UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Advanced Statistics

**2627-1-F7704M020-F7704M020-1**

## Learning objectives

The course aims at introducing the main concepts of statistical reasoning. When analysing a dataset, students will be able to formalise a statistical problem and to identify probabilistic tools and suitable statistical methods for the data. The focus of the module will be on the rationale underlying basic statistical methods so that students might develop an autonomous critical approach and be able to understand and apply statistical techniques, even if not covered by the syllabus of this module.

Knowledge and Understanding (Dublin Descriptor 1)

In relation to "Knowledge and Understanding", the student will acquire the fundamental concepts and methods of statistical analysis, including descriptive statistics, probability theory, random variables and their distributions, sampling distributions, statistical estimation and hypothesis testing. The student will also acquire the basic principles of linear regression and statistical data analysis.

Ability to Apply Knowledge and Understanding (Dublin Descriptor 2)

The student will demonstrate "Ability to apply knowledge and understanding" by applying statistical methods to practical problems involving the analysis and interpretation of data. The student will be able to calculate and interpret descriptive statistics and probabilities, construct estimates, perform hypothesis tests and apply linear regression models. These skills will be further developed through practical exercises using Stata.

Autonomy of Judgment (Dublin Descriptor 3)

The student will develop "Autonomy of judgment" by learning to select appropriate statistical methods according to the characteristics of the problem and the available data, critically evaluate statistical results and draw appropriate conclusions from empirical evidence.

Communication Skills (Dublin Descriptor 4)

The student will develop "Communication skills" (Dublin Descriptor 4) through the ability to present and interpret statistical analyses and results using appropriate statistical terminology, numerical summaries and graphical representations. Practical activities with Stata will further develop the ability to communicate findings based on empirical data.

Learning Skills (Dublin Descriptor 5)

The student will develop "Learning skills" through the acquisition of conceptual and methodological tools that will enable them to approach statistical problems independently, connect theoretical concepts with practical applications and further develop their knowledge of statistical methods and data analysis.

## Contents

- Using statistics to summarise datasets
- Essential review of probability theory
- Distribution of sampling statistics
- Estimation
- Testing statistical hypothesis
- Linear regression
- Data analysis with Stata

## Detailed program

Using statistics to summarise datasets

- Populations and samples
- Sample mean
- Linearity of sample mean
- Deviations
- Sample median
- Sample percentile
- Sample quartiles
- Sample mode
- Sample variance and standard deviation
- Property of sample variance
- Sample correlation coefficient and interpretation

Essential review of probability theory

- random experiment, sample space, events
- defining properties of probability
- frequentist interpretation of probability
- probability of the complement and addition rule
- equally likely outcomes
- independent events
- random variables (RV)
- discrete RVs
- distribution of a RV
- expected value of a discrete RV

- properties of the expectation
- variance of a discrete RV (equivalent definitions)
- Bernoulli RV
- Binomail distribution, with derivation
- Factiorial numbers and binomail coefficient
- continuous RVs
- probability density function of X and P(a

## Prerequisites

Basic calculus and descriptive statistics

## Teaching methods

The course will consist of a total of 35 hours of classes, of which 27 regular classes and 8 lab sessions (with Stata)

## Assessment methods

The exam is written and consists of questions about theory and exercises. The former verify students' knowledge and understanding of the main concepts of the subject; the latter measure students' ability in the application of such concepts to solve simple practical problems.

## Textbooks and Reading Materials

Textbook: Sheldon Ross, Introductory Statistics (4th edition)

Other material is provided during the course

## Semester

First semester (second cycle)

## Teaching language

English

## Sustainable Development Goals

QUALITY EDUCATION