GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Advanced Architectures of Neural Networks, PG_00054194		
Field of study	Informatics		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2024/2025
Education level	second-cycle studies	Subject group	Optional 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	2	Language of instruction	Polish
Semester of study	3	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Computer Architecture -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Jan Cychnerski	
	Teachers	dr inż. Jan Cychnerski	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	30.0	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	2.0	28.0	75

Subject objectives	The aim of the course is to provide students with knowledge and skills regarding the construction, training and application of advanced deep artificial neural networks, such as, for example, multimodal networks, multi-output networks, modern deep convolution networks, transformer networks, etc. After completing the course, the student should have extensive knowledge on this subject and be able to build, learn and apply (using appropriate tools and frameworks) this type of neural network to solve a selected practical problem.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[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.	Knowledge of the construction and applications of architecturally advanced deep neural networks.	[SW1] Assessment of factual knowledge
[K7_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study by:n- appropriate selection of source information and its critical analysis, synthesis, creative interpretation and presentation,n- application of appropriate methods and toolsn	The ability to analyze a selected problem related to machine learning and design the proper architecture of a neural network and the method of training this network in order to solve the problem.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_U05] can plan and conduct experiments related to the field of study, including computer simulations and measurements; interpret obtained results and draw conclusions	The ability to conduct experiments with the use of deep neural networks, including searching the space of network learning hyperparameters.	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
[K7_U03] can design, according to required specifications, and make a complex device, facility, system or carry out a process, specific to the field of study, using suitable methods, techniques, tools and materials, following engineering standards and norms, applying technologies specific to the field of study and experience gained in the professional engineering environment	The ability to design, implement and train a deep neural network, which is a key element of a system dedicated to solving a selected problem.	[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	Ability to build and train advanced neural networks using frameworks such as Tensorflow or Pytorch.	[SU4] Assessment of ability to use methods and tools

Subject contents

- Federated learning
- Neural network as a computational graph - building blocks and basic mechanisms - implementations
- Multi-input and multi-output models (multi-modal and multitasking)
- Multi-gpu (model-parallelism) models
- Breakthrough convolutional network architectures (AlexNet, InceptionNet, ResNet, DenseNet ...)
- Normalization layers (Batch Normalization, Layer Normalization ...)
- Light architectures (e.g. MobileNets, ShuffleNet, EfficientNet, GhostNet, TinyNet)
- Sequence processing and recursive networks in the basic variant and LSTM and GRU
- Attention mechanisms and the Transformer architecture
- Transformer applications (e.g. ELMo, BERT, GPT)

Prerequisites and co-requisites

- Basic linear algebra (vector and matrix operations)
- Ability to program in Python

<table>
<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>Written multiple choice test</td><td>50.0%</td><td>50.0%</td></tr>
<tr><td>Project</td><td>50.0%</td><td>50.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016, url: http://www.deeplearningbook.org/

Michael Nielsen, Neural Networks and Deep Learning, http://neuralnetworksanddeeplearning.com/</td></tr>
<tr><td>Supplementary literature</td><td>Andrew Ng, Machine Learning Yearning, http://www.mlyearning.org/

Tutorials on deep learning frameworks pages, such as: https://www.tensorflow.org/tutorials, http://torch.ch/docs/tutorials.html</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">• What is and what are the advantages of federated learning?
• How does it work and when is it worth using the Batch Normalization layer?
• How to implement and learn a multi-output network?
• Design a neural network and conduct experiments to solve complex artificial intelligence task</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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