Universitat Autònoma de Barcelona

2023/2024

Bayesian Methods

Code: 104858
ECTS Credits: 6

Degree	Type	Year	Semester
2503852 Applied Statistics	OB	3	1

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

Gabriel Vicent Jover Mañas

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 and Contextualisation

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.

Competences

- Analyse data using statistical methods and techniques, working with data of different types.
- Correctly use a wide range of statistical software and programming languages, choosing the best one for each analysis, and adapting it to new necessities.
- Make efficient use of the literature and digital resources to obtain information.
- Select statistical models or techniques for application in studies and real-world problems, and know the tools for validating them.
- Select the sources and techniques for acquiring and managing data for statistical processing purposes.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.

- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Summarise and discover behaviour patterns in data exploration.

Learning Outcomes

1. Analyse data through different inference techniques using statistical software.
2. Analyse data through various inference techniques for one or more samples.
3. Describe the basic properties of point and interval estimators in classical and Bayesian statistics.
4. Identify statistical distributions.
5. Identify statistical inference as an instrument of prediction.
6. Interpret the results obtained and formulate conclusions regarding the experimental hypothesis.
7. Make effective use of references and electronic resources to obtain information.
8. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
9. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
10. Understand the concepts associated with hypothesis tests in classical and Bayesian statistics.
11. Use specific software for Bayesian methods.
12. Use statistical software to obtain summary indices of the variables in the study.
13. Use the properties of the functions of distribution and density.
14. Validate and manage information for statistical processing.

Content

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 Simulation of the posterior distribution 1: AR method.
3.2 Simulation of the posterior distribution 2: MCMC.
3.3 Laplace approximation and INLA models

Methodology

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.

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practical sessions	15	0.6	1, 2, 11, 9, 12, 14
Theoretical lectures	30	1.2	2, 10, 3, 4, 5, 6, 9, 8, 7, 13, 14
Type: Supervised			
Mentoring	10	0.4	1, 2, 10, 3, 11, 4, 5, 6, 9, 8, 7, 13, 12, 14
Workshop of exercises	15	0.6	10, 4, 5, 6, 9, 8, 13
Type: Autonomous			
Personal working	66	2.64	1, 2, 10, 3, 11, 4, 5, 6, 9, 8, 7, 13, 12, 14

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 second-chance examination only will be allowed to the students having a minimum score of 3 at the final mark, recovering only the part correpong¡ding to Theory.

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 and a practice exam in front of the computer. 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.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exercises	30	10	0.4	1, 2, 10, 3, 11, 4, 5, 6, 9, 8, 7, 13, 12, 14
Partial exam 1	35	2	0.08	10, 3, 4, 5, 6, 9, 8, 13, 14
Partial exam 2	35	2	0.08	2, 10, 3, 4, 5, 6, 9, 8, 13, 14

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.