Methods of computational intelligence

COURSE SYLLABUS

Code and name of specialty	122 Computer Science	**Institute / faculty**	Faculty of Computer Science and Software Engineering
Program name	“Computer Science and Intelligent Systems”	**Department**	Software Engineering and Management Information Technologies
Type of program	**Educational and Professional**	**Language of instruction**	**Ukrainian/English**

LECTURER

Moskalenko Valentyna Volodymyrivna Valentyna.Moskalenko@khpi.edu.ua

Doctor of Technical Sciences, Associate Professor, Professor of SEMIT Department. Number of scientific and educational publications is more than 90. (https://publons.com/researcher/1588564/valentyna-moskalenko/; Web of Science Researcher ID R-9960-2018; https://scholar.google.com.ua/citations?user=eUidJHIAAAAJ&hl=ru; https://www.scopus.com/authid/detail.uri?authorId=36021571200; https://orcid.org/0000-0002-9994-5404).

Courses taught: "Probability Theory and Mathematical Statistics", "Fundamentals of Computer Science and Artificial Intelligence Methods", "Fundamentals of Information Systems and Technologies", "Software Requirements Engineering", "Fundamentals of Business Analysis", "Computational Intelligence Methods", "Methods of computational intelligence and intellectual analysis", "Machine learning", "Business systems analytics"

GENERAL DESCRIPTION OF THE COURSE

Summary	The course “Methods of computational intelligence” is a discipline in the cycle of special mandatory training in the specialty 122 "Computer Sciences". It is taught in the seventh semester in the amount of 150 hours (4 ECTS credits), in particular: lectures - 32 hours, workshops - 32 hours, independent work – 86 hours. The course provides two content modules and two module tests. The discipline ends with an exam. The study of the academic discipline provides a systematized detailed teaching of the foundations of the theory, methods and technologies of computational intelligence and their application in various fields.
Course objectives	The purpose of studying the discipline is to form theoretical knowledge and practical skills in the basics of computational intelligence among computer scientists for the development of intelligent control systems.
Types of classes and control	Lectures, laboratory classes. Continuous assessment – laboratory works, intermediate modular assessment. Final assessment – an exam.
Term	7

Student workload (credits) / Type of course	4 / Mandatory	**Lectures (hours)**	32	**Workshops (hours)**	32	**Self-study (hours)**	86

Program competences	GC1. Ability to abstract thinking, analysis and synthesis. GC2. Ability to apply knowledge in practical situations. GC3. Knowledge and understanding of the subject area and understanding of professional activity. GC6. Ability to learn and master modern knowledge. GC7. Ability to search, process and analyze information from various sources

	PC 2. Ability to detect statistical patterns of non-deterministic phenomena, the use of computational intelligence methods, including statistical, neural network and fuzzy data processing, machine learning and genetic programming methods, etc. PC 4. Ability to use modern methods of mathematical modelling of objects, processes, and phenomena, to develop models and algorithms for the numerical solution of mathematical modelling problems, to take into account the errors of approximate numerical solution of professional problems. PC 6. Ability to think systematically, apply the systems analysis methodology to study complex problems of different nature, methods of formalization and solution of system problems with conflicting goals, uncertainties, and risks. PC 11. Ability to conduct intelligent data analysis based on methods of computational intelligence, including large and poorly structured data, their operational processing and visualization of analysis results in the process of solving applied problems. PC 17. Ability to apply the theoretical and practical basics of modern management theory for complex organizational, technical and socio-economic systems to build intelligent management systems, in the process of designing intelligent systems to use modern information processing technologies and methods of computational intelligence.

Learning outcomes	**Teaching and learning methods**	**Forms of assessment (continuous assessment CAS, final assessment FAS)**
PLO 3. Use knowledge of the laws of random phenomena, their properties and operations with them, models of random processes, and modern software environments to solve problems of statistical data processing and construction of predictive models. PLO 4. Use methods of computational intelligence, machine learning, neural network, and fuzzy data processing, genetic and evolutionary programming to solve problems of recognition, prediction, classification, identification of management objects, etc. PLO6. Use methods of numerical differentiation and integration of functions, solution of ordinary differential and integral equations, features of numerical methods and possibilities of their adaptation to engineering problems, have skills of software implementation of numerical methods. PLO8. Use the methodology of system analysis of objects, processes, and systems for the tasks of analysis, prediction, management, and design of dynamic processes in macroeconomic, technical, technological, and financial objects. PLO 12. Apply methods and algorithms of computational intelligence and intelligent data analysis in the tasks of classification, prediction, cluster analysis, search for associative rules using software tools to support multidimensional data analysis based on technologies DataMining, TextMining, WebMining. PLO 17. Apply for the construction of intelligent management systems theoretical and practical foundations of modern management theory, design intelligent systems using modern information processing technologies and methods of computational intelligence.	Interactive lectures with presentations, discussions, laboratory classes, teamwork, case method, student feedback method, problem-based learning	Written individual assignments for laboratory works (CAS), assessment of knowledge in laboratory classes (CAS), express surveys (CAS), online tests (CAS), final/semester control in the form of a semester test, according to the schedule of the educational process (FAS)

ASSESSMENT AND GRADING

Ranges of points corresponding to grades	**Total score (points) for all types of learning activities**	**ECTS grading scale**	**The national grading scale**	**Allocation of grade points**	**100% Final assessment** as a result of Final exam (10%) and Continuous assessment (90%). **10% Final exam** **90% Continuous assessment**:
	90-100	A	excellent		
	82-89	B	good		
	74-81	C			

	64-73	D	satisfactory		Test №1 (5%) Test №2 (5%) Laboratory works (80%) Laboratory work №1 (16%) Laboratory work №2 (16%) Laboratory work №3 (16%) Laboratory work №4 (16%) Laboratory work №5 (16%)
	60-63	E			
	35-59	FX	Unsatisfactory (with the exam retake option)		
	0-34	F	Unsatisfactory (with mandatory repetition of the course)		

Course policy	Students must attend all classes according to the study schedule and adhere to the norms of academic ethics. To study the course, students need to have their personal computer and (or) use computers of the computer center at the department. Students must work with compulsory and recommended reading, including Internet resources. Students must complete and submit all laboratory works during the semester in which the course is taught, before the examination session. The final assessment is not carried out without the personal presence of students.

COURSE STRUCTURE AND CONTENT

Lecture 1	System analysis of directions of computational intelligence			**Self-study**	Frameworks used to solve artificial intelligence problems
Lecture 2	Overview of the main technologies of computational intelligence: Fuzzy systems, Artificial neural Networks, Evolutionary computation				
Lecture 3	Basic concepts and provisions of fuzzy logic. Fuzzy inference stages				
Lecture 4	Basic algorithms for fuzzy inference: Mamdani, Tsukamoto, Sugeno and Larsen				
Lecture 5	Principles of construction and classification of neural networks	**Laboratory work 1**	Studying the properties of a linear neuron and a linear neural network		
Lecture 6	Train single-layer and multilayer neural networks	**Laboratory work 2**	Study of multilayer nonlinear perceptron and error backpropagation algorithm		
Lecture 7	Neural network of radial basic functions	**Laboratory work 3**	Study of radial basic, probabilistic neural networks, regression networks.		The main tasks of regression analysis
Lecture 8	Fuzzy neural networks and learning algorithms for fuzzy neural networks.	**Laboratory work 4**	Learning Algorithms for Learning Fuzzy Neural Networks		
Lecture 9	Cascading neophazzi - neural networks, their architecture, properties and learning algorithms				
Lecture 10	The essence of evolutionary computing. Fundamentals of Genetic Algorithms				Trends in the development of evolutionary modeling and evolutionary strategies in solving problems of computational and intelligence

Lecture 11	Solving an optimization problem using genetic algorithms	**Laboratory work 5**	Application of genetic algorithms in optimization problems		Ways to improve the mechanisms of crossing over, mutations and selection in genetic algorithms
Lecture 12	Evolutionary modeling. Swarm intelligence				
Lecture 13	The main provisions of the swarm optimization algorithms. Basic algorithm				
Lecture 14	Swarm intelligence-based algorithms: "ant" algorithms, "bee colony" algorithms, algorithms based on the particle swarm method				
Lecture 15	Examples of using the Artificial Bee Colony Algorithm to solve optimization problems				
Lecture 16	Prospects for the development of computable intelligence methods				

RECOMMENDED READING

Compulsory

1. Luger, George F. (2021) Knowing our World: An Artificial Intelligence Perspective. Springer.
2. Zgurovsky M.Z., Zaychenko Y.P.(2016)The Fundamentals of Computational Intelligence: System Approach. Springer International Publishing Switzerland,
3. Stuart Russell, Peter Norvig (2020) Artificial Intelligence: A Modern Approach, 4th US ed .. Pearson
4. Dranishnikov L. V.(2018) Intellectual methods in management: a textbook Kamyanske: DSTU
5. Mitchell Melanie (2020) Artificial Intelligence / A Guide for Thinking Humans. Pelican
6. Hlybovets, M.M., Oletsky O.V. (2002) Artificial intelligence textbook К иїв: Вид. House "KM Academy".
7. Kavun, S. V., Korotchenko. V.M. (2007) Systems of artificial intelligence [Text]: textbook. way. Kharkiv: Ed. KhNEU
8. Khaikin S. (2008) Neural networks: a complete course. 2nd ed. Moscow: Williams Publishing House.
9. ByClarence W. de Silva. (2018) Intelligent Control. Fuzzy Logic Applications. CRC Press; 1st ed.
10. Hung T. Nguyen; Nadipuram R. Prasad; Carol L. Walker; Elbert A. Walker (2005) A First Course in Fuzzy and Neural Control. Chapman & Hall
11. Subbotin S. O. (2008) Representation and processing of knowledge in artificial intelligence systems and decision support: a textbook. Zaporozhye: ZNTU.

Додаткова

1. Turing A.M.(2009) Computing machinery and intelligence. // Parsing the Turing Test, Editors Robert Epstein, Gary Roberts, Grace BeberSpringerLink
2. Mark Fenner (2019) Machine Learning with Python for Everyone. Addison-Wesley Professional.
3. Zaichenko Yu.P. (2004) Fundamentals of intelligent systems design. Teaching. manual. Kyiv: Slovo Publishing House.
4. Machine Learning in MATLAB Retriyeved from:// https://www.mathworks.com/help/stats/machine-learning-in-matlab.html
5. Mastering Machine Learning: A Step-by-Step Guide with MATLAB Retriyeved from: // https://www.mathworks.com/campaigns/offers/mastering-machine-learning-with-matlab.html
6. : Melin, P., Castillo, O., Kacprzyk, J., Reformat, M., Melek, W. (2018) Fuzzy Logic in Intelligent System Design / Editors (Eds.) Springer,
7. What is Fuzzy Logic in AI and What are its Applications? Retriyeved from https://www.edureka.co/blog/fuzzy-logic-ai/
8. What Is A Neural Network? Introduction To Artificial Neural Networks Retriyeved from:// https://www.edureka.co/blog/what-is-a-neural-network/
9. C. Perez (2019) NEURAL Networks Using Matlab. Cluster Analysis And CLASSIFICATION. Lulu.com
10. Zgurovsky M.Z., Zaychenko Y.P.(2010). Big Data: Conceptual Analysis and Applications. Springer International Publishing Switzerland.

ACADEMIC INTEGRITY

Students are expected to adhere to the Code of Ethics of Academic Relations and Integrity of NTU “KhPI”.

The content of this syllabus is consistent with the course program.