MD-2045, CHISINAU, 9/7 STUDENŢILOR STR, PHONE: 022 50-99-05 | FAX: 022 50-99-05, www.utm.md

COMPUTATIONAL STATISTICS

1. Course/Module information

Faculty	Computers, Informatics, and Microelectronics				
Chair/department	Informatics and Systems Engineering				
Study cycle	Cycle II, Master's Studies				
Master's program	**Data Science**				
Year of study	**Semester**	**Evaluation type**	**Formative category**	**Optionality category**	**ECTS credits**
I	1	E	S – Specialized course unit	O - Optional course unit	5

2. Estimated total time

Total hours in the curriculum	Including				
	Auditory hours		Individual work		
	Lecture	Practical work	Term paper	Theoretical study material	Application preparation
150	20	20	-	70	40

3. Prerequisites for Access to the Course/Module

According to the curriculum of Cycle I, bachelor's degree	• Advanced mathematics. • Data structures and algorithms. • Special mathematics.
According to the competencies	• Computer programming. • Algebraic and probabilistic calculus.

4. Conditions for the educational process

Lecture	Classroom equipped with a whiteboard, projector, and computer.
Practical work	Computer lab with appropriate software.

5. Specific competencies acquired

Professional competencies	• Operating with concepts and scientific methods from mathematics, the field of applied informatics, information project management, and information and communication technology; • Designing, developing, implementing, and managing complex intelligent information systems; • Identifying, formulating, and solving problems using the tools of computer science and engineering; • Managing the processes of developing information systems and ensuring the quality of products and services; • Using advanced methods of modeling, simulation, identification, and analysis of software systems, phenomena, and processes in the field of intelligent information systems; • Scientific research in the field of information and communication technology; Managing IT products and services in accordance with market requirements.
Transversal competencies	• Honorable, responsible, and ethical behavior, in accordance with the law, to ensure the fulfillment of professional duties; • Demonstrating the ability to work in a team, identifying individual and collective roles

	and responsibilities, making decisions, and assigning tasks, while applying communication and effective work techniques within the team; • Demonstrating initiative and action for professional and personal development through continuous learning, using documentation sources in Romanian and international languages.

6. Course/Module objectives

General objective	Mastering the most important calculation methods used in Mathematical Statistics.
Specific objectives	• Knowledge of modern computational methods used in statistics, especially simulation, estimation, and visualization methods for statistical data; • Understanding the role of computational calculation as a tool for statistical data analysis; • Proper application of computational methodologies in solving statistical problems; • Solving economic and engineering problems using mathematical methods, statistical methods, and computer techniques; • Deepening and applying knowledge in identifying and analyzing development trends, processing methods, modeling, and using applications in the field of applied computer science. • Analyzing market requirements and contemporary trends regarding the development of software products in the field of applied computer science.

7. Course/Module content

Syllabus of teaching activities	Number of hours
Syllabus of lecture activities	
T1. The main classical distributions and their mathematical modeling. Introductory concepts regarding the R language.	2
T2. Generation of random variables using a computer.	2
T3. Monte Carlo simulations. Monte Carlo integration and numerical integration.	2
T4. Statistical hypotheses. Statistical tests. Simulations. Shapiro-Wilk test. Pearson's $\chi 2$ (chi-square) test. Kolmogorov-Smirnov test.	2
T5. Student's t-test. Fisher's F-test. Wilcoxon test.	2
T6. Jackknife methods.	2
T7. Bootstrap methods.	2
T8. Fisher's scoring algorithm.	2
T9. The EM algorithm (engl. "Expectation – Maximization", Aşteptare-Maximizare).	2
T10. Data visualization and result analysis.	2
Total lectures:	**20**

Syllabus of teaching activities	Number of hours
Syllabus of seminar/practical work activities	
LP1. The main classical distributions and their mathematical modeling: binomial, Poisson, normal (Gaussian), exponential, gamma, beta. Implementation in R language.	2
LP2. Generation of random variables using a computer: uniform random numbers, non-uniform random numbers. R functions.	2
LP3. Monte Carlo simulations. Monte Carlo methods. Importance of sampling. Random processes. Confidence intervals. Implementation in R language.	2

LP4. Monte Carlo integration and numerical integration. Implementation in R language.	2
LP5. Statistical tests. Simulations. Estimation quality. R functions.	2
LP6. Jackknife methods. Implementation in R language.	2
LP7. Bootstrap methods. Implementation in R language.	2
LP8. Fisher's scoring algorithm. Maximum likelihood estimation. Hardy Weinberg example. Implementation in R language.	2
LP9. EM algorithm (Expectation-Maximization). Implementation in R language.	2
LP10. Data visualization methods and result analysis. R functions.	2
Total practical works:	**20**

8. Using generative AI

Permission to use	The use of generative AI in assignments and projects is permitted, provided that students adhere to the following rules: • Generative AI may be used to generate ideas, text structures, or code, but all generated materials must be reviewed and adjusted by the student to ensure that they meet academic requirements. • Any use of generative AI must be declared in the appendix section of each paper, using the phrase: "During the preparation of this paper, the author used [NAME OF TOOL / SERVICE] for the purpose of [REASON]. After using this tool / service, the author reviewed and edited the content as necessary and assumes full responsibility for the content of the paper."
Restrictions to use	Students ***MUSTN'T consider generative AI as a reliable source of information***, as it does not provide clear references or documented sources. • ***Direct citation of AI-generated content*** in academic papers as if it were a primary source ***isn't permitted.*** • Activities in which the use of **generative AI is prohibited** are specified by the teacher and are usually ***intermediate and final assessments*** or that don't involve professional competence development activities.

9. Bibliographic References

Main	• Morariu, C. O., Statistică aplicată, Editura Universitatii "Transilvania", Brasov, 2014. • Givens G.H., Hoeting J.A.: Computational Statistics, 2013, John Wiley & Sons Inc., New Jersey. • E.Paradis. R pentru începători. Franța, 2013. • Sawitzki G.: Computational Statistics: An Introduction to R., Exercises, CRC Press, Boca Raton (FL), 2014 • John A. Rice. Mathematical Statistics and Data Analysis, Third Edition, 2010. • James E. Gentle. Computational Statistics. New York : Springer, 2009. • Longhai Li. Some Lecture Notes for STAT 812 Computational Statistics. Canada, 144 p. 8. https://www.tutorialspoint.com/execute_r_online.php
Supplementary	1. Micula, S., Probability and Statistics for Computational Sciences, Cluj University Press, Cluj-Napoca, 2009. 2. Demidovich B.P., Maron I.A., Computational Mathematics, Mir Publishers, 1981. 3. Introduction to Computational Thinking and Data Science:

	https://www.edx.org/course/introduction-computational-thinking-data-mitx-6-00-2x-4 4. Computational Probability and Inference https://www.edx.org/course/computational-probability-inference-mitx-6-008-1x.

10. Evaluation

Periodic		Current evaluation	Individual work	Final examination
Mid-term 1	Mid-term 2			
15%	15%	15%	15%	40%

1. Evaluation criteria

Activity	Evaluation components	Evaluation method, evaluation criteria	Weight in final grade for the Activity	Weight in course evaluation
Full-time education				
Mid term I	Theoretical content, topics 1-3	Test	100%	**15%**
Mid term II	Theoretical content, topics 4-5	Activities during practical work/seminar	100%	**15%**
Current evaluation	Practical activity	Attendance and participation in classes	50%	**15%**
Individual study	Task 1: Classification of research by activity type	Presentation/Discussion on the topic	50%	**15%**
	Task 2: Developing a scientific article	Article presented for evaluation	50%	
Final examination	Theoretical and practical content	Oral exam. Grading according to grading scale	100%	**40%**