UAB
Universitat Autònoma de Barcelona

Bayesian Methods

2026/2027

Code: 104858
Credits: 6

Degree programme	Type	Course
Applied Statistics	OB	3

Contact lecturer

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Teaching staff

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Group languages

You can consult this information at the end of the document.

Prerequisites

It is convenient a good knowledge of the subjects of Probability and Inference 1 and 2. A good formation in Calculus 1 and 2 is also important.

Objectives

This is the only course of Bayesian Statistic of the degree (GEA). The principal aim is to introduce the Bayesian thought to the students, providing the necessary elements to solve simple problems of inference using Bayesian methodology.

Learning outcomes

- KM09 (Discover the fundamental properties of estimators: invariance, sufficiency, efficiency, bias, mean square error and asymptotic properties, in the classical and Bayesian domains.) Discover the fundamental properties of estimators: invariance, sufficiency, efficiency, bias, mean square error and asymptotic properties, in the classical and Bayesian domains.
- KM10 (Describe the characteristics of the distribution and density functions of random variables.) Describe the characteristics of the distribution and density functions of random variables.
- SM09 (Analyse data through different inference techniques using statistical software.) Analyse data through different inference techniques using statistical software.
- SM10 (Use different estimation methods depending on the context of application.) Use different estimation methods depending on the context of application.

Contents

The contens of the course are divided into three chapters:

1- Introduction to Bayesian Inference

1.1 Bayes' theorem and its consequences.

1.2 The basics of Bayesian Statistics: prior distributions.

1.3 Bayesian inference: the posterior distribution.

2-Bayesian Inference for some one and two-parameter models

2.1 Poisson distribution

2.2 Conjugate distributions

2.3 Prior and Posterior predictive distributions

2.4 Normal distribution (σ2 known)

2.5 Normal distribution (μ and σ2 unknown)

2.6 Jeffreys priors.

2.7 Bayesian hypothesis testing

3- Bayesian approximated inference for complex models

3.1 Laplace approximation

3.2 Simulation of the posterior distribution 1: AR method.

3.3 Simulation of the posterior distribution 2: MCMC.

3.4 INLA models

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Practical sessions	15	0.6	SM09, SM10
Personal working	66	2.64	KM09, KM10, SM09, SM10
Theoretical lectures	30	1.2	KM09, KM10
Workshop of exercises	15	0.6	KM09, KM10, SM09, SM10
Mentoring	10	0.4	KM09, KM10, SM09, SM10

Accordingly with the aims of the subject, the development of the course will be based on the following

activities:

Theoretical lectures: The student acquires the scientific and technic skills of the subject assisting to the theoretical lectures and complementing them with the personal work on the topics explained. The theoretical lectures are the activities demanding less interactiveness: they are conceived like a fundamentally unidirectional method of transmission of knowledge of the teacher to the student. The lectures will be given using a support of slides (PowerPoint) in English that will be uploaded also at the Virtual Campus.

Problems and practices: The problem and practical sessions have a double mission. On the one hand the students will work with the scientifical and technical issues exposed in the theoretical lectures to complete its understanding developing a variety of activities, since the typical resolution of problems until the discussion of practical cases. On the other hand, the lectures solving problems are the natural forum at which argue in common the development of the practical work, providing the necessary knowledge to carry it forward, or indicating where and how they can be acquired. The practices of this subject are designed to guide students through each stage of statistical fieldwork. Students carry out practical exercises independently using the R software, with the aim of solving specific real-world problems. This approach is intended to encourage active learning and develop critical thinking, as well as the ability to analyse and synthesise information.

In all aspects of teaching/learning activities, the best efforts will be made by teachers and students to avoid language and situations that can be interpreted as sexist.

In order to achieve continuous improvement in this topic, everyone must collaborate to highlight the deviations they observe with respect to this objective.

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Exercises	30	10	0.4	SM09, SM10
Partial exam 1	35	2	0.08	KM09
Partial exam 2	35	2	0.08	KM10

Continued assessment

The evaluation runs continuously along the course. The continued evaluation has several fundamental aims: to check the process of education and learning and to verify that the student has attained the corresponding skills of the course.

This is the method of evaluation: The practical exercises delivered by the students (30%), a partial examination of Theory in the middle of the course (35%), and another partial examination of Theory at the end of the course (35%). The final grade will be: N = 0.35*Midterm1 + 0.35*Midterm2 + 0.3*Exercises, provided that each grade is

at least 3 out of 10. Otherwise, that component will be counted as 0 in the calculation of N.The second-chance examination only will be allowed to the students having a minimum score of 3 at the final mark, recovering only the part of Theory not passed (first part, second part or both).

A student will be considered assessable if they have participated in at least one assessed activity. Otherwise, they will be recorded as Not Evaluable.

Single assessment

The students who chose the single assessment modality must take a final test that will consist of an exam in which there may be questions of theory and problem-solving (70%) and a practice exam that may be carried out using a computer if deemed appropriate (30%). The final grade will be: N = 0.7*Theory_Exam + 0.3* Practical_Exam, provided that each grade is at least 3 out of 10. Otherwise, that component will be counted as 0 in the calculation of N. This test will be carried out on the same day, time, and place in which the test of the second partial is carried out. Anyone who misses the test without a valid excuse will be classified as Not Evaluable. If a grade of less than a 5 is received, it may be recovered on the same day, at the same time, and in the same location as the other students in the course with the same format.

If $N \geq 5$, the course is passed with a final grade NF = N.

The retake exam cannot be used under any circumstances to improve the grade if the course has already been passed.

General considerations on assessment

Based on the instructions of the Vice-Rector for Studies and Quality at UAB, sanctions and the use of AI are regulated as follows:

Any irregularity in an assessment activity (academic fraud, plagiarism, or misuse of AI, unless such use is explicitly authorized in the course guide) that may lead to a significant change in the grade will result in that activity being graded as 0. If the course guide establishes that obtaining a minimum grade in this assessment activity is an essential requirement to pass the course, or if multiple irregularities occur in the assessment activities of the same course, the final grade for the course will be 0. Additionally, a disciplinary procedure may be initiated against any student who commits any of these irregularities.

Bibliography

- Albert, Jim (2007). Bayesian Computation with R. Springer, New York.

- McElreath, Richard (2015). *Statistical Rethinking: A Bayesian Course with Examples in R and Stan*. Chapman and Hall/CRC.

- Andrew Gelman, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, Donald B. Rubin, (2013). *Bayesian data analysis*, third edition, Chapman and Hall/CRC.

Software

We will mostly use the R programming language.

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TE) Theory	1	Catalan	second semester	afternoon
(PAUL) Classroom practices	1	Catalan	second semester	afternoon
(PLAB) Practical laboratories	1	Catalan	second semester	afternoon