GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Learning Math with ChatGPT – Matrix Decompositions, PG_00069089		
Field of study	Technical Physics, Materials Engineering, Mathematics, Nanotechnology, Nanotechnology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	Optional subject group
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish I encourage you to watch the MIT lecture. It is not necessary
Semester of study	3	ECTS credits	1.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Institute of Applied Mathematics -> Faculty of Applied Physics and Mathematics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Karol Dziedziul	
	Teachers	dr hab. Karol Dziedziul	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	0.0	0.0	15.0	0.0	0.0	15

E-learning hours included: 0.0

eNauczanie source addresses:

Moodle ID: 954 Uczenie się matematyki z ChatGPT – rozkłady macierzowe
https://enauczanie.pg.edu.pl/2025/course/view.php?id=954

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	15	2.0	8.0	25

Subject objectives

Students will be introduced to selected matrix decomposition methods, including the singular valence decomposition (SVD), the Cholesky decomposition, and the CUR. Practical use of ChatGPT in mathematics learning: generating solutions, analyzing results, and assessing the correctness of answers. Students will develop independent mathematical problem-solving skills with the support of artificial intelligence, with an emphasis on critical thinking and assessing the quality of answers.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U10] understands the mathematical foundations of the analysis of algorithms and computational processes, constructs algorithms with good numerical properties, used to solve typical and unusual mathematical problems	Using R, ability to use matrix decompositions for image compression. Evaluate compression efficiency visually and using the Frobenius norm.	[SU1] Assessment of task fulfilment
[K7_K04] forms opinions on mathematical issues	Ability to ask prompts that demonstrate the level of insight into mathematical and numerical questions	[SK2] Assessment of progress of work

Subject contents

Basic matrix concepts. More-Penrose matrices. Matrix decompositions: Cholesky, LU, Rank factorization, CUR, singular SVD, Jordan, Schur, QZ.
Additional refreshers or supplementary concepts: Rank of a matrix, Uniqueness theorem, Inverse matrix (when $\det(A)\neq 0$), Projection of a vector onto a subspace, Determinant of a matrix and its geometric interpretation, Matrix as operator $A:R^n \to R^m$, operator image and its kernel, Complex matrix as operator $A:C^n \to C^m$, operator image and its kernel, Orthogonal matrix \(Q\): \(Q^\top Q = I\), Vandermonde matrix and interpolation with polynomials and their relationship, Orthogonal matrices, example: Hadamar matrix.
Discussion of prompt formulation methods that allow for obtaining accurate results.

<table>
<tr><td>Prerequisites
and co-requisites</td><td colspan="2">Create an account at https://chatgpt.com. In principle, a course in linear algebra is not required. The limited knowledge of algebra taught in universities can even be limiting.</td></tr>
<tr><td>Assessment methods
and criteria</td><td colspan="2"><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Mini-tests at the end of each block</td><td>60.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>Gilbert Strang Linear Algebra nad its Application

Gilbert Strang The geometry of linear equations (MIT OCW)</td></tr>
<tr><td>Supplementary literature</td><td>Lloyd N. Trefethen & David Bau III "Numerical Linear Algebra

Ivan Markovsky "Low Rank Approximation: Algorithms, Implementation, Applications"</td></tr>
<tr><td>eResources addresses</td><td>Basic
https://mostwiedzy.pl/pl/karol-dziedziul,4112-1 - see matrix decompositions
Supplementary
https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/resources/lecture-1-the-geometry-of-linear-equations/ - Strang lectures MIT</td></tr>
<tr><td>Example issues/
example questions/
tasks being completed</td><td colspan="2">1. Compute the singular value decomposition (SVD) for a matrix A=(1324). 2. Compute the Cholesky decomposition for a symmetric matrix, e.g., A=(4223). 3. Explain when the CUR decomposition is used, giving an example of its application in data analysis. 4. For any square matrix B of dimension 3×3, find the matrix P_I that eliminates the second raw, i.e., for $I=\{1,3\}$ \[P_IB=B(I,:) \] for any matrix B of dimension 3×4. 5. Compare the quality of solutions (e.g., reconstruction error) in NMF for different starting points</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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