UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Statistical Inference

2526-1-F8205B001

Learning objectives

The course aims at introducing advanced methods of inferential statistics, mainly with respect to estimation and hypothesis testing. Students will learn the main tools to analyze and to process sampling data, aiming both at supporting decisions and at applying complex models. Students will also get the ability to understand more specific inferential procedures, which are the content of other courses in the degree programme.
Specific goals of the course are as follows:

- *knowledge and understanding:* students should know the main methods to estimate the parameters of a distribution or of a model, along with their strengths and weaknesses; students should know the main statistical techniques to produce decisions based on data; students should know the criteria used to assess the optimality of the statistical methodologies used for estimation and testing
- *applied knowledge and understanding:* students should be able to locate the suitable inferential tool for a given framework or a given model; students should be able to implement the known inferential methods in some analytically intractable frameworks, possibly by reverting to numerical approximations or to simulations; students should be able to face with inferential problems where the usual assumptions are violated, possibly by reverting to suitable techniques which are not based on specific distributions (so called nonparametric techniques)
- *making judgements:* students should understand the challenges arising when the inferential methods are applied; markedly, students should be aware of the limitations derived from the fulfilment of the basic assumptions of some methodologies; students should be able to interpret and to locate the flaws of inferential results produced by third parties
- *communication skills:* students should be able to propose and to explain some inferential tools aimed at making judgments and decisions; students should be able to explain the distinction among the techniques based on the concept of likelihood and those which can also incorporate subjective knowledge
- *learning skills:* students should be able to understand the contents of other courses of the degree programme, which are focused on the use of statistical models, on bayesian statistics or on computational statistics

Contents

Point estimation: optimality, main estimation methods. Interval estimation. Hypothesis testing: optimality, main methods to find tests. Nonparametric methods. Applications with SAS.

Detailed program

Samples and sampling distributions. Sampling from the Normal distribution. Convergences of sequences of random variables. Limit theorems and their applications. Simulation of sampling distributions by the Monte Carlo method. Principles of data reduction: sufficiency, minimal sufficiency, ancillary, completeness. Likelihood functions and the likelihood principle. Point estimation and methods of finding estimators: method of moments, method of maximum likelihood, Bayes estimators, the EM algorithm. Optimality of estimators: Cramer-Rao inequality, Rao-Blackwell theorem, Lehman-Scheffé theorem. Interval estimation: pivotal quantities, Bayesian intervals, coverage probability. Testing hypotheses: likelihood-ratio tests, Bayes tests, union-intersection tests, optimality of tests. Asymptotic evaluation and robustness: consistency, Bootstrap, large-sample intervals, asymptotic likelihood-ratio tests. SAS procedures for the main parametric and nonparametric tests.

Prerequisites

No formal prerequisites. In any case, for students who don't have a quantitative formation, it is recommended to take the course of "Introduction to statistical inference".

Teaching methods

21 2-hour lessons (theory and examples) held in direct-teaching mode and carried out in presence.

Assessment methods

The exam includes an oral interview which, although of a predominantly theoretical nature, also ckecks the student's ability to solve simple inferential problems. In other words, the knowledge and understanding of the inferential techniques treated will be tested, as well as the ability to apply these techniques to a specific problem and to interpret the results obtained. Furthermore, the ability to use a suitable technical language will be tested.

There is no formal distinction between the assessment methods for students attending and those not attending lessons. However, during the period of lessons, students can decide to solve some assignments to be done at home. Participation to the assignments is free, namely there is no mandatory need to attend lessons and the assignments are administered trough the e-learning. The assignments deal with exercises, developments about theory and applications by the SAS software. Students who get sufficient marks in the assignments can substitute a part (about a third) of the oral test and the final mark is obtained as a weighted average.

Textbooks and Reading Materials

Details about textbooks will be provided at the start of lessons.

Semester

2nd semester - 3rd period

Teaching language

Italian

Sustainable Development Goals