University of Gdańsk

Subject card

Subject name and code	Stochastic Processes: Introduction and Applications, PG_00155286		
Field of study	Mathematical Modeling and Data Analysis		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2027/2028
Education level	Bachelor's studies	Subject group	Obligatory subject group in the field of study
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	3	Language of instruction	Polish Polish
Semester of study	5	ECTS credits	5.0
Learning profile	academic	Assessment form	exam
Conducting unit	Faculty of Mathematics, Physics and Informatics -> Rector		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Anita Dąbrowska	
	Teachers		

Lesson types							
	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	15.0	15.0	0.0	0.0	60
	E-learning hours included: 0.0						

Learning activity and number of study hours					
	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	60	5.0	60.0	125

Subject objectives	The aim of the course is to familiarize students with the basics of stochastic processes and their applications.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[MMiADL3_W04] knows the basic concepts, methods and theorems of the theory of probability and statistics, and basic examples both illustrating specific concepts in these areas, and allowing to refute incorrect hypotheses or unauthorized reasoning	The student knows and understands: the concept of a stochastic process and the basic mathematical tools used to characterize it, the concept of conditional expectation, the concept of the Poisson process and its properties, the concept of Markov chains and methods for their description and analysis, the concepts of branching processes and queueing processes, the MCMC method.	[SW4] test/exam - oral or written [SW5] implementation of a problem task
[MMiADL3_U04] correctly uses the concepts of probability theory and statistics, is able - at a simple and medium level of difficulty - to apply the theorems and methods of these fields, and is able to interpret the results obtained	The student is able to: - use the generating function method to calculate moments and sums of independent random variables, - determine basic characteristics of stochastic processes both analytically and through simulations, - analyze the properties of discrete Markov processes using analytical tools, - perform simulations of stochastic processes in Python, - describe and interpret the results of simulations.	[SU3] text preparation/written work [SU4] test/exam - oral or written [SU5] implementation of a problem task
[MMiADL3_K10] is ready to analyse data and communicate the conclusions of such analysis in an accessible form	The student is ready to analyze data concerning stochastic processes and present conclusions from the analysis performed.	[SK1] oral statement/conversation/ discussion [SK6] demonstration of practical skills [SK8] observation of student's independent or team work
[MMiADL3_K02] is ready to precisely formulate questions to deepen his/her own understanding of a given topic or to find missing elements of reasoning	The student correctly identifies what he or she does not understand and formulates pertinent questions regarding problems in the field of stochastic processes.	[SK1] oral statement/conversation/ discussion [SK8] observation of student's independent or team work
[MMiADL3_K06] is ready to formulate opinions on basic mathematical issues	The student formulates correct opinions on basic issues related to stochastic processes.	[SK1] oral statement/conversation/ discussion [SK8] observation of student's independent or team work

Subject contents

1. Generating function method: calculating moments and sums of independent random variables.
2. Basic concepts, examples, and properties of stochastic processes.
3. Conditional expectations.
4. Poisson process.
5. Discrete Markov chains:
   a) Construction of discrete Markov chains
   b) Transition matrix
   c) Chapman-Kolmogorov equation
   d) Classification of states
   e) Periodicity
   f) Transient and recurrent states
   g) Random walks in one and multiple dimensions; absorbing and reflecting barriers
   h) Absorption probability and expected time to absorption
   i) Stationary distributions
   j) Limiting distributions
6. Branching processes.
7. Queueing processes.
8. Fundamentals of Monte Carlo methods.
9. Introduction to English-language terminology related to the subject.

Prerequisites and co-requisites

Knowledge of probability calculus.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Evaluation of the student's attitude	100.0%	0.0%
Tests	51.0%	25.0%
Project	51.0%	25.0%
Exam	51.0%	50.0%

Recommended reading	Basic literature	1. Z. Brzeźniak, T. Zastawniak, Basic Stochastic Processes, Springer 2005 2. A. Iwanik, J. Misiewicz, Wykłady z procesów stochastycznych z zadaniami. Część pierwsza: Procesy Markowa. SCRIPT, Warszawa 2015 3. S. M. Ross, Introduction to Probability Models, Elsevier, Oxford, 2014 4. H. M. Taylor, S. Karlin, An introduction to stochastic modelling, Academic Press, 1998 5. C. P. Robert, G. Casella, Monte Carlo Statistical Methods, Springer, 2004
	Supplementary literature	1. J. Jakubowski, R. Sztencel, Wstęp do teorii prawdopodobieństwa, Script, 2000 2. G. R. Grimmett and D. R. Stirzaker, *Probability and Random Processes*, Oxford University Press, 2001 3. W. Stewart, Probability, Markov Chains, Queues, and Simulation, Princeton University Press, Princeton 2009 4. R. Durett, Essentials of Stochastic Processes, Springer, 1999
	eResources addresses	Basic http://www.stat.yale.edu/~pollard/Courses/251.spring09/Handouts/Chang-notes.pdf - J. Chang, Stochastic Processes
Example issues/ example questions/ tasks being completed	not applicable	
Work placement	Not applicable	

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