Course guide
200611 - AB - Bayesian Analysis

Last modified: 09/06/2023

Unit in charge: School of Mathematics and Statistics
Teaching unit: 715 - EIO - Department of Statistics and Operations Research.

Degree: MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: XAVIER PUIG ORIOL

Others: Segon quadrimestre:
JESUS CORRAL LOPEZ - A
XAVIER PUIG ORIOL - A

PRIOR SKILLS

We start from scratch and hence there are no pre-requisites for this course. But having some basic knowledge of statistics and R will help get the best out of the course.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
3. CE-1. Ability to design and manage the collection of information and coding, handling, storing and processing it.
4. CE-3. Ability to formulate, analyze and validate models applicable to practical problems. Ability to select the method and / or statistical or operations research technique more appropriate to apply this model to the situation or problem.
5. CE-4. Ability to use different inference procedures to answer questions, identifying the properties of different estimation methods and their advantages and disadvantages, tailored to a specific situation and a specific context.
6. CE-6. Ability to use appropriate software to perform the necessary calculations in solving a problem.
7. CE-7. Ability to understand statistical and operations research papers of an advanced level. Know the research procedures for both the production of new knowledge and its transmission.
8. CE-8. Ability to discuss the validity, scope and relevance of these solutions and be able to present and defend their conclusions.
9. CE-9. Ability to implement statistical and operations research algorithms.

Transversal:
1. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

TEACHING METHODOLOGY

Our goal is to focus the learning goals on the student and adapt the teaching to the achievement of the goals. That’s why we want classes to be valuable for learning and tasks to be well thought out and defined. Half of the sessions will be theoretical and half will be based on computer use.

Theoretical concepts are presented in theory classes and are usually expository classes, where exercises or discussions between students are often interspersed. These classes also work on learning through case studies.

In the practical classes, the practical cases are solved with the help of the statistical software R, WinBugs, JAGS and STAN.

LEARNING OBJECTIVES OF THE SUBJECT

The main objective of this subject is that the student ends up with a good knowledge and mastery of Bayesian modeling in terms of both theoretical and practical knowledge. This knowledge must allow, in the face of an objective or question, to intervene in the design of the experiment necessary to obtain the study data, to analyze them satisfactorily in order to reach the conclusions according to the initial objective.

And as specific objectives (abilities to be acquired):
* Knowledge of the difference between Bayesian and non Bayesian statistical modelling, and of the role of the likelihood function.
* Understand the role of the prior distribution, the role of reference priors and how to go from prior to posterior distributions.
* Understand the difference between hierarchical and non-hierarchical Bayesian models.
* Understand how to check a Bayesian model, how to compare Bayesian models and how to use them for prediction.
* Understand the Montecarlo methods that allow one to simulate from the posterior and how to make inferences from those simulations.
* Posing and solving Bayesian inference problems analytically with exponential family statistical models and conjugate prior distributions.
* Posing and solving Bayesian inference problems numerically under complex situations using WinBugs, JAGS or STAN.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	12.00
Hours large group	30,0	24.00
Self study	80,0	64.00

Total learning time: 125 h

CONTENTS

1- Bayesian Model

Description:
1. What is a statistical model. 2. The four problems in statistics. 3. The Likelihood function. 4. Bayesian model. 5. Posterior distribution. 6. Prior predictive and posterior predictive distributions. 7. Choice of the prior distribution.

Full-or-part-time: 45h
Theory classes: 14h
Laboratory classes: 6h
Self study : 25h

2- Bayesian Inference

Description:
1. Posterior distribution as an estimator. 2. Point estimation. 3. Interval estimation 4.Prediction 5. Hhypothesis test

Full-or-part-time: 39h
Theory classes: 10h
Laboratory classes: 4h
Self study : 25h

3- Bayesian computation

Description:
1. The need for integration and for simulation. 2. Markov chain montecarlo simulation. 3. Monitoring Convergence

Full-or-part-time: 13h
Theory classes: 2h
Laboratory classes: 1h
Self study : 10h

4- Hierarchical Models

Description:
1. Hierarchical Models

Full-or-part-time: 14h
Theory classes: 2h
Laboratory classes: 2h
Self study : 10h

5. Checking and defining the model

Description:
Checking and defining the model

Full-or-part-time: 14h
Theory classes: 2h
Laboratory classes: 2h
Self study : 10h

GRADING SYSTEM

Final grade = 0.4*Assignments + 0.2*Exam + 0.4*Project

where,
Assigments is the grade obtained from the resolution of exercises delivered to both practical and theoretical classes,
Project is the grade of a group work, and
Exam is the grade of the exam that will take place in the second half of the course

BIBLIOGRAPHY

Basic:
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Complementary:
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- Leonard, Thomas; Hsu, John S. J. Bayesian methods. Cambridge: Cambridge University Press, 1999. ISBN 0521594170.
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