GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Statistical modeling and data visualization, PG_00053367		
Field of study	Biomedical Engineering, Biomedical Engineering, Biomedical Engineering		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	Obligatory subject group in the field of study Specialty subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Biomedical Engineering -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Tomasz Neumann	
	Teachers	dr Tomasz Neumann	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	30.0	15.0	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	4.0	36.0	100

Subject objectives

The aim of the course is to present the methods of programming of complex numerical simulations of biomedical phenomena using the Monte Carlo method in Python.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W04] knows and understands, to an increased extent, the principles, methods and techniques of programming and the principles of computer software development or programming devices or controllers using microprocessors or other elements or programmable devices specific to the field of study, and organization of work of systems using computers or such devices	The student has knowledge of the use of appropriate libraries for implementation, testing and validation as well as visualization of numerical calculations of biomedical problems using the Monte Carlo method.	[SW1] Assessment of factual knowledge
[K7_U12] is able, to an increased extent, to analyze the operation of components and systems related to the field of study, as well as to measure their parameters and study their technical characteristics, and to plan and carry out experiments related to the field of study, including computer simulations, interpret the obtained results and draw conclusions	Skills gained by a student: - create and analyze numerical simulations in Python, - visualize simulation results using appropriate libraries in Python, - design and test numerical calculations related to the use of the Monte Carlo method in biomedical engineering problems, - optimize a software solution using the Monte Carlo method as well as process and visualize data.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
[K7_K02] is ready to provide critical evaluation of received content and to acknowledge the importance of knowledge in solving cognitive and practical problems	The student uses the acquired Python programming and data visualization skills as well as statistical modelling using the Monte Carlo method to solve a biomedical problems in a project group.	[SK5] Assessment of ability to solve problems that arise in practice [SK1] Assessment of group work skills [SK2] Assessment of progress of work

<table>
<tr><td>Subject contents</td><td colspan="3">1. Introduction to the subject of statistical modeling 2. Modeling of numerical calculations in Python 3. Visualization of modeling results using Python 4. Basic distributions and theorems used in statistical modeling 5. Taking random samples 6. Verification of statistical hypotheses 7. Pseudorandom number generators 8. Introduction to the classical Monte Carlo method 8. The use of the Monte Carlo method in solving various physical and biomedical problems (light propagation in a weakly and strongly scattering medium, modeling therapeutic radiation beams, etc.) 9. Optimization of the Monte Carlo method's 10. Application of the Monte Carlo method in statistical tests 11. Introduction to Markov chains 12. Sampling Monte Carlo with Markov chains 13. Application of the Monte Carlo method in other fields of science and technology</td></tr>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">Basics of programming in any high-level language.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Laboratory</td><td>51.0%</td><td>40.0%</td></tr>
<tr><td>Project</td><td>51.0%</td><td>30.0%</td></tr>
<tr><td>Exam</td><td>51.0%</td><td>30.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">1) Python for Scientists, 2014, John M. Stewart, Cambridge University Press
2) Data Analysis Statistical and Computational Methods for Scientists and Engineers 4th edition, 2014, Siegmund Brandt, Springer
3) Monte Carlo Methods for Radiation Transport, 2017, Oleg N. Vassiliev, Springer</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">1) A primer on pseudorandom generators, 2010, Oded Goldreich, American Mathematical Society
2) Monte Carlo Simulation in the Radiological Sciences, Edited by Richard L. Morin, CRC Press, 2019</td></tr>
<tr><td>eResources addresses</td><td colspan="2">Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3">Examples of project topics:
1) Modeling the light field in the skin using the Monte Carlo method
2) Modeling the dose distribution in the phantom using the Monte Carlo method
3) The use of the Monte Carlo method in the analysis and processing of signals</td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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