



## Subject card

|   |   |  |          |                                     |   |            |     |
|---|---|--|----------|-------------------------------------|---|------------|-----|
| Subject name and code                       | Deep learning, PG_00064441  |  |          |                                     |   |            |     |
| 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  |          |                                     | Optional subject group<br>Specialty subject group<br>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   |          |                                     | 3.0   |            |     |
| 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  | prof. dr hab. inż. Jacek Rumiński                        |          |                                     |   |            |     |
|   | Teachers  | prof. dr hab. inż. Jacek Rumiński                        |          |                                     |   |            |     |
| Lesson types and methods of instruction     | Lesson type   | Lecture  | Tutorial | Laboratory                          | Project   | Seminar    | SUM |
|   | Number of study hours   | 30.0   | 0.0      | 15.0                                | 0.0   | 0.0        | 45  |
|   | 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   | 45   |          | 4.0                                 |   | 26.0       | 75  |
| Subject objectives                          | The aim of the course is to provide students with knowledge in the field of deep, artificial neural networks and to develop practical skills in this field. |  |          |                                     |   |            |     |

| Learning outcomes | Course outcome   | Subject outcome  | Method of verification                |
|-------------------|--|--|---------------------------------------|
|                   | [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   | The result of the learning process is that the student acquires the skills to conduct experiments using deep learning and interpret the results.   | [SU1] Assessment of task fulfilment   |
|                   | [K7_U04] can apply knowledge of programming methods and techniques as well as select and apply appropriate programming methods and tools in computer software development or programming devices or controllers using microprocessors or programmable elements or systems specific to the field of study, making assessment and critical analysis of the prepared software as well as a synthesis and creative interpretation of information presented with it | The result of the learning process is that the student acquires the ability to practically apply deep learning algorithms, in particular convolutional and recurrent networks, in particular through the implementation of network model software, their training, testing and interpreting the results. | [SU1] Assessment of task fulfilment   |
|                   | [K7_W01] knows and understands, to an increased extent, mathematics to the extent necessary to formulate and solve complex issues related to the field of study  | The effect of the learning process is the student gaining knowledge in the field of understanding the definition of deep learning algorithms, in particular convolutional and recursive networks related patterns and problems related to the deep network learning process.                             | [SW1] Assessment of factual knowledge |
|                   | [K7_W03] knows and understands, to an increased extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum  | The effect of the learning process is the acquisition of knowledge by the student in the field of deep learning methods, in particular in the field of data classification tasks, object detection and other tasks related to the field of study.  | [SW1] Assessment of factual knowledge |

| Subject contents   | <p>Introduction to deep learning</p> <p>Convolution operation and its importance</p> <p>CNN layers and their versions</p> <p>Convolutional neural networks (types of layers, learning)</p> <p>Classification with the use of convolutional networks</p> <p>Problems with learning deep networks (overfitting, fading gradient, etc.)</p> <p>Methods of counteracting problems related to learning deep networks (regularization, augmentation, dropout, early stopping, etc.)</p> <p>Transfer learning</p> <p>RNN models</p> <p>Development of RNN models (including LSTM etc.)</p> <p>The use of RNN models in NLP</p> <p>Generational models</p> <p>Autoencoders</p> <p>Application of generation models</p> <p>Reinforcement learning</p> <p>Reinforcement learning with the use of deep models part 1</p> <p>Reinforcement learning with the use of deep models part 2</p> |  |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
|--|--|--|--|--------------------------|-------------------|-------------------------------|-----|-------|-------|-------------|------|-------|------|-------|-------|
| Prerequisites and co-requisites                                | Implementation of the subjects from the first semester.  |  |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
| Assessment methods and criteria                                | <table border="1"> <thead> <tr> <th data-bbox="451 1525 794 1563">Subject passing criteria</th> <th data-bbox="794 1525 1137 1563">Passing threshold</th> <th data-bbox="1137 1525 1477 1563">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="451 1563 794 1597">Lab</td> <td data-bbox="794 1563 1137 1597">50.0%</td> <td data-bbox="1137 1563 1477 1597">50.0%</td> </tr> <tr> <td data-bbox="451 1597 794 1630">Assignments</td> <td data-bbox="794 1597 1137 1630">0.0%</td> <td data-bbox="1137 1597 1477 1630">10.0%</td> </tr> <tr> <td data-bbox="451 1630 794 1664">Exam</td> <td data-bbox="794 1630 1137 1664">50.0%</td> <td data-bbox="1137 1630 1477 1664">40.0%</td> </tr> </tbody> </table>   |  |  | Subject passing criteria | Passing threshold | Percentage of the final grade | Lab | 50.0% | 50.0% | Assignments | 0.0% | 10.0% | Exam | 50.0% | 40.0% |
| Subject passing criteria                                       | Passing threshold  | Percentage of the final grade  |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
| Lab  | 50.0%  | 50.0%  |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
| Assignments  | 0.0%   | 10.0%  |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
| Exam   | 50.0%  | 40.0%  |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
| Recommended reading  | Basic literature   | <p>Bengio Yoshua, Courville Aaron, Goodfellow Ian, Deep Learning, Systemy uczące się, PWN 2018</p> <p>Andrew W. Trask, Zrozumieć głębokie uczenie, PWN, 2019</p> |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
|  | Supplementary literature   | brak   |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
|  | eResources addresses   | Adresy na platformie eNauczanie:   |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
| Example issues/<br>example questions/<br>tasks being completed |  |  |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |
| Work placement   | Not applicable   |  |  |                          |                   |                               |     |       |       |             |      |       |      |       |       |

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