UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# SYLLABUS DEL CORSO

## Laboratorio di Calcolo e Statistica

**2526-2-E3001Q086**

### Aims

Introduction to proability and data analysis techniques typical of statistics applied to physics, by means of computer exercises to simulate experimental measurements, to which studied techniques will be applied.In particular, by the end of the course, students will have achieved the following objectives:

- possess the mathematical tools necessary to understand and deepen the quantitative description of experimental data
- acquire knowledge of computer science and modern programming languages
- model the statistical content of measurements of physical systems in various fields
- analyze data using modern tools
- analyze and solve data analysis problems based on modern mathematical and computational tools

### Contents

- Probability and Statistics for physicists
- Foundations of object oriented programming (Python)
- Data analysis techniques used in physics

### Detailed program

**Probability, Statistics and Data Analysis:**

- definition of probability, fundamental properties
- continuous probability distribution functions: properties

- notable examples and graphical representation through histograms
- central limit theorem
- discrete probability distribution functions and notable examples
- multi-dimensional distributions
- estimators, properties, notable examples
- likelihood
- estimators definition: maximum likelihood, least squares
- goodness-of-fit test
- hints on confidence intervals

**C++ proramming language and the object oriented paradigm**

- Algorithms design: pseudo-random numbers, distributions, zeroes of functions and numerical integration
- Monte Carlo techniques
- the Python programming language and its scientific libraries
- Python usage examples for data analysis: fits and data interpretation

## Prerequisites

**Programming in Linux environment:** basic unstructions to work in a Unix environment (file-system, text editor, program compiling and running), basic knowledge of programming languages (variables nad their representation in memory, control structures, function design).

**Probability and Statistics:** calculus, linear algebra, first introduction to probability and statistics (as taught in Laboratorio 1 course)

## Teaching form

The course consists in 12 2-hour frontal lectures of instructional teaching on probability and statistics, and 12 4-hour laboeratory ones on computing and data analsysis with compulsory attendance.
Probability and statistics lectures will take place in two groups, while those of computing and data analysis in four of them.

**One of the two frontal lecture groups and two corresponding ones in laboratory will be held in English.**
**The attendance to the lectures in English is optional.**
**Before the start of the lectures, students are required to express a language preference in this poll, to optimse the groups organisation.**

## Textbook and teaching resource

The teaching resourses will be published in the eLearning page of the course, and will contain on-line material, probability and statistics manuals and user guides to Python and its libraries.

The suggested manuals for probability and statistics are:

- W. J. Metzger - Statistical Methods in Data Analysis

- M. Loreti - Teoria degli Errori e Fondamenti di Statistica
- Claude A. Pruneau - Data Analysis Techniques for Physical Scientists
  For consultation:
- C. Walck - Hand-book on Statistical Distributions

## Semester

First semester

## Assessment method

A practical computing exercise will grant admission to an oral exam, where the practical exercise will be discussed, and probability, statistics, data analysis and programming skills discussed during lectures will be tested.
Upon request, the exam may be taken in English.

## Office hours

By email appointment

## Sustainable Development Goals

QUALITY EDUCATION | GENDER EQUALITY | DECENT WORK AND ECONOMIC GROWTH | INDUSTRY, INNOVATION AND INFRASTRUCTURE