# Statistics

## Prof. Gabriele Cantaluppi

***COURSE AIMS AND EXPECTED LEARNING OUTCOMES***

The aim of the course is to provide students with the quantitative knowledge and abilities to construct and interpret synthetic indexes for data arising in economic, business, and social phenomena. The course will provide also instruments to analyse the relationships between two or more variables, as well as basic elements of probability theory and random variables.

The following learning abilities are provided and expected to be achieved by participants at the end of the course:

1. Knowledge of concepts, terms and methods concerning descriptive statistics and probability (DD1- Knowledge and understanding).
2. Ability to correctly apply descriptive statistics and probability methods to problems arising in economics and management applications (DD2- Applying knowledge and understanding).
3. Quantitative thinking to make independent judgements, driven by descriptive and probabilistic statements (DD3- Making judgements).
4. Ability to read, interpret and communicate data driven results, through the extraction of qualitative information from data (DD4-Communication).
5. Mastery of tools useful for quantitative analyses in courses that the students will take later in the curriculum, as well as for simple quantitative analyses required in future careers involving management of data, rigorous reasoning and data-driven decision-making (DD5- Lifelong learning skills).

***COURSE CONTENT***

*Statistical methodology and scientific research.*

Statistical approach in natural and social sciences. The statistical analysis process: data gathering, classifying, examining and processing (statistical units, variable types, frequency distributions). Descriptive and inductive approach.

*Univariate analysis.*

– Measurement scales.

– Graphical displays of data.

– Definition and proprieties of location indices: Non-analytical mean values (mode, percentage points). Algebraic means (arithmetic, quadratic, geometric, harmonic). Mean selection criteria.

– Variability and dissimilarity measures: Indices of variability (variance, average differences). Indices of dissimilarity (mutability/heterogeneity). Absolute, relative and normalised indices.

– The analysis of variance.

– Shape indices.

– Box & Whisker Plots.

– Index numbers. Simple and weighted, fixed base and changing base index numbers. Consumer price indices.

#### Multivariate analysis

– Analysis of conditional distributions. Definition of stochastic independence. Association, dependence and correlation.

– Measures of association (between two categorical variables).

– Measures of dependence. Study of the average relationship between two variables. Ordinary least squares and the regression function. Analysis of variance and the correlation ratio. Statistical interpolation by using conditional mean values. Measures of linear dependence.

 \* The regression line and the linear correlation coefficient.

 \* Review of multiple linear regression model. Interpretation of a regression output obtained by means of standard software. The use of *dummy* variables in regression problems.

*Elements of probability theory.*

– Definition of probability and basic theorems.

– Conditional Probability and the Bayes’ theorem.

– Definition of random variable.

– Univariate probability models (uniform, binomial, hypergeometric, normal).

– Moments of random variables and their linear transformation.

– The central limit theorem.

##### READING LIST

G. Boari, G. Cantaluppi, *Notes of Descriptive Statistics and Probability*, EDUCatt, Milano, 2022.

L. Bertoli Barsotti, *Probabilità: aspetti storici ed assiomatizzazione*, EDUCatt, Milano, 1998.

Further readings:

S. Borra-A. Di Ciaccio, *Statistica. Metodologie per le scienze economiche e sociali,* Mc-Graw-Hill, Milano, 2021, 4a ed. [Gli argomenti del programma sono trattati nei capp. 1-9, 15].

G. Cicchitelli-P. D’Urso-M. Minozzo  *Statistica: principi e metodi,* Pearson, Milano, 2018 (3a ed.). [capp. 1-14].

B.V. Frosini, *Metodi statistici: teoria e applicazioni economiche e sociali,* Carocci, Roma, 2009.

[ch. 1-5, 6 (only sect. 1), 7 (sect. 1-4,6), 8 (sect. 1-3,6,8,9), 9-10, 11 (sect. 1-4 reading)].

L. Santamaria, *Statistica descrittiva: applicazioni di carattere economico e aziendale,* Vita e Pensiero, Milano, 2006.

A. Zanella, *Elementi di statistica descrittiva. Una presentazione sintetica*, CUSL, Milano, 2008.

***TEACHING METHOD***

Lectures with exercises.

***ASSESSMENT METHOD AND CRITERIA***

The assessment consists of a written exam followed by an oral exam.

The written exam is made by 4 exercises and 8 theoretical questions, each with three possible answers. The first exercise is referred to univariate statistics and association, the second one to index numbers (maximum score of the first two exercises 14/31 points); the third exercise concerns regression and the fourth one probability (maximum score of the third ad fourth exercises 14/31 points). Each correct and justified response to theoretical questions gives 0.75 points; a penalty of -0.25 points is assigned to each wrong answer; no given answers have no points and no penalty (maximum score 6 points). Available time: 90 minutes.

The oral exam can be made only if the score of the written part is no lower than 17/31. The oral exam consists of two questions (only one question if at least 6 theoretical questions were answered correctly) and gives a score in the interval between -4 and +4 points.

Students attending class regularly have the possibility to substitute the written exam with two partial tests which contribute equally to the final evaluation: the first test (two exercises and 4 theoretical questions) is planned during the class period and the second one during the winter exam session. More detailed information about the assessment process are available on the e-learning platform *Blackboard.*

The aim of the exam is to assess reasoning analytic abilities on the course subjects. Language properties and communication abilities are also assessed.

***NOTES AND PREREQUISITES***

Students are suggested to attend the course of Statistics after having passed the exam of Mathematical Methods for Economics.