#### card of course

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| Subject name | Mathematical Foundations of Artificial Intelligence - Laboratory |

1. The placement of the subject in the study system

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| 1.1. Field of study | Computer science |
| 1.2. Form and path of study | Full-time/Part-time |
| 1.3. Level of education | First-cycle studies |
| 1.4. Study profile | Practical |

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| 1. 5. Specialty | Artificial intelligence |
| 1.6. Subject Coordinator | Dr Michał Kalisz |

2. General characteristics of the subject

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| 2.1. Belonging to a subject group | Optional/practical |
| 2.2. Number of ECTS | 2 |
| 2.3. Language of lectures | English |
| 2.4. Semesters in which the subject is taught | III |
| 2.5.Criteria for selecting course participants | For specialization: Artificial Intelligence |

1. Learning outcomes and course delivery
   1. Subject Objectives

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| No. | Subject Objectives |
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| C1 | Familiarization with key mathematical concepts supporting artificial intelligence, developing knowledge of linear algebra, probability and statistics. |
| C2 | Developing practical skills in implementing the basics of mathematics in programming, using the Python language and its libraries to perform mathematical operations. |
| C3 | Preparation for analyzing and solving AI problems using mathematical tools, interpreting results in the context of practical applications. |

* 1. Subject-specific learning outcomes, divided into knowledge , skills and competences , with reference to the directional learning outcomes

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| No. | Description of subject  learning outcomes | Reference to  directional effects  learning (symbols) | Method of implementation (mark "X") | | | |
| ST | | NST | |
| Classes at the University | Activities on  the platform | Classes at the University | Activities on  the platform |
| After passing the course, the student knows and understands **the knowledge** | | | | | | |
| W1 | Knows basic operations of linear algebra, such as operations on matrices, vectors, and matrix decompositions. | INF\_W02 INF\_W07 INF\_W10 INF\_W19 | X |  | X |  |
| W2 | Understands the concepts of probability, random variables and their distributions, and knows their application in AI modeling. | X |  | X |  |
| W3 | Familiar with optimization methods, including gradient descent and iterative methods, and understands their role in training AI models. | X |  | X |  |
| W4 | Understands the importance of statistics in data analysis, knows basic statistical measures and methods of statistical inference. | X |  | X |  |
| After passing the course, the student is **able** to: | | | | | | |
| U1 | Can perform matrix and vector operations in Python using NumPy and similar libraries. | INF\_U13 INF\_U19 INF\_U21 INF\_U27 | X |  | X |  |
| U2 | Is able to perform probabilistic and statistical analyses using programming tools. | X |  | X |  |
| U3 | Can implement optimization methods and analyze their performance in AI tasks. | X |  | X |  |
| U4 | Is able to visualize data and results of mathematical analyses using Matplotlib or Seaborn. | X |  | X |  |
| After completing the course, the student is ready to take part in **social competences.** | | | | | | |
| K1 | He is aware of the need for continuous development of the mathematical foundations of AI, especially in the context of their practical applications. | INF\_K02 | X |  | X |  |

3.3. Forms of teaching and their number of hours - Full-time studies (ST), Part-time studies (NST)

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Path | Lecture | Exercises | Design | Workshop | Laboratory | Seminar | Lecturer | Classes conducted using distance learning methods and techniques in the form of ………………. | Other | **ECTS points** |
| **ST** |  |  |  |  | 20 |  |  |  |  | 2 |
| **NST** |  |  |  |  | 10 |  |  |  |  | 2 |

3.4. Content of education (separately for each form of classes: (W, ĆW, PROJ, WAR, LAB, LEK, OTHER). It should be marked (X) how the given content will be implemented (classes at the university or classes on the e-learning platform conducted using distance learning methods and techniques)

TYPE OF CLASS: LABORATORY

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| --- | --- | --- | --- | --- | --- | --- |
| No. | Content of the course | Reference to subject-specific learning outcomes | Method of implementation (mark "X") | | | |
| ST | | NST | |
| **Classes at the University** | **Activities on  the platform** | **Classes at the University** | **Activities on  the platform** |
| 1. | Linear algebra operations in Python, operations on matrices and vectors, NumPy as a tool supporting analysis. | W1, U1 | X |  | X |  |
| 2. | Basics of probability theory, random variables, distributions and their application in AI modeling. | W2, U2 | X |  | X |  |
| 3. | Descriptive statistics and statistical inference, basic statistical measures, hypothesis tests. | W4, U2 | X |  | X |  |
| 4. | Optimization methods in AI, gradient descent, iterative approach to finding the minimum of the cost function. | W3, U3 | X |  | X |  |
| 5. | Visualization of mathematical analysis results, Matplotlib and Seaborn as data presentation tools. | W4, U4, K1 | X |  | X |  |
| 6. | Examples of using the mathematical foundations of AI in practice, analysis of selected models. | W3, U3, K1 | X |  | X |  |
| 7. | Summary of classes and discussion of grades |  | X |  | X |  |

3.5. Methods of verifying learning outcomes (indication and description of methods of conducting classes and verification of achievement of learning outcomes and method of documentation)

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| Subject Effects | Teaching methods | Methods of verifying learning outcomes | Documentation methods |
| KNOWLEDGE | | | |
| W1-W4 | Knowledge provided during the laboratory | Term project: Implementation of a selected mathematical problem supporting AI  Description:Students are asked to select and implement a selected mathematical problem (e.g. matrix decomposition, regression analysis, gradient method) in Python, then analyze the results and visualize them. | The project was placed on the platform |
| SKILLS | | | |
| U1-U4 | Practical classes performed at computer stations | Term project: Implementation of a selected mathematical problem supporting AI  Description:  Students are asked to select and implement a selected mathematical problem (e.g. matrix decomposition, regression analysis, gradient descent method) in Python, then analyze the results and visualize them. | The project was placed on the platform |
| SOCIAL COMPETENCES | | | |
| K1 | Practical classes performed at computer stations | Term project: Implementation of a selected mathematical problem supporting AI  Description:Students are asked to select and implement a selected mathematical problem (e.g. matrix decomposition, regression analysis, gradient method) in Python, then analyze the results and visualize them. | The project was placed on the platform |

3.6. Assessment criteria for the achieved learning outcomes

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| Learning effect | For a grade of 3 or "pass."  the student knows and understands/is able to/is ready to | For a grade of 3.5, the student knows and understands/is able to/is ready to | For a grade of 4, the student knows and understands/is able to/is ready to | For a grade of 4.5, the student knows and understands/is able to/is ready to | For a grade of 5, the student knows and understands/is able to/is ready to |
| W | 51-60% of knowledge indicated in learning outcomes | 61-70% of knowledge indicated in learning outcomes | 71-80% of knowledge indicated in learning outcomes | 81-90% of knowledge indicated in learning outcomes | 91-100% of knowledge indicated in learning outcomes |
| U | 51-60% of skills indicated in learning outcomes | 61-70% of skills indicated in learning outcomes | 71-80% of skills indicated in learning outcomes | 81-90% of skills indicated in learning outcomes | 91-100% of skills indicated in learning outcomes |
| K | 51-60% of skills indicated in learning outcomes | 61-70% of skills indicated in learning outcomes | 71-80% of skills indicated in learning outcomes | 81-90% of skills indicated in learning outcomes | 91-100% of skills indicated in learning outcomes |

3.7. Literature

**Basic**

1. Raschka S., Mirjalili V., "Python Machine Learning. Wydanie III", Helion, 2021.
2. Vasiliev Yuli, Python w Data Science . Praktyczne wprowadzenie, Helion, 2024

**Supplementary**

1. Bradford Tuckfield, Data Science i Python, Helion, 2024

4. Student workload - ECTS points balance

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| **Types of student activity** | **Student Load** | |
| **ST** | **NST** |
| **Classes requiring direct contact between the student and the academic teacher at the university premises** | **20** | **10** |
| Classes included in the study plan | 20 | 10 |
| **Student's own work** | **30** | **40** |
| Ongoing preparation for classes, preparation of project work/presentations/etc. | 15 | 20 |
| Preparation for passing classes | 15 | 20 |
| **TOTAL STUDENT HOURLY LOAD** | **50** | **50** |
| **Number of ECTS points** | **2** | **2** |

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| Last change date | 30/09/2024 |
| The changes were introduced | INF Education Quality Team |
| The changes were approved | Arkadiusz Gwarda, M.A. |