GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Deep Learning in Computer Vision, PG_00063940						
Field of study	Informatics						
Date of commencement of studies	February 2027		Academic year of realisation of subject	2027/2028			
Education level	second-cycle studies		Subject group	Optional subject group Specialty 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	1		Language of instruction	English			
Semester of study	2		ECTS credits	2.0			
Learning profile	general academic profile		Assessment form	exam			
Conducting unit	Department of Computer Architecture -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Adam Brzeski					
	Teachers	dr inż. Adam Brzeski					

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	15.0	0.0	30
	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	30	5.0	15.0	50

Subject objectives	The aim of the course is to present modern, advanced architectures of neural networks and training methods applied in image processing and analysis.

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	Student knows and uses advanced, modern convolutional neural networks and recurrent networks as well as proper software libraries for applications in image processing and analysis	[SW1] Assessment of factual knowledge
[K7_W101] is able to make an in-depth identification of key objects and phenomena related to the field of study, as well as theories that describe them and applicable analytical and design methods	Student knows and understands methods for modelling complex cognitive and decision processes in the field of vision and image analysis as well as the principles of developing and deploying computer vision systems based on machine learning	[SW1] Assessment of factual knowledge
[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	Student is able to design deep neural network architectures appropriate for given problems by choosing proper base architectures and applying suitable training methods	[SU1] Assessment of task fulfilment
[K7_U09] can carry out a critical analysis of the functioning of existing technical solutions and assess these solutions, as well as apply experience related to the maintenance of advanced technical systems, devices and facilities typical for the field of studies, gained in the professional engineering environment	Student knows quality criteria used in image analysis problems, quality metrics achieved by state-of-the-art methods for a set of common problems, advantages and disadvantages of base architectures applied in the field	[SU1] Assessment of task fulfilment

Subject contents

Course content – lecture

1. Overview of deep learning applications in computer vision.
2. Advanced neural networks architectures for computer vision.
3. Applications in object localisation and detection.
4. Semantic segmentation, instance-aware segmentation.
5. Model visualisation and explanation, activation and saliency maps.
6. Weakly-supervised, semi-supervised and unsupervised training methods.
7. Generative models.
8. Image transforms.
9. Prediction from video sequences.
10. Predicting sequences from images, image captioning.

Course content – project

1. Selection of a task from the field of computer vision, e.g., in the area of image classification or segmentation, object detection, image-based search, image captioning, image generation.
2. Precise identification or formulation of the task objective and reflecting it in appropriately chosen quality metrics and a loss function to be used for the model training process.
3. Preparation of the computational environment.
4. Preparation of training and testing datasets.
5. Implementation and training of a baseline solution and its evaluation.
6. Introducing optimizations in the model and in the training algorithm.
7. Introducing optimizations in the data processing algorithms.
8. Evaluation of the impact of the optimizations on the quality of the solution.

Prerequisites and co-requisites

Basic knowledge of neural networks, deep learning techniques and machine learning, basic familiarity with Python programming language

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
project	50.0%	50.0%
exam	50.0%	50.0%

Recommended reading

Basic literature

1. V Kishore Ayyadevara, "Modern Computer Vision with PyTorch".
2. Magnus Ekman, "Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, Natural Language Processing, and Transformers Using TensorFlow".
3. Mohamed Elgendy, "Deep Learning for Vision Systems".

	Supplementary literature	1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning. 2. Sebastian Raschka, "Build a Large Language Model (From Scratch)".
	eResources addresses	
Example issues/ example questions/ tasks being completed	• Implementation and training of chosen deep neural network architecture for analysis or processing of images • Choosing proper architectures for given data analysis problems • Naming techniques used in advanced convolutional neural networks	
Practical activites within the subject	Not applicable	

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