Bayesian Inference

Academic Year: (2021 / 2022) **Review date: 10-05-2021**

Department assigned to the subject: Statistics Department

Coordinating teacher: CABRAS , STEFANO

Type: Compulsory ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Experience with classical statistical methods.

OBJECTIVES

Basic Skills:
1. To gain and understand knowledge that provides a basis or opportunity for originality in developing and/or applying ideas, often in the context of research
2. That the students can apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
3. That students are able to integrate knowledge and handle the complexity of formulating judgments based on the incomplete or limited information that include reflecting on the social and ethical responsibilities linked to the application of their knowledge and judgments
4. That student can communicate their conclusions and underlying knowledge to specialists and non-specialists clearly and unambiguously.
5. That students possess the learning skills that enable them to continue studying autonomously.

Specific Skills:
1. Employ statistical concepts in developing methods to analyze real problems where samples have great importance for their solution.
2. Use of free software for statistical analysis such as R and/or Python.
3. Use of multivariate statistical concepts to relate stochastic phenomena based on observed data
4. Use of Bayesian Analysis to develop and apply complex models for dependent samples.
5. Use of stochastic process knowledge to develop and analyze the real problems in which the prediction of a response variable is important.
6. Use of non-parametric models to interpret and predict random outcomes
7. Use of optimization technique for parameter estimation in complex statistical models
8. Identify the appropriate statistical analysis for a specified knowledge objective given the collected data
9. Apply the statistical model to the relevant problem in scientific research
10. Use of models for supervised and unsupervised learning Modeling of complex data via conditional stochastic dependence

DESCRIPTION OF CONTENTS: PROGRAMME

1. Concepts of proability relateded with Bayesian Statistics
2. Conjugate families of distributions
3. Subjective and objective prior distributions
4. Numerical methods y MCMC
a) analytic approximations
b) Monte Carlo
c) MCMC and Gibbs sampling
5. Estimation and hypothesis testing
6. Regression and hierarchical models
7. Time series and forecasting

LEARNING ACTIVITIES AND METHODOLOGY

Practical sessions on Bayesian computing and on the use of Bayesian software to implement MCMC algorithms. Classes will be mainly oriented at practicing and verify concepts illustrated in the corresponding book chapters. It is up to the student to arrive at class with all these concepts already understood and

studied. This is the only activity demanded out of the class. This is in a coherent realization of the flipped classroom methodology.

ASSESSMENT SYSTEM

1) Computing projects and tasks by using software to implement Bayesian inference.
3) A written test with problems and relevant questions.

% end-of-term-examination:	30
% of continuous assessment (assigments, laboratory, practicals…):	70

BASIC BIBLIOGRAPHY

- Jeff Gill Bayesian Methods A Social and Behavioral Sciences Approach Third Edition , CRC Press.

ADDITIONAL BIBLIOGRAPHY

- Bolstad, W.M. Introduction to Bayesian statistics, Wiley.

- Box, G.E. and Tiao, G.C. Bayesian inference in statistical analysis, Wiley.

- Chen, M-H Monte Carlo methods in bayesian computation, Springer.

- Congdon, P. Applied Bayesian modelling, Wiley.

- D' Agostini, J. Bayesian reasoning in data analysis : a critical introduction, World Scientific.

- Dey, D.K. and Rao, C.R. Bayesian thinking : modeling and computation, Elsevier.

- Gamerman, D. Markov chain Monte Carlo : stochastic simulation for Bayesian inference, Chapman & Hall.

- Gilks, W., Richardson, S. and Spiegelhalter, D.J. Markov chain Monte Carlo in practice, Chapman and Hall.

- Robert, C.P. The Bayesian choice : from decision-theoretic foundations to computational implementation (2nd edition), Springer.