

COURSE DATA

Data Subject				
Code	36419			
Name	Bayesian models			
Cycle	Grade			
ECTS Credits	6.0			
Academic year	2020 - 2021			
Study (s)				
Degree		Center		Acad. Period year
1400 - Degree in Computer Engineering		School of Engine	ering	4 First term
1406 - Degree in Data Science		School of Engine	ering	3 First term
Subject-matter				
Degree		Subject-matter	10 S74111	Character
1400 - Degree in Computer Engineering		16 - Optional subj	ject	Optional
1406 - Degree in Data Science		6 - Statistical Moc	delling	Obligatory
Coordination				
Name		Departm	ent	2 7277
CONESA GUILLEN,	DAVID VALENTIN	130 - Sta	tistics and Operatio	nal Research

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.



Vniver§itat \vec{p} d València

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

OUTCOMES

1400 - Degree in Computer Engineering

- C1 Ability to know the fundamentals, paradigms and techniques in the field of intelligent systems, and to analyse, design and build computer systems, services and applications that use these techniques in any field of application.
- 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

- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- (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.
- (CT01) To be able to access (bibliographical) information tools and appropriately use them in the development of their daily tasks.
- (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.

LEARNING OUTCOMES

Learn the basic elements of Bayesian statistical learning (Competences: CB5, CG1, CT1, CE9, CE15)



Vniver§itatö́tdValència

Course Guide 36419 Bayesian models

Understand the power of the Bayesian concept of probability (Competences: CB5, CG1, CT1, CE9, CE15).

Combine expert and experimental information in basic inferential processes (Competencies: CB5, CG1, CG3, CT1, CE9, CE15).

Know how to work in inferential and predictive environments (Competences: CB5, CG1, CT1, CE9, CE15).

Know the concept of probabilistic graphical model (Competences: CB5, CG1, CT1, CE9, CE15).

Calculate joint probabilities using a Bayesian network (Competencies: CB5, CG3, CT1, CE9, CE15).

Know the inference algorithms of the probabilistic graphical models (Competences: CB5, CG1, CG3, CT1, CE9, CE15).

DESCRIPTION OF CONTENTS

1. Bayesian Statisctics basics

Probability as a quantifying tool for uncertainty. Simulation of random variables. Bayes' theorem: events and random variables.

The Bayesian learning process.

2. Bayesian inference and prediction

Statistical modelling and inference from the Bayesian perspective (model; likelihood function; parameters; parametric space; estimation and hypothesis testing).

Prior and posterior distributions.

Prior and posterior predictive distribution.

Bayesian inference and prediction as a description of posterior distributions and posterior predictive distributions.

Univariate models: proportions and Gaussian data.

Multivariate models: Gaussian data and generalization to more complex models.

3. Advanced Bayesian modelling

Inference and prediction in linear models and generalized linear models.

Models with random effects.

Bayesian hierarchical models.

Numerical approximations: MCMC, Hamiltonian approximation, INLA.



Vniver§itat \vec{p} d València

4. Bayesian networks

Graphical probability models Directed Acyclic Graph: nodes, parents, children Chain rule for joint probability. Bayesian learning in networks. Examples

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	32,00	100
Laboratory practices	20,00	100
Classroom practices	8,00	100
Development of group work	5,00	0
Development of individual work	10,00	0
Study and independent work	20,00	0
Readings supplementary material	10,00	0
Preparation of evaluation activities	10,00	0
Preparing lectures	15,00	0
Preparation of practical classes and problem	10,00	0
Resolution of case studies	10,00	0
тот	AL 150,00	

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 (Competences: GC01, CB5, CE09).

MD2 - Practical activities. Learning through problem solving, exercises and case studies through which skills are acquired on different aspects of the subject (Skills: CB2, CE15).

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 (Competences: CT01, CE09, CE15).



EVALUATION

SE1 - Objective test with theoretical-practical questions that will account for 40% of the grade. (GC01, CB5, CE09)

SE2 - Preparation of a memory in pdf of the questions addressed in the practical sessions, which will represent 40%. The evaluation of this part may be recovered through a practical test that will be carried out on the same date as the theoretical test of the second call. (CB2, CE15)

SE3 - Continuous assessment, based on the participation and degree of involvement of the student in the teachinglearning process. This implication may be quantified in two ways from which one must choose:

* Through oral presentations (individual and / or in group) of the studied subject and through the resolution of problems in the classroom (it will imply attendance not necessarily face-to-face);

* Through problems to be solved at home and delivered via virtual classroom on a pre-established date.

Whatever the form of evaluation chosen, these activities will be non-recoverable and will account for 20% of the grade (CT01, CE09, CE15)

It will be necessary to get a 4 in each part to be able to average and more than a 5 as a final grade to pass the course.

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

REFERENCES

Basic

- John K. Kruschke (2011). Doing Bayesian Data Analysis: A Tutorial with R and BUGS. Academic press Elsevier.
- T. M. Donovan y R. M. Mickey (2019) Bayesian Statistics for Beginners. Oxford University Press

Additional

- D. Barber (2012). Bayesian Reasoning and Machine Learning. Cambridge University Press.

ADDENDUM COVID-19



Vniver§itatö́dValència

Course Guide 36419 Bayesian models

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

The teaching methodology of this course will follow the Teaching Model approved by the Academic Committee for the Degree in Data Science (https://go.uv.es/cienciadatos/ModelDocentGCD). In the event of a closure of the School of Engineering that totally or partially affects the lessons, classes will be replaced by virtual sessions following the established schedule. If the closure affects any face-to-face examination task, it will be replaced by a virtual exam of a similar nature using the tools supported by the University of Valencia. Percentages of all examination tasks will be maintained, as established in this guide.

