UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Statistical Inference

2122-1-F8203B003

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 sample 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.

This course will provide knowledge and understanding related to:

- The main methods to estimate the parameters of a distribution or of a model, along with the virtues and vices of each method
- The problems arising when the methods above are applied; markedly, what limitations derive from the assumptions on which they are based
- The challenges arising when the methods above are used to produce decisions

At the end of the course, students will be able:

- To Locate the suitable inferential tool for a given framework or a given model. Specifically, students will distinguish among techniques based on the concept of likelihood and those which can incorporate prior knowledge (so called bayesian techniques)
- To interpret and to locate the flaws of ready results which other users obtained by specific inferential techniques
- To implement the main inferential methods in some analytically intractable frameworks, possibly by reverting to numerical approximations or to simulations
- 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)
- To understand the contents of other courses of the 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

The course is taught by frontal lessons and practical sessions (exercises).

Assessment methods

The exam consists of a written test, containing both exercises and questions about theory, and of an oral test. Only students with a grade of at least 18/30 can take the oral test.

Questions about theory aim at testing knowledge and understanding of the inferential methods which are dealt with. Exercises aim at testing the ability to apply the methods above to specific probles and to interpret their results. Moreover, both questions about theory and exercises aim at testing the ability to use a suitable technical language.

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 correctly solve the assignments can substitute a part

(about a third) of the written test.

Textbooks and Reading Materials

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

Semester

2nd semester - 3rd period

Teaching language

Italian