UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Statistical Models and Bayesian Inference

2526-2-F8203B042

Learning objectives

The course is structured into two modules that fall within the fields of statistical sciences, computer science, and social sciences, with the shared goal of providing students with both theoretical knowledge and practical skills for advanced statistical analysis, with particular attention to the reproducibility and replicability of analyses and the effective communication of results.
The first module introduces students to classical inferential approaches, including bootstrap methods, generalized linear models, mixture models, and predictive models. The teaching activities involve the use of R software within the RMarkdown environment to carry out statistical analyses on real and simulated data, enabling students to develop autonomy in statistical reasoning, problem-solving skills, and written communication competencies.
The second module focuses on the Bayesian approach to statistical inference, integrating it with the classical methods presented in the first module. Students are introduced to Bayesian models, computational methods (MCMC), and the use of software tools such as R and SAS for model estimation and evaluation. This module also emphasizes reproducibility and the creation of integrated documents that clearly present code, analyses, and interpretation of results.
For a detailed description of the program, please refer to the syllabus published on the course webpage.
Overall, the course enables students to acquire a solid theoretical foundation and practical abilities to address statistical analysis problems in applied fields such as biostatistics, epidemiology, genetics, and public health. By the end of the course, thanks to the provided materials and the practice- and communication-oriented approach, students will be able to independently deepen their understanding of the subject and apply their knowledge in various professional contexts.

Contents

Detailed program

Prerequisites

Teaching methods

Assessment methods

Textbooks and Reading Materials

The teaching material consists mainly of handouts prepared by the teacher. These cover theory, applications, exercise and solutions developed with R software. All the files are available on the course page of the university's e-learning platform. In addition, the teacher publishes the following material at the end of each lesson: slides, R and SAS code, exercises, datasets, and solutions to some of the exercises. Previous exam texts are also published on the same page.

The main references are listed in the bibliography of the handouts, some of which are as follows and are available in the university library, also in ebook format:

Albert, J. (2009). Bayesian computation with R. Springer Science & Business Media.

Albert, J., Hu, J. (2019). Probability and Bayesian modeling. Chapman and Hall/CRC.

Bartolucci, F., Farcomeni, A., Pennoni, F. (2013). Latent Markov Models for longitudinal data. Chapman and Hall/CRC, Boca Raton.

Bishop, Y. M., Fienberg, S. E., Holland, P. W. (2007). Discrete multivariate analysis: theory and practice. Springer Science & Business Media, New York.

Blitzstein, J. K., Hwang, J. (2014). Introduction to probability. Chapman & Hall/CRC.

Dipak, D. K., Ghosh, S. K., Mallick, B. K. (2000). Generalized linear models: A Bayesian perspective. CRC Press.

Gentle, J. E., Hardle, W., Mori, Y. (2004). Handbook of computational statistics. Springer, Berlin.

Lange, K. (2010). Numerical analysis for statisticians (2nd ed.). Springer, New York.

Migon, H. S., Gamerman, D., Louzada, F. (2014). Statistical inference: an integrated approach. Chapman & Hall.

Pennoni, F. (2025). Dispensa di Inferenza Bayesiana: Teoria e applicazioni con R e SAS. Dipartimento di Statistica e Metodi Quantitativi, Università degli Studi di Milano-Bicocca.

Pennoni, F. (2025). Dispensa di Modelli Statistici II, parte di teoria e applicazioni con R. Dipartimento di Statistica e Metodi Quantitativi, Università degli Studi di Milano-Bicocca.

R Core Team (2023). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Robert, C., Casella, G. (2004). Monte Carlo Statistical Methods (2nd ed.). Springer–Verlag, New York.

SAS Institute (2012). SAS/STAT PROC MCMC, User’s Guide.

Semester

From September 2025 - January 2026

Teaching language

Sustainable Development Goals

NO POVERTY | GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION