***Applied Statistics*** **(9 CFU)**

Coordinator: Marcello Fidaleo
Other instructors: Ines Delfino, Luca Secondi, Roberto Moscetti
Objectives: The aim of the course is to supply the basic statistical concepts necessary for the statistical analysis of data and the design and analysis of experiments. The course is organized in modules.

Programma:

| | Modulo | Docente | CFU |
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| 1. | Definition and description of statistical phenomena. Frequency distribution and graphical representations. Descriptive statistics and exploratory data analysis. location, variability and shape measures. Histograms, box-plots and dot-plots. Association measures for qualitative and quantitative characters. Independence, dependence and interdependence.<br>Probability: random experiment and events. Classical, frequentist and subjective approaches to probability. Axiomatic approach to probability. Conditional probability. Bayes theorem and introduction to Bayesian inference.<br>Definition of random variable. Continuous and discrete random variables. The mass probability function, the density function and the cumulative distribution function. Definition, main properties and applications of some probability distributions: Bernoulli and Binomial distributions, Poisson distributions, Normal and standardized normal distribution, Chi squared distribution, Student's t distribution and F distributions. Excel use for statistical analysis. | L. Secondi | 1 |
| 2. | Introduction to sampling. Population and sample. Population parameters, sample statistics and sampling distributions. Sample design. Probabilistic and non-probabilistic sampling methods: definition, main properties and characteristics of selected types of sampling. | L. Secondi | 1 |
| 3. | Confidence interval for the mean and the proportion. Theory of hypothesis tests. Hypothesis test for the mean and the proportion. Errors associated to hypothesis tests: type I and type II errors. Significance level and power of hypothesis tests. Minitab use for inferential statistics. | M. Fidaleo | 1 |
| 4. | Design of experiments and nomenclature. Completely randomized design (CRD). Single and multiple mean model for the CRD. Analysis of variance (ANOVA) for the CRD. F-test for the CRD. ANOVA assumptions: residual analysis. Transformation of responses. Sample size and power of CRD. Introduction to simultaneous inference: per comparison and per experiment type I error. Methods of Bonferroni and Scheffé. Multiple comparisons methods (LSD, Least Significant Difference; HSD, Honest Significant Difference; etc.), comparison with control and with best. Introduction to factorial designs. Minitab use for design of experiments. | M. Fidaleo | 1 |
| 5. | Linear regression analysis. Multivariate analysis methods. Multivariate Linear Regression Models. Analysis using principal components (PCA, Principal Component Analysis): definitions, meaning of the main components and weight. Classification procedures: Cluster Analysis. Minitab for regression, PCA and clustering. | I. Delfino | 1 |
| 6. | Methods and tools for quantitative measurements and for the analysis of experimental data. Characteristics of instruments measuring physical quantities Notes to theory of error analysis. Confidence interval. Experimental errors. Systematic errors, reading errors, random errors, errors, significant figures, error propagation. Statistical methods (tests, regression analyisis, etc.) for the analysis of experimental errors. Comparison between experiments and models: fitting procedures. | I. Delfino | 1 |

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| 7. | Introduction to R statistical software and the R Studio IDE. Basic R. functions of R: import/export data, installation of packages to expand the functionality of R-base. Data management, statistical data analysis, regressions, function creation, creation and export of vector plots. Performing exercises related to what is studied in the other modules. Jupyter: installation of the R kernel and use of R Magic. | R. Moscetti | 3 |

Teaching method: lectures, numerical exercises with statistical software packages.
Semester: 2nd semester, Academic Year 2021-2022.
Final examination: written exam.