned to the group. A final report and presentation are due at the end of the course.

At the end of the semester, you must submit the full report including all sections described in the document that explains how the group project has to be carried out (available on the Campus Online). Information (description, specifics, etc.) related to each section as well as the final report (format, content, etc.) and presentation (time, format, content, etc.) which be available on Campus Online/Documents.

C. Quizzes (10%)

All asynchronized-theoretical sessions will end up with a small quiz/test based on previously covered material. These quizzes will help you assess your overall understanding of the subject being studied and identify any caveat in your learning. Not submitting the final test means a score of 0. NO MAKE UP FOR QUIZZES WILL BE PERMITTED.

D. Class participation and discussion (15%)

Three main criteria will be used in reaching a judgment about your class participation:

1- Assistance: Assistance to class is compulsory. (1) Students must comply with the 70%attendance rule. Otherwise, they will lose their 1st and 2nd chance and go directly to the 3rd one (they will need to enroll again in this course next academic year). (2) Punctuality will be taken into consideration when grading this assistance item and the teacher reserves the right to allow attendance to class to those students not being on time. Finally, (3) general attitude and behavior in class will be also considered. Students affecting the class environment in a negative way will lose points in the assistance grade. In asynchronous sessions, assistance will be evaluated by completing the study case exercises.

2- (Active) Class participation: participation in class will be evaluated positively if students: (1) attaina threshold quantity of contributions that is sufficient for making a reliable assessment of comment quality. Additionally, (2) participation will be evaluated in quality terms. A high-quality comment reveals a depth of insight, rigorous use of case evidence, consistency of argument, and realism. A high-quality presentation of ideas must consider the relevance and timing of comments and the flow and content of the ensuing class discussion. It demands comments that are concise and clear, and that are conveyed with a spirit of involvement in the discussion at hand. In the asynchronous session, the active participation will be evaluated through the interactions in the forum discussion (Blackboard), and through the completion of the activities that are proposed.

MyStatLab (homework): Students may solve exercises and quizzes using the platformMyStatLab. Students will receive feedback about their submitted answers in an easy way. Only the completion of these exercises will be evaluated, not the grade obtained in these exercises. It is highly recommended that you solve these exercises by hand and using R-Studio.

BIBLIOGRAPHY

Compulsory

 - Mcclave, J.T, Benson, P.G., & Sincich, T.. (2018). *Statistics for Business and Economics. 13th edition.* 13th. Pearson Prentice Hall. ISBN ISBN97812922 (Digital)

   The electronic version of this textbook is freely available on IE Campus

Recommended

 - Diez, David; Barr Christopher; Cetinkaya-Rundel, Mine.. *OpenIntro Statistics..* 2nd. Openintro. ISBN ISBN19434500 (Digital)

   This textbook is supplementary and can be used to review some of the topics presented in class, to find extra exercises, etc. The textbook is offered under a Creative Commons license at https://www.openintro.org/.

   https://www.openintro.org/.

 - Danielle Navarro. *Learning statistics with R: A tutorial for psychology students and other beginners..* ISBN ISBN97813261 (Digital)

BEHAVIOR RULES

Please, check the University's Code of Conduct here. The Program Director may provide further indications.

ATTENDANCE POLICY

Please, check the University's Attendance Policy here. The Program Director may provide further indications.

ETHICAL POLICY

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