UAB Universitat Autònoma de Barcelona	Stochastic Processes Code: 104859 Credits: 6	2026/2027

Degree programme	Type	Course
Applied Statistics	OB	2

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 advisable to have successfully completed the following mandatory courses: Càlcul 1, Àlgebra lineal, Introducció a la probabilitat, Eines informàtiques per a l'estadística, Probabilitat and Distribucions multidimensionals.

Objectives

We introduce the students into the theory of the stochastic processes, with a special emphasis on how they can be used to mathematically model several examples and real situations. More precisely, the main part of the course is devoted to deal with Markov chains, which provide one of the more important tools in stochastic modeling, with a lot of applications, for example in biology, medicine or queuing theory. We introduce discrete-time and continuous-time Markov chains and, due to its highly level of applicability, we specially treat the Poisson process, as a example of birth and death processes, and branching processes. During the course mathematical proofs will be mostly avoided, although we give a reference for them, and we focus on the applications of the methods and techniques to particular examples. Indeed, one of the principal aims consists that students learn to choose the convenient method in order to model some phenomenon, and also to implement it as well as to extract conclusions.

Another major objective is to introduce the Brownian motion, which represents the paradigmatic example of stochastic process with non-countable state space. Its definition will be motivated, emphasizing all variety of fields where Brownian motion can be applied, and some of its properties will be studied. We also introduce some processes related to Brownian motion, such as the Brownian bridge and the geometric Brownian motion.

Finally, the last aim of the course is that the students learn to use the software R in order to simulate different types of stochastic processes and extract the pertinent conclusions in view of the phenomenon that is being modeled.

Learning outcomes

- CM09 (Assess the suitability of the models with the correct use and interpretation of indicators and graphs.) Assess the suitability of the models with the correct use and interpretation of indicators and graphs.
- KM12 (Provide the experimental hypotheses of modelling, considering the technical and ethical implications involved.) Provide the experimental hypotheses of modelling, considering the technical and ethical implications involved.
- SM12 (Interpret the results obtained to formulate conclusions about the experimental hypotheses.) Interpret the results obtained to formulate conclusions about the experimental hypotheses.

Contents

1. Introduction to stochastic processes

2. Discrete-time Markov chains

3. Branching processes

4. Poisson process

5. Continuous-time Markov chains

6. Brownian motion

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Theoretical classes	26	1.04	
Personal study, problem solving and computer work	90.5	3.62	
Problem classes	14	0.56	
Computer sessions	12	0.48	

Theory sessions consist of lectures in which the instructor presents the course content. Students are expected to adopt a positive and proactive attitude towards learning.

During problem-solving sessions, the instructor will work through exercises selected from problem sets that will have been made available to students in advance. Students are strongly encouraged to attempt the exercises independently before attending the corresponding class.

Practical sessions will take place in computer labs and will be highly interactive. Students will solve problems and complete practical assignments using the R software environment. These sessions are designed to put into practice the concepts covered in the theory and problem-solving classes by addressing real-world situations, where students will be required to develop appropriate models to analyse different phenomena and draw meaningful conclusions.

Tutorial sessions provide students with the opportunity to clarify doubts and receive guidance from the instructor. They are intended to support the directed learning activities. Students are strongly encouraged to make regular use of these sessions in order to assimilate the course material progressively and at an appropriate pace, rather than postponing questions or difficulties until later.

A gender perspective in teaching extends beyond course content and also involves reviewing teaching methodologies and the interactions between students and instructors, both inside and outside the classroom. In this regard, participatory teaching methods that foster an inclusive and equitable learning environment, reduce hierarchical dynamics in the classroom, avoid gender stereotypes and sexist language, and promote critical thinking together with respect for diversity and plurality of ideas, people, and situations, tend to encourage the integration and full participation of all students. Accordingly, these principles will be actively implemented throughout this course.

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
Final exam	50	3	0.12	CM09, KM12, SM12
Midterm exam	30	2	0.08	CM09, KM12, SM12
Practical exam	20	2.5	0.1	CM09, KM12, SM12

Continuous Assessment

To pass the course, students must obtain a grade of at least 4.0 in both the midterm exam and the final exam. In addition, the practical exam grade must also be at least 4.0.

The final grade (FG) is calculated as follows:

FG = 0.2 × P + 0.8 × CG

where P is the practical exam grade and CG is the course grade, computed as the weighted average (out of 10 points) of the midterm and final exams. To pass the course, the final grade FG must be at least 5.0.

To be eligible for the resit examination, students must have obtained a final grade FG of at least 3.0. In addition, they must have previously been assessed through a set of activities accounting for at least two-thirds of the total course grade.

If a student takes the resit examination, the final grade is calculated as follows. The resit examination replaces the course grade (CG). The practical grade is not recoverable but is still taken into account when calculating the final grade.

Let:

- R: resit examination grade.
- FCG: final course grade.

The final course grade is calculated as:

$$FCG = 0.3 \times CG + 0.7 \times R$$

Note that FCG depends both on the resit examination grade and on the original course grade (CG).

The final grade is then computed as:

$$FG = 0.2 \times P + 0.8 \times FCG$$

Not Assessed

A student will be considered Not Assessed if they have completed assessment activities accounting for less than 50% of the final course grade.

Single Assessment

The single assessment consists of two examinations, covering the same syllabus as the midterm and final examinations of the continuous assessment, together with a practical examination. To pass the course, students must satisfy the same requirements as under the continuous assessment system. The final grade is calculated in the same way as for continuous assessment.

The same resit policy applies as in the continuous assessment system, and the final course grade after the resit examination will be calculated as described above. The same criterion for the Not Assessed status also applies.

Honors Distinctions

Honors distinctions will be awarded on the basis of the final grade obtained before the resit examination.

Use of AI

The use of Artificial Intelligence (AI) technologies is not permitted at any stage of this course. Any work that includes AI-generated content will be considered a breach of academic integrity and may result in a partial or total penalty to the activity's grade, or more severe disciplinary sanctions in cases of greater seriousness.

Irregularities in Assessment Activities

Any irregularity committed during an assessment activity (including academic fraud, plagiarism, or the improper use of AI) that may lead to a significant alteration of the student's grade will result in that assessment being graded as 0. If the course syllabus establishes that obtaining a minimum grade in that assessment is a mandatory requirement for passing the course, or if multiple irregularities are committed in the assessment activities of the same course, the final grade for the course will be 0. In addition, disciplinary proceedings may be initiated against any student who commits any of these irregularities.

Bibliography

Borovkov, Konstantin. Elements of stochastic modelling. Second edition. World Scientific Publishing Co., 2014.

Dobrow, Robert P. Introduction to stochastic processes with R. John Wiley & Sons, 2016. (*)

Rincón, Luis. Introducción a los procesos estocásticos. Las Prensas de Ciencias, Fac. de Ciencias, UNAM. It can be downloaded from: http://www.matematicas.unam.mx/lars/flip-procesos/flip-en-pdf/procesos2012.pdf

Pinsky, Mark A. and Karlin, Samuel. An introduction to stochastic modeling. Fourth edition. Elsevier/Academic Press, 2011.

(*) Most important

Software

We will use the statistical software R.

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

(PLAB) Practical laboratories	2	Catalan	second semester	afternoon