



UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Scienze Economiche, Aziendali e Statistiche		
ACADEMIC YEAR	2023/2024		
MASTER'S DEGREE (MSC)	STATISTICS AND DATA SCIENCE		
INTEGRATED COURSE	ADVANCED STATISTICAL METHODS - INTEGRATED COURSE		
CODE	21226		
MODULES	Yes		
NUMBER OF MODULES	2		
SCIENTIFIC SECTOR(S)	SECS-S/01		
HEAD PROFESSOR(S)	MUGGEO VITO	Professore Ordinario	Univ. di PALERMO
	MICHELE ROSARIO		
OTHER PROFESSOR(S)	ABBRUZZO ANTONINO	Professore Associato	Univ. di PALERMO
	MUGGEO VITO	Professore Ordinario	Univ. di PALERMO
	MICHELE ROSARIO		
CREDITS	9		
PROPAEDEUTICAL SUBJECTS			
MUTUALIZATION			
YEAR	2		
TERM (SEMESTER)	1° semester		
ATTENDANCE	Not mandatory		
EVALUATION	Out of 30		
TEACHER OFFICE HOURS	ABBRUZZO ANTONINO Monday 15:00 17:00 DSEAS secondo piano stanza 222 MUGGEO VITO MICHELE ROSARIO Tuesday 10:00 12:00 stanza 217 2° piano		

DOCENTE: Prof. VITO MICHELE ROSARIO MUGGEO

PREREQUISITES	Elements of inferential statistics. Basics of multiple linear regression and generalized linear models.
LEARNING OUTCOMES	<p>Knowledge of the methodologies of non-parametric and Bayesian statistical methods. Acquisition of the language and terminology proper to the discipline. Ability to understand methodology with strong emphasis on relationships.</p> <p>Ability to apply knowledge and understanding Ability to deal with concrete problems using methods acquired during lectures. Ability to use the R statistical environment to apply the methods acquired during frontal lectures and to verify theoretical results by simulation.</p> <p>Autonomy of judgment Be able to critically understand characteristics, potentials and limitations of Bayesian and nonparametric methods. Be able to frame a specific problem in Bayesian and nonparametric terms.</p> <p>Communication skills. Be able to discuss the characteristics of a given problem. Be able to use statistical terminology and problem formalization in a written exposition.</p> <p>Learning skills Be able to consult scientific literature on the subject; ability to learn extensions of models studied in lecture; ability to learn specialized statistical software even different from that used in the classroom.</p>
ASSESSMENT METHODS	<p>The examination will consist of a written test and an oral discussion (subject to passing the written test).</p> <p>The written test will consist of an analysis of a dummy dataset and its implementation in R.</p>
TEACHING METHODS	<p>The course will be held in English.</p> <p>The course will be divided into lectures and practicals. All the theoretical arguments developed during the lectures will be addressed in terms of applications via the R environment. During the "Bayesian Statistics" module, group work and analysis reports will be organised with autonomous presentations of students and activities in homework mode to be discussed in the classroom. The R software will be used for data set analysis.</p>

**MODULE
BAYESIAN STATISTICS**

Prof. ANTONINO ABBRUZZO

SUGGESTED BIBLIOGRAPHY

A first course in Bayesian statistical methods, Hoff, Peter D, 2009, Springer Science & Business Media. Capitoli 2, 3, 5, 6, 9, 10 e 11.

Bayesian Data Analysis, Gelman et. al, Capitoli 2, 3, 10, 11, 12, 14, 16

Stan Reference Manual e Stan User's Guide

Appunti del docente

AMBIT	21031-Attività formative affini o integrative
INDIVIDUAL STUDY (Hrs)	54
COURSE ACTIVITY (Hrs)	21

EDUCATIONAL OBJECTIVES OF THE MODULE

The course guides the student to the knowledge of the primary methods of Bayesian statistics and the acquisition of the ability to apply these methodologies to real datasets. Students should be able: to understand both the positive and negative aspects of Bayesian statistics with respect to the classical ones, and to use these techniques to investigate real datasets.

SYLLABUS

Hrs	Frontal teaching
3	Bayesian statistical modelling and Inference; Prior, Posterior distribution, and Predictive distributions
3	Conjugate Bayesian Models: Poisson-Gamma, Normal-Normal
3	Monte Carlo Markov Chain for non-conjugate models: The Gibbs sampling and the Metropolis-Hastings
3	Inference and prediction in generalized linear models
Hrs	Practice
2	Beta-Binomial Model: an Application
2	Conjugate Multinomial-Dirichlet model: An application
2	Application of MCMC through STAN
3	Generalized linear model: some applications

**MODULE
NON PARAMETRIC STATISTICS**

Prof. VITO MICHELE ROSARIO MUGGEO

SUGGESTED BIBLIOGRAPHY

Eilers, P. G. and Marx, B. D. (2021). Practical Smoothing: the joys of P-splines. Cambridge University Press.
Wood S. (2006) Generalized Additive Models: an introduction with R, CRC

AMBIT	21031-Attività formative affini o integrative
INDIVIDUAL STUDY (Hrs)	108
COURSE ACTIVITY (Hrs)	42

EDUCATIONAL OBJECTIVES OF THE MODULE

The course aims to provide students with the modern tools for modeling non-linear relationships in the most common regression models: LM and GLM. The topics will be discussed both from a theoretical and an applied point of view through the implementation in R.

SYLLABUS

Hrs	Frontal teaching
2	Introduction to non-parametric modeling. From the linear regression model to the "flexible" regression model using "smoothers". Polynomials for modeling non-linear relationships and their limits. The first smoother: B-splines.
4	Characteristics and properties of B-splines: nodes and degree of the polynomial. The derivatives of the B-splines.
4	The risk of under- and over-fitting of B-splines. The use of the penalty. Penalized splines (P-splines)
6	Model fitting with penalized splines. Penalized Least Squares through Ordinary Least Squares. The role of the differences order in the penalty.
8	Smoothing parameter selection: CV, AIC, BIC, and through random effects models. Additive models. Introduction to the tensor product of B-splines for surface modelling.
Hrs	Practice
6	Implementation in R of the methods described in class
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