Machine Learning

COURSE SYLLABUS

Code and name of specialty	121 Software Engineering 122 Computer Science 126 Information Systems and Technologies	**Institute / faculty**	Faculty of Computer Science and Software Engineering
Program name	Software Engineering Computer Science and Intelligent Systems Information Systems Software	**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 then 90. (https://publons.com/researcher/1588564/valentyna-moskalenko/; Web of Science ResearcherID 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 “Machine Learning” is an optional course in the profiled discipline package 01"Research and Development" of the specialties 121 “Software Engineering”, 122 “Computer Science”, and 126 “Information Systems and Technologies”. It is taught in the fourth semester in the amount of 90 hours (3 ECTS credits), in particular: lectures – 32 hours, laboratory classes – 16 hours, independent work – 42 hours. The study of the discipline ends with the test. The study of the academic discipline provides a systematized detailed teaching of the fundamentals of machine learning, methods and technologies of computational intelligence and their application in various industries
Course objectives	The goal of mastering the "Machine Learning" discipline is to develop students' theoretical knowledge and practical skills in the basics of machine learning, mastering the tools, models and methods of machine learning, as well as acquiring the skills of a data scientist and developer of mathematical models, methods and algorithms for analysis. data.
Types of classes and control	Lectures, laboratory classes. Continuous assessment – laboratory works, intermediate modular assessment. Final assessment – test.
Term	6

Student workload (credits) /	3 / Optional	**Lectures (hours)**	32	**Workshops (hours)**	16	**Self-study (hours)**	42

Type of course							

Program competences	121-GC 01. Ability to abstract thinking, analysis and synthesis. 121-GC 02. Ability to apply knowledge in practical situations. 121-GC 05. Ability to learn and master modern knowledge. 121-GC 06. Ability to search, process and analyze information from various sources. 121- PC20. Ability to apply fundamental and interdisciplinary knowledge to successfully solve software engineering problems. 122-GC1. Ability to abstract thinking, analysis and synthesis. 122-GC2. Ability to apply knowledge in practical situations. 122-GC3. Knowledge and understanding of the subject area and understanding of professional activity. 122-GC6. Ability to learn and master modern knowledge. 122-GC7. Ability to search, process and analyze information from various sources 122-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. 122-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. 122-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. 122-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. 122-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. 126-GC 1. Ability to abstract thinking, analysis and synthesis. 126-GC 2. Ability to apply knowledge in practical situations. 126-GC 3. Ability to understand the subject area and professional activity. 126-GC 5. Ability to learn and master modern knowledge. 126-GC 6. Ability to search, process and summarize information from various sources. 126-GC 7. Ability to develop and manage projects. 126-GC 8. Ability to evaluate and ensure the quality of work performed. 126-PC 1. Ability to analyze the object of design or operation and its subject area. 126-PC 11. Ability to analyze, synthesize and optimize information systems and technologies using mathematical models and methods. 126-PC 13. Ability to perform computational experiments, compare the results of experimental data and solutions.

Learning outcomes	**Teaching and learning methods**	**Forms of assessment (continuous assessment CAS, final assessment FAS)**
121-PLO 01. Analyze, purposefully search for and select the necessary information and reference resources and knowledge to solve professional problems, taking into account modern advances in science and technology. 121-PLO 05. Know and apply relevant mathematical concepts, methods of domain, system and object-oriented analysis and mathematical modelling for software development.	Interactive lectures with presentations, discussions, laboratory classes,	Written individual assignments for laboratory works (CAS), assessment of knowledge in laboratory classes (CAS), express surveys (CAS), online tests

122-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. 122-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. 122-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. 122-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. 122-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. 126-PLO 2. Apply knowledge of basic and natural sciences, systems analysis and modeling technologies, standard algorithms and discrete analysis in solving problems of design and use of information systems and technologies. 126-PLO 6. Demonstrate knowledge of the current level of information systems technology, practical skills of programming and use of applied and specialized computer systems and environments for their implementation in professional activities.	teamwork, case method, student feedback method, problem-based learning	(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
90-100	A	excellent
82-89	B	good
74-81	C	
64-73	D	satisfactory
60-63	E	
35-59	FX	Unsatisfactory (with the exam retake option)
0-34	F	Unsatisfactory (with mandatory repetition of the course)

Allocation of grade points

100% Final assessment as a result of Final test (10%) and Continuous assessment (90%).
10% Final test
90% Continuous assessment:
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%)

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	Types of machine learning and learning objectives.				
Lecture 2	Supervised machine learning algorithms. Classification problem	**Laboratory work 1**	Solving the classification problem by various methods		Bayesian classification methods
Lecture 3	Supervised machine learning algorithms. Decision tree				Using Scikit-Learn (Python) Library to Implement Machine Learning Algorithms
Lecture 4	Decision tree construction algorithms				An Overview of Classification Methods in Machine Learning with Scikit-Learn
Lecture 5	Supervised machine learning algorithms. Regression and other classification methods	**Laboratory work 2**	Solving analytical problems using regression		Least square method Building Regressors in Python
Lecture 6	Supervised machine learning algorithms. K-nearest neighbors method				
Lecture 7	Supervised machine learning algorithms. Support vector machine				
Lecture 8	Unsupervised machine learning algorithms. Clustering	**Laboratory work 3**	Solving the clustering problem by various methods		Markov decision-making process
Lecture 9	Quality assessment in the clustering problem			**Self-study**	
Lecture 10	Unsupervised machine learning algorithms. Dimension reduction methods				
Lecture 11	Dimension reduction methods. Feature selection methods				
Lecture 12	Dimension reduction methods. Feature extraction methods.				
Lecture 13	Reinforcement learning algorithms. learning strategies				
Lecture 14	Machine learning models with pidcripts: 1) Markov decision-making process; 2) Q- learning.				
Lecture 15	Neural networks and deep learning. Using Deep neural network to solve problems. Software systems for training deep neural networks Principles of image classification. Convolutional Networks (CNN)	**Laboratory work 4**	Convolutional networks and imaging		Possibilities of a neural package for modeling neural systems
Lecture 16	Recurrent neural networks. Neural networks for predicting processes of various nature	**Laboratory work 5**	Forecasting with recurrent neural networks		Statistical forecasting methods

RECOMMENDED READING

Compulsory	1. Flach, P. (2012). Machine learning: The art and science of algorithms that make sense of data. Cambridge University Press. [Electronic resource]. Access mode: https://doi.org/10.1017/CBO9780511973000 2. Henrik Brink Joseph W. Richards Mark Fetherolf. (2016). Real-World Machine Learning. Manning Publications. 3. Andreas, C. Müller, Sarah Guido (2016) Introduction to Machine Learning with Python. O'Reilly Media, Inc. 4. Zgurovsky, M. Z., Zaychenko, Y. P. (2016). The Fundamentals of Computational Intelligence: System Approach. Springer International Publishing Switzerland, 375 p. 5. Richard S. Sutton, Andrew G. Barto. (2018). Reinforcement Learning: An Introduction. Second Edition. MIT Press. Cambridge, MA. 6. Nielsen, M. (2018). Neural Networks and Deep Learning. [Electronic resource]. Access mode: //https://static.latexstudio.net/article/2018/0912/neuralnetworksanddeeplearning.pdf 7. Kevin, P. Murphy. (2012). Machine Learning: A Probabilistic Perspective. MIT Press. 8. Christopher, M. Bishop. (2016). Pattern Recognition and Machine Learning. *Springer* New York. 9. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong. (2020). Mathematics for Machine Learning. Cambridge University Press.
Додаткова	1. Zaichenko, Yu. P. (2004). Fundamentals of intelligent systems design. Teaching. manual. Kyiv: Slovo Publishing House, 352 p. 2. George, F., Stubblefield William A Luge. (2013). Artificial intelligence : structures and strategies for complex problem solving. 3rd ed. Harlow, England Reading, Mass. Addison-Wesley. 3. Breiman Friedman, J. H., Olshen, R. A., & Stone C. T. (2017). Classification and Regression Trees. Routledge. [Electronic resource]. Access mode: https://doi.org/10.1201/9781315139470 4. Stuart Russell, Peter Norvig. (2021). Artificial Intelligence: A Modern Approach. 4th US ed. Hoboken Pearson. 5. Mitchell Melanie. (2020). Artificial Intelligence: A Guide for Thinking Humans. Pelican. 6. Trevor Hastie, Robert Tibshirani, Jerome Friedman. (2011). The Elements of Statistical Learning. Springer Dive into Deep Learning. [Electronic resource]. Access mode: http://www.d2l.ai/index.html 7. Aurélien Géron. (2019). Hands-On Machine Learning with Scikit-Lear. Keras and Tensorflow: Concepts, Tools, and Techniques to Build Intelligent Systems. O'Reilly Media. 8. Zgurovsky, M. Z., Zaychenko, Y. P. (2019). Big Data: Conceptual Analysis and Applications. *Springer International Publishing Switzerland*, 277 p.

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.