#### card of course

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| Subject name | Neural networks part II |

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 inż. Róża Dzierżak |

2. General characteristics of the subject

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| 2.1. Belonging to a subject group | Directional/Practical |
| 2.2. Number of ECTS | 2 |
| 2.3. Language of lectures | Polish |
| 2.4. Semesters in which the subject is taught | IV |
| 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 | Understanding architectures such as convolutional neural networks (CNN) and recurrent neural networks (RNN) and their applications. |
| C2 | Implementing advanced neural networks using popular libraries. |
| C3 | Solving problems such as image recognition, text processing, and time sequence analysis. |

* 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 the basic principles of operation and applications of convolutional networks (CNN) and recurrent networks (RNN). | INF\_W07  INF\_W10 INF\_W19 | X |  | X |  |
| W2 | Understands the differences between basic and advanced architectures such as ResNet, LSTM, and GRU. | X |  | X |  |
| W3 | Knows model regularization and optimization mechanisms such as dropout, batch normalization and learning rate schedulers. | X |  | X |  |
| W4 | Understands the importance of transfer learning and transfer learning techniques in practice. | X |  | X |  |
| W5 | Possesses knowledge of the evaluation of advanced models and the analysis of their results. | X |  | X |  |
| After passing the course, the student is **able** to: | | | | | | |
| U1 | Can implement convolutional neural networks (CNN) and recurrent neural networks (RNN) using TensorFlow or PyTorch. | INF\_U13 INF\_U19 INF\_U21 | X |  | X |  |
| U2 | Is able to apply regularization and optimization techniques to improve model performance. | X |  | X |  |
| U3 | Can prepare data for training advanced models, including images, time sequences, and texts. | X |  | X |  |
| U4 | Can perform transfer learning and adapt existing models to new problems. | X |  | X |  |
| U5 | Can evaluate models and interpret results based on advanced metrics such as F1-score | X |  | X |  |
| After completing the course, the student is ready to take part in **social competences.** | | | | | | |
| K1 | Understands the importance of correct implementation and interpretation of advanced neural network models. | INF\_K05 | X |  | X |  |
| K2 | Is aware of the ethical and social implications of the applications of advanced artificial intelligence technologies. | 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 a lecture | Other | **ECTS points** |
| **ST** |  |  |  |  | 30 |  |  |  |  | 2 |
| **NST** |  |  |  |  | 15 |  |  |  |  | 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. | Convolutional neural networks (CNN)  Basic concepts, implementation of models for image classification. | W1, U1, K1 | X |  | X |  |
| 2. | Recurrent Networks (RNN)  Architecture, LSTM and GRU, temporal sequence analysis. | W2, U1 | X |  | X |  |
| 3. | Model regularization and optimization techniques  Dropout, batch normalization, hyperparameter tuning. | W3, U2 | X |  | X |  |
| 4. | Transfer learning  Using pre-trained models and adapting them to new problems. | W4, U4 | X |  | X |  |
| 5. | Preparing data for advanced models  Formatting image data, time sequences, and text. | W5, U3, K2 | X |  | X |  |
| 6. | Advanced model evaluation metrics  F1-score, confusion matrix, AUC, results analysis. | W5, U5 | 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-W5 | Knowledge provided during the laboratory | Term project: Implementation of an advanced neural network model to solve a selected problem  Description:Students implement an advanced model, e.g. CNN for image classification, RNN for text or temporal sequence analysis. | The project was placed on the platform |
| SKILLS | | | |
| U1-U5 | Practical classes performed at computer stations | Term project: Implementation of an advanced neural network model to solve a selected problem  Description:Students implement an advanced model, e.g. CNN for image classification, RNN for text or temporal sequence analysis. | The project was placed on the platform |
| SOCIAL COMPETENCES | | | |
| K1-K2 | Practical classes performed at computer stations | Term project: Implementation of an advanced neural network model to solve a selected problem  Description:Students implement an advanced model, e.g. CNN for image classification, RNN for text or temporal sequence analysis. | 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. Julian David Designing machine learning systems with Python; Packt Publishing; Birmingham 2016
2. Raschka S., Mirjalili V., "Python Machine Learning. Wydanie III", Helion, 2021.
3. Sarah Guido, Andreas C Muller, Machine Learning, Python i data science, Helion, 2023

**Supplementary:**

1. Ameisen Emmanuel Building Machine Learning Powered Applications : Going from Idea to Product; O'Reilly; Sebastopol 2020
2. Wróblewski Piotr, Machine learning i natural language processing w programowaniu.. Podręcznik z ćwiczeniami w Pythonie, 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** | **30** | **15** |
| Classes included in the study plan | 30 | 15 |
| **Student's own work** | **20** | **35** |
| Ongoing preparation for classes, preparation of project work/presentations/etc. | 10 | 20 |
| Preparation for passing classes | 10 | 15 |
| **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. |