COURSE DATA

DATA SUBJECT

Code: 36419
Name: Bayesian models
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1406 - Degree in Data Science	Escola Tècnica Superior d'Enginyeria	3	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1406 - Degree in Data Science	Statistical Modelling	COMPULSORY

COORDINATION

MARTINEZ BENEITO MIGUEL ÁNGEL

SUMMARY

Bayesian Models course aims to provide the necessary knowledge to address inference and prediction in statistical models from the Bayesian point of view. Tools of probability will be used (highlighting Bayes' Theorem as the central axis) to carry out the inferential and predictive process but now including the previous knowledge that we have about the problem. All this Bayesian learning process will be particularized in known models but also with more complex models such as Bayesian networks and, more generally, probabilistic graphical models will be presented. For complex models, numerical methods will be introduced to approximate the posterior distributions.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

For a correct follow-up of the course it will be essential to have assimilated everything learned in the

previous courses in the subjects of probability and simulation, statistical inference and linear models

COMPETENCES / LEARNING OUTCOMES

1400 -

C3 - Ability to recognise and develop computational learning techniques and to design and implement applications and systems that use them, including those for the automatic retrieval of information and knowledge from large volumes of data.

1406 - Degree in Data Science

(CB5) Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

(CE09) To methodologically know and apply the concepts and techniques of probability and statistics necessary for the extraction of useful knowledge from data analysis.

(CE15) Ability to model and analyse the uncertainty in data-based studies, as well as to know how to interpret and contextualise the results obtained.

(CG01) Knowledge of basic subjects and technologies that enable students to learn new methods and technologies, and to provide them with versatility to adapt to new situations.

(CG03) Capability to elaborate models, calculations, reports, to plan tasks and other works analogous to the specific field of data science.

(CG05) Analysis and synthesis capability in the preparation of reports and in the defence of ideas.

(CT03) Ability to defend your own work with rigor and arguments and to expose it in an adequate and accurate way with the use of the necessary means.

DESCRIPTION OF CONTENTS

1. Elements of Bayesian Statistics

Probability, mathematical conception
Random variables and simulation
Bayes theorem

2. Bayesian Inference and Prediction

Statistics from a Bayesian perspective

Likelihood information
Prior distributions
Posterior distributions
Predictive distributions
Estimation and prediction: point, intervals and contrasts
Bayesian inference in normal models

3. Advanced Bayesian Modeling

Simulation-based inference, a motivation
Markov Chain Monte Carlo
Convergence analysis in MCMC
MCMC simulation with JAGS
Bayesian inference in linear and GLM models
Bayesian Hierarchical Models

4. Bayesian networks

Bayesian networks and graphical models, the concept.
Analytical computations in a (simple) Bayesian network.
Computational approach to more complex Bayesian networks.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	32,00
Laboratory	20,00
Classroom practices	8,00
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	15,00
Independent study and work	30,00
Preparation of lessons	25,00
Preparation for assessment activities	10,00
Resolution of case studies	10,00
Total hours	**90,00**

TEACHING METHODOLOGY

MD1 - Theoretical activities. Expository development of the subject with the participation of the students in the resolution of specific questions. Completion of individual evaluation questionnaires (Outcomes: GC01, CG03, CE09, CE15, CB5, C3).

MD2 - Practical activities. Learning through problem solving, exercises and case studies through which skills are acquired on different aspects of the subject (Outcomes: GC01, CG03, CE09, CE15, CB5, C3).

MD4 - Laboratory and / or computer classroom work. Learning by carrying out activities developed individually or in small groups and carried out in laboratories and / or computer classrooms (Outcomes: GC01, CG03, CE09, CE15, CB5, C3).

EVALUATION

SE1 - Objective test, consisting of one or more exams of both theoretical and practical questions and problems, will account for 50% of the grade. (Outcomes: GC01, CG03, CE09, CE15, CB5, C3)

SE2 - Evaluation of the practical activities based on the elaboration of papers/memories and/or oral presentations. It will represent 30% of the grade, of which 10% corresponds to the evaluation of a memory in pdf of the issues addressed in the laboratory sessions and 20% with the evaluation of (individual) activities deliverable at the end of each of the laboratory sessions. (Outcomes: GC01, CG03, CG05, CT01, CT03, CE09, CE15, CB5, C3)

SE3 - Continuous evaluation of each student, based on the participation and degree of involvement of the student in the teaching-learning process, taking into account the regular attendance to the scheduled face-to-face activities and the resolution of questions and problems proposed periodically. It will represent 20% of the final grade. (Outcomes: GC01, CG03, CG05, CT01, CT03, CE09, CE15, CB5, C3).

It will be necessary to obtain a grade of 5 in each part in order to pass the course.

In the event that, due to a justified academic incompatibility, it becomes impossible in a specific situation to regularly attend the course's practical sessions, the final grade for the course will be based exclusively on the exam (section SE1).

Regarding the course resit, in the second examination session, a second exam corresponding to this session will be administered. If the student has already passed sections SE2 and SE3 in the first session, the grade of the second exam will be averaged with the grades obtained in those sections in the first session. Otherwise, the grade for the second session will be based exclusively on the exam grade (SE1) from that session.

In any case, the evaluation system will be governed by the provisions of the Evaluation and Qualification

Regulations of the University of Valencia for Degrees and Master's degrees: https://www.uv.es/graus/normatives/2017_108_Reglament_avaluacio_qualificacio.pdf

Copying or plagiarism of any activity that is part of the evaluation will result in the impossibility of passing the course, and the student will then be subject to the appropriate disciplinary procedures indicated in the ACTION PROTOCOL FOR FRAUDULENT PRACTICES AT THE UNIVERSITY OF VALENCIA (ACGUV 123/2020).

REFERENCES

- John K. Kruschke (2011). Doing Bayesian Data Analysis: A Tutorial with R and BUGS. Academic press Elsevier.
- I. Ntzoufras (2011). Bayesian Modeling Using WinBUGS. John Wiley & Sons.
- A. Gelman, J. B. Carlin, H. S. Stern, D. B. Dunson, A. Vehtari, D. B. Rubin (2013) Bayesian Data Analysis (3rd Ed.). CRC
- T. M. Donovan y R. M. Mickey (2019) Bayesian Statistics for Beginners. Oxford University Press
- S. K. Ghosh y B. J. Reich (2019). Bayesian statistical methods. Chapman & Hall; CRC
- D. Barber (2012). Bayesian Reasoning and Machine Learning. Cambridge University Press.