# Rudiments in Statistical Inference

## Prof. Diego Attilio Mancuso

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course completes the presentation of statistical methods by addressing the issues of estimation and hypothesis testing concerning the mean and variance of a normal population, the proportion of success in a Bernoulli population and the multiple regression model considered under the condition of a homoskedastic error component and not correlated with the explanatory variables.

At the end of the course, students are expected to be able to:

– determine the estimator of a parameter obtained with the maximum likelihood estimation method;

– calculate confidence intervals and conduct hypothesis tests on a population for the mean and variance of a *normal* distribution and the proportion of successes in a *Bernoulli*distribution;

– compare the mean of a character in two populations by applying the student's *t-test* in its different versions.

– obtain the ordinary least squares estimates for a multiple regression model and calculate the ANOVA test attached to it;

– know the main variable selection mechanisms such as *Akaike* information criterion or *stepwise* procedures.

– correctly interpret the results of an automatic processing programme dedicated to homoskedastic linear regression models.

***COURSE CONTENT***

– *Summary of probability* - Random variables and expected value operator. The *Gaussian*random variable. The problems of sampling from a population and the distribution of the sample mean of a character.

– *Point and interval estimation*– Consistency and unbiased estimator. The *log-likelihood* function and the *maximum likelihood* estimates. Notes on the *method of moments*. The confidence intervals.

– *Hypothesis testing*– Systems of hypotheses and decision rules. The *chi-square* test for contingency tables. The significance tests on the mean, variance, and proportion. The observed significance level (*p–value*). *Student's t-tests* for comparing the means of two populations in the case of *normal* or *Bernoulli* distribution.

– *Stochastic linear regression model*– The sample distribution of the model parameters. *Gauss–Markov* assumptions and *maximum likelihood* estimates. Confidence intervals and hypothesis testing on individual coefficients. The ANOVA test on the overall fit of the model. Variable selection methods: the partial ANOVA test and stepwise procedures, the *Akaike* and *Bayesian* information criteria.

***READING LIST***

Textbooks (more details will be given at the beginning of the course)

S. Ross, *Introduzione alla statistica*, Apogeo educational – Maggiolieditore.

Complementary texts

M. Pelosi, T. Sandifer, *Introduzione alla statistica*, McGraw – Hill Educational.

B.V. Frosini, *Analisi di regressione,* con *Appendice su Vettori e matrici*, EDUCatt, Milan.

***TEACHING METHOD***

Lectures and practical exercises.

***ASSESSMENT METHOD AND CRITERIA***

Written test divided into four sections consisting of exercises only, or three exercises and a theoretical question. The topics covered by the exercise or theoretical question are the following: *a)* the search for estimators obtained with the *maximum likelihood* method and the calculation of estimates by interval; *b)* the hypothesis test concerning *Bernoulli* and *normal* population parameters (with calculation of the *p-value*) and the *chi-squared* test on the contingency tables; *c)* the *student’s t test* for the comparison between the means of two populations; *d)* the estimation of a multiple regression model, the ANOVA test and the variable selection methods. Each section contributes equally to the final evaluation.

***NOTES AND PREREQUISITES***

Prerequisites for the course are the contents learnt in the courses of Statistics I and General Mathematics.In case the current Covid-19 health emergency does not allow frontal teaching, remote teaching will be carried out following procedures that will be promptly notified to students

Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=ENG or on the Faculty notice board.