National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of Computer Engineering

Artificial Intelligence Technologies

The program of the academic discipline (Syllabus)

Details of the academic discipline	
Cycle of Higher Education	***First cycle of higher education (Bachelor's degree)***
Field of Study	*12 Information technologies*
Specialty	*121 Software Engineering*
Education Program	*Computer Systems Software Engineering*
Type of Course	*Normative*
Mode of Studies	*Full-time education*
Year of studies, semester	*4 year (1 semester)*
ECTS workload	*4.5 credits*
Testing and assessment	*Exam*
Course Schedule	*Lectures 18 (36 hours), Laboratory 9 (18hours)*
Language of Instruction	*English*
Course Instructors	Lecturer: *Vladyslav Taran, taran@comsys.kpi.ua* Laboratory: Volodimir Valko*, valko@comsys.kpi.ua*
Access to the course	https://classroom.google.com/u/0/c/NTI3MjE1NDY1OTQ4

Program of academic discipline

1 Course description, goals and objectives, and learning outcomes

The discipline "Artificial Intelligence Technologies" is aimed at students' study of modern approaches and methods of building systems with artificial intelligence, as well as the development of intelligent entities - agents that are able to learn and effectively solve complex problems. The discipline considers: the field and concept of artificial intelligence, structures of intelligent agents, types and properties of environments where agents operate, types of data representation in intelligent agents, principles of choosing actions and decision-making by agents, the search task using local search algorithms, evolutionary and genetic algorithms , the knowledge base of an intelligent agent and the process of logical judgment, the logic of statements, probabilistic judgments and the choice of actions by an agent under conditions of uncertainty, the task of training an intelligent agent using machine and deep learning methods, deep neural networks. The study of this discipline by future specialists will allow them to acquire important competencies in the field of intelligent systems and artificial intelligence.

The purpose of studying the discipline "Artificial Intelligence Technologies" is to train specialists capable of solving complex problems in the field of developing intelligent systems and using modern means and technologies of artificial intelligence.

The subject of the discipline is:

- theoretical and practical foundations of artificial intelligence and intelligent systems;
- methods and means of building intelligent systems — agents;
- methods of logical judgments;
- methods of probabilistic judgments;

• methods of machine learning;
• deep learning methods.

According to the requirements of the EP, applicants after mastering the discipline "Artificial Intelligence Technologies" must demonstrate the following competencies and program learning outcomes:

• ability to abstract thinking, analysis and synthesis;
• ability to algorithmic and logical thinking;
• ability to develop and use artificial intelligence systems;
• know and be able to apply artificial intelligence methods and tools.

According to the results of studying the educational discipline "Artificial Intelligence Technologies", the following **knowledge** should be obtained:

• conceptual and theoretical knowledge in the field of artificial intelligence and intelligent systems;
• methodological knowledge in terms of applying modern methods and means of artificial intelligence for the development of intelligent programs — rational agents.

Skills that should be acquired as part of studying the academic discipline "Artificial Intelligence Technologies":

• to develop basic rational agents capable of solving the given task in the environment;
• use search algorithms to select actions by the agent;
• build intelligent agents that are based on knowledge and perform logical judgments using the logic of statements for decision-making;
• apply probabilistic judgments for decision-making by the agent under conditions of uncertainty;
• build agents that are able to learn using machine and deep learning methods;
• apply deep convolutional neural networks to supplement the capabilities of an intelligent agent to process visual information.

Such a combination of general and special competences, theoretical and practical knowledge, skills and abilities helps to increase the professional level of bachelor's degree holders in order to carry out effective activities in the field of development of systems with artificial intelligence.

2 Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

Necessary disciplines: "Algorithms and data structures", "Databases", "Methodologies and technologies of software development", "Software support of high-performance computer systems".

The discipline "Artificial Intelligence Technologies" provides the following competencies and program learning outcomes: ЗК 1, ФК 14, ФК 19, ПРН 28.

3 Structure of the credit module

A list of the main topics included in the study program of the discipline "Artificial Intelligence Technologies":

Section 1. Introduction to artificial intelligence
Topic 1.1. The field and concept of artificial intelligence

Topic 1.2. The history of the development of artificial intelligence
Topic 1.3. Artificial intelligence using a rational agent

Section 2. Intelligent agents
Topic 2.1. Properties and types of agents
Topic 2.2. General structure of the agent
Topic 2.3. Representation of data in the agent
Topic 2.4. Classification of the problem environment
Topic 2.5. Selecting actions by searching
Topic 2.6. Local search algorithms
Topic 2.7. Evolutionary algorithms

Section 3. Knowledge-based agents
Topic 3.1. Agent knowledge base
Topic 3.2. Logical representation of data in the agent
Topic 3.3. The logic of statements
Topic 3.4. Algorithms and the process of forming a logical conclusion
Topic 3.5. Hybrid intelligent agent

Section 4. Selection of actions by an agent under conditions of uncertainty
Topic 4.1. Probable agents
Topic 4.2. Judgment under conditions of uncertainty
Topic 4.3. Probability theory
Topic 4.4. Bayes' rule and the naive Bayesian model
Topic 4.5. Knowledge representation using Bayesian networks

Section 5. Learning based on observation
Topic 5.1. Types of training
Topic 5.2. Hypotheses, model selection and optimization
Topic 5.3. Machine learning
Topic 5.4. Ensemble method of machine learning
Topic 5.5. Preparation of data for training
Topic 5.6. Deep learning and deep neural networks

4 Educational resources and materials

Basic:

1 *S. Russell and P. Norvig. Modern Approach to Artificial Intelligence. - Pearson Series in Artifical Intelligence, 2021. URL: https://zoo.cs.yale.edu/classes/cs470/materials/aima2010.pdf*
2 *Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. - MIT Press book, 2016. URL: https://www.deeplearningbook.org/*
3 *Shai Shalev-Shwartz and Shai Ben-David. Understanding Machine Learning From Theory To Algorithms. - Cambridge University Press, 2014. URL: https://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/understanding-machine-learning-theory-algorithms.pdf*

Supplementary:

1 *Python code for the book Artificial Intelligence: A Modern Approach. URL: https://github.com/hzhang7/Russel-Norvig*
2 *Deep Learning for Computer Vision: The Abridged Guide. URL: https://www.run.ai/guides/deep-learning-for-computer-vision*
3 *Machine Learning Google Developers. URL: https://developers.google.com/machine-learning*

4 *YOLO: Real-Time Object Detection Explained. URL: https://www.v7labs.com/blog/yolo-object-detection*
5 *Image Segmentation: Architectures, Losses, Datasets, and Frameworks. URL: https://neptune.ai/blog/image-segmentation*
6 *TensorFlow Probability - library for probabilistic reasoning and statistical analysis. URL: https://www.tensorflow.org/probability*
7 *Introduction to OpenCV Object Tracker. URL: https://docs.opencv.org/4.4.0/d2/d0a/tutorial_introduction_to_tracker.html*

Educational content

5 Methodology

Sections and topics	Hours			
	Total	including		
		Lectures	Practical work	Self-study
Section 1. Introduction to artificial intelligence Topic 1.1. The field and concept of artificial intelligence Topic 1.2. The history of the development of artificial intelligence Topic 1.3. Artificial intelligence using a rational agent	14	4		10
Section 2. Intelligent agents Topic 2.1. Properties and types of agents Topic 2.2. General structure of the agent Topic 2.3. Representation of data in the agent Topic 2.4. Classification of the problem environment Topic 2.5. Selecting actions by searching Topic 2.6. Local search algorithms Topic 2.7. Evolutionary algorithms	26	6	4	16
Section 3. Knowledge-based agents Topic 3.1. Agent knowledge base Topic 3.2. Logical representation of data in the agent Topic 3.3. The logic of statements Topic 3.4. Algorithms and the process of forming a logical conclusion Topic 3.5. Hybrid intelligent agent	28	8	4	16
Section 4. Selection of actions by an agent under conditions of uncertainty Topic 4.1. Probable agents Topic 4.2. Judgment under conditions of uncertainty Topic 4.3. Probability theory Topic 4.4. Bayes' rule and the naive Bayesian model Topic 4.5. Knowledge representation using Bayesian networks	24	6	4	14
Section 5. Learning based on observation Topic 5.1. Types of training Topic 5.2. Hypotheses, model selection and optimization Topic 5.3. Machine learning Topic 5.4. Ensemble method of machine learning Topic 5.5. Preparation of data for training Topic 5.6. Deep learning and deep neural networks	43	12	6	25
Total hours in semester	135	36	18	81

Laboratory works:

The purpose of conducting laboratory classes is for students to consolidate theoretical knowledge and acquire the necessary practical skills for working with modern technologies for systems with artificial intelligence.

- Laboratory work #1: Introduction to the Google Colab environment;
- Laboratory work #2: Intelligent agents;
- Laboratory work #3: Intelligent agents based on knowledge;
- Laboratory work #4: Neural networks.

6 Self-study

- preparation for lectures by studying the previous lecture material;
- preparation for laboratory work with the study of the theory of laboratory work with an oral answer to the given questions of the section;
- preparation of results of laboratory work in the form of a protocol.

Attendance Policy and Assessment

7 Attendance Policy

During classes in an academic discipline, students must adhere to certain disciplinary rules:
- extraneous conversations or other noise that interferes with classes are not allowed;
- the use of mobile phones and other technical means is not allowed without the teacher's permission.

Laboratory works are submitted personally with a preliminary check of theoretical knowledge, which is necessary for the performance of laboratory work. Validation of practical results includes code review and execution of test tasks.

8 Monitoring and grading policy

Current control: survey on the subject of the lesson
Calendar control: conducted twice a semester as a monitoring of the current status of meeting the syllabus requirements.
Semester control:exam
Conditions for admission to semester control: enrollment of all laboratory work

Table 1 — Maximum points for individual laboratory works

Laboratory	Points
Laboratory work №1	20
Laboratory work №2	20
Laboratory work №3	20
Laboratory work №4	20
$R_{Л}$	80

The maximum score for the exam (R_{e}) is 40 points:

$$R_{e} = 40$$

The semester rating of a student in a discipline consists of grades for: laboratory work ($R_{Л}$) and exam (R_{e}).

$$R = 0{,}6 \cdot (R_{Л} \cdot 1.25) + R_{e}$$

The student has the opportunity to get a grade for the exam automatically (R_{a}). To do this, it is necessary to fulfill the conditions for admission to the exam no later than **a week** before the consultation before the exam. In this case, the grade for the discipline will be:

$$R = R_{a} = R_{Л} \cdot 1.25$$

If assignments are submitted **24 hours** before the consultation, the student loses the right to be automatically enrolled in the exam. In this case, the maximum score for the corresponding work will be 60% of that indicated in Table 1.

Table 2 — Correspondence of rating points to grades on the university scale

Score	*Grade*
100-95	Exellent
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	Sufficient
below 60	Fail
Course requirements are not met	Not graded

9 Additional information about the course

theoretical and practical questions, which are presented during the defense of laboratory works and semester control, correspond to the list of main topics included in the study program of the discipline "Artificial Intelligence Technologies".

Syllabus of the course:

Designed by assistant of the Department of Computer Engineering, Vladyslav Taran

Adopted by Department of Computer Engineering (protocol № 10, 25.05.2022)

Approved by the methodical commission of FICT (protocol № 10, 09.06.2022)