UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Computational Statistics

2526-1-F8206B003-F8206B003-2

Learning objectives

The course aims to provide students with the competencies required to develop computational techniques for statistical model inference.

In terms of knowledge and understanding, the course introduces essential elements of programming in R, focusing specifically on their application in implementing computational inference techniques within statistical models.

Regarding the ability to apply knowledge and understanding, students will acquire practical skills in programming and computational methodologies, enabling them to effectively implement and interpret statistical inference methods using R.

Concerning independent judgment, by the end of the course, students will be able to critically assess and select suitable computational techniques for statistical inference, evaluating their appropriateness and effectiveness in various statistical contexts.

In relation to communication skills, students will learn to clearly and accurately present the outcomes of statistical analyses and computational implementations, effectively communicating complex concepts to both specialized and broader audiences.

Finally, regarding learning skills, the course aims to strengthen students' abilities to autonomously learn and update their knowledge concerning advanced statistical inference methods, preparing them for continuous professional and academic development within the learning area of "Statistics" in the Master's degree program in Statistical and Economic Sciences.

Contents

Definition of random and pseudo-random numbers. Algorithms for generating pseudo-random numbers,

randomness tests. Introduction to the Monte Carlo method and the plug-in principle. Jackknife and bootstrap resampling methods.

Detailed program

- Random numbers generation for uniform, non-uniform, discrete and continuous distributions
- Introduction to Monte Carlo simulation and Monte Carlo Integration
- Variance reduction techniques
- Resampling Techniques: bootstrap and jackknife
- Bootstrap confidence intervals
- Bootstrap Hypothesis Testing

Prerequisites

There are no formal prerequisites for this course; however, a knowledge of statistical inference, probability theory, and the R language is highly desirable.

Teaching methods

The entire course will be delivered in person through 2- or 3-hour lectures, during which theoretical concepts will be applied and tested through concrete examples involving simulations and the use of algorithms using the R programming language.

Assessment methods

Attending students: written exam and computational part with R.
Non-attending students: written exam and computational part with R.

During the exam, the correctness and clarity of the answers will be evaluated. The exam aims to assess the skills described in the learning objectives.

The written exam consists of 3 open-ended questions, including theoretical questions and exercises to be performed using R/RStudio through the Piattaforma degli Esami Informatizzat.

Students and the instructor may request an optional oral exam covering the entire program.

The use of texts or any other materials is not permitted during the exam, except for the codes provided by the instructor at the beginning of the exam.

The use of mobile phones or any digital support is not allowed during the exam.

Textbooks and Reading Materials

- Lecture notes provided by the instructor
- Robert, C.P. e Casella, G. (2009), Introducing Monte Carlo Methods with R, New York: Springer-Verlag
- Davison and Hinkley (1997). Bootstrap Methods and their Applications, Chapman and Hall.

Semester

First semester (I period).

Teaching language

Italian.

Sustainable Development Goals

QUALITY EDUCATION