



University of Messina - Master's Degree in Mathematics

Advanced Statistics

(Prof. Filippo D. Cammaroto)

Academic Year 2025/2026

1. Review of Probability Theory (8 hours)

Random phenomena. Axiomatic approach to probability. Probability spaces. Conditional probability. Random variables. Discrete probability distributions. Probability density functions. Various types of discrete probability distributions. Continuous probability distributions. Relationships among distributions and approximation methods. Mean, variance, and moments.

2. Descriptive Statistics (6 hours)

Frequency distributions. Graphical representation of frequency distributions. Measures of central tendency and dispersion. Computation of the mean and variance for grouped data. Shape of a distribution. Correlation between variables. Least squares method. Linear regression. Polynomial regression. Linearization methods.

3. Elementary Sampling Theory (6 hours)

Populations and samples. Sampling methods. Sampling distributions. Distribution of the sample mean (known variance). Distribution of the sample mean (unknown variance). Distribution of the sample variance.

4. Parameter Estimation (12 hours)

Point estimation and interval estimation. Confidence intervals for the mean (known variance). Confidence intervals for the mean (unknown variance). Confidence intervals for a proportion. Confidence intervals for the difference between two means (known variances). Confidence intervals for the difference between two means (unknown variances). Confidence intervals for the difference between two proportions. Confidence intervals for the variance and the standard deviation. Confidence intervals for the ratio of two variances.

5. Hypothesis Testing (12 hours)

Statistical hypotheses. Types of errors and significance level. Hypothesis tests for the mean (known variance). Hypothesis tests for the mean (unknown variance). Hypothesis tests for a proportion. Hypothesis tests for the difference between two means (known variances). Hypothesis tests for the difference between two means (unknown variances). Hypothesis tests for the difference between two proportions. Hypothesis tests for the variance and the standard deviation. Hypothesis tests for the ratio of two variances.

6. Statistical Tests (4 hours)

An introductory Student's t-test. Critical significance level. Student's t-test. Fisher's F-test. The two chi-square tests: the chi-square goodness-of-fit test and the chi-square test of independence.

Recommended Textbooks

- A. M. Mood, F. A. Graybill, D. C. Boes, *Introduction to the Theory of Statistics*, McGraw-Hill.
- A. Sgarro, L. Franzoi, P. Vicig, *Statistica di base*, Zanichelli.
- P. Newbold, W. Carlson, B. Thorne, *Statistics for Business and Economics*, Pearson.