

ELEMENTARY STATISTICS SYLLABUS, ACADEMIC YEAR 2025-2026

“La filosofia scritta in questo grandissimo libro che continuamente ci sta innanzi agli occhi (io dico l'universo), ma non si può intendere se prima non s’impara a intendere la lingua e a conoscere i caratteri, nei quali è scritto. Egli è scritto in lingua matematica, e i caratteri son triangoli, cerchi ed altre figure geometriche, senza i quali mezzi è impossibile a intendere umanamente parola; senza questi un aggirarsi vanamente per un oscuro laberinto.” - Galileo Galilei (1564-1642).

This short course aims to enable students to analyze with statistical methods real-world data from physics, humanities and, above all, engineering.

1) Descriptive statistics.

Populations and samples. Categorical variables and numerical variables (discrete and continuous). Absolute, relative, and percentage frequencies. Frequency distributions and their graphs. Sample statistics. Position indices: mode, median, and mean: advantages and disadvantages. Properties of the mean. Mean computed from frequencies. Indices of dispersion: sample variance and standard deviation. Data pairs: scatterplot. Covariance and its properties. Correlation coefficient between variables. Properties of the correlation coefficient. Linear regression and the least squares method. Regression line: parameters estimates.

2) Probability and inferential statistics.

The concept of probability. Random experiments, sample space, events. Axiomatic definition of probability and fundamental theorems. Random variables. Discrete variables: probability distribution, distribution function, expected value, and variance. Continuous variables: probability density, distribution function, expected value, and variance. Normal or Gaussian variables: distribution and properties. The law of large numbers and the central limit theorem. Pointwise, unbiased, and efficient estimators. Expected value and distribution of sample mean and sample variance (known and unknown probabilistic mean).