

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
LVIV POLYTECHNIC NATIONAL UNIVERSITY



"APPROVED"

Rector of the
Lviv Polytechnic National University

Yu. Ya. Bobalo

"29" December 2023

EDUCATIONAL AND PROFESSIONAL PROGRAM
"COMPUTER SCIENCE (ARTIFICIAL INTELLIGENCE SYSTEMS)"
FIRST (BACHELOR'S) LEVEL OF HIGHER EDUCATION

DISCIPLINE	<u>12 Information Technology</u>
SPECIALTY	<u>122 Computer Science</u>
QUALIFICATION	<u>Bachelor of Computer Science with Specialization</u>
	<u>"Artificial Intelligence Systems"</u>

Reviewed and approved
at the meeting of the Academic Council of
Lviv Polytechnic National University
"28" December 2023
Protocol No. 7

Lviv 2023

LETTER OF AGREEMENT
educational and professional program

Level of higher education	<u>First (bachelor's)</u>
Discipline	<u>12 Information Technology</u>
Specialty	<u>122 Computer Science</u>
Qualification	<u>Bachelor of Computer Science with a specialization in "Artificial Intelligence Systems"</u>

DEVELOPED AND APPROVED

Scientific and Methodological
Commission of the specialty 122
Computer Science
Protocol No. 3-23/24
from "23" October 2023

Head of the SMC of the specialty
 U. B. Marikutsa

AGREE

Vice-Rector for Scientific and
Pedagogical Affairs
of Lviv Polytechnic National University

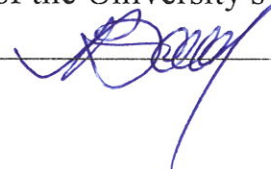
 O. R. Davydchak
"22" Desember 2023

Head of the University's Educational and
Methodological Department

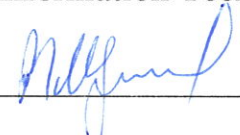
 V. V. Tomjuk
"22" Desember 2023

RECOMMENDED

The Scientific and Methodological Council
of the University
Protocol No. 75
"21" Desember 2023

Head of the University's SMC
 A. G. Zagorodniy

Director of the Educational and Scientific
Institute of Computer Science and
Information Technologies

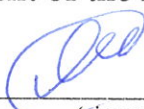
 M. O. Medykovskyy
"26" October 2023

PREFACE

Developed by the project group of the scientific and methodological commission of specialty 122 "Computer Science" based on the Standard of Higher Education in specialty 122 "Computer Science" for the first (bachelor's) level of higher education, approved by Order of the Ministry of Education and Science of Ukraine No. 962 dated July 10, 2019:

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Nataliya Shakhovska	– Doctor of Technical Sciences, Professor, Head of the Artificial Intelligence Systems Department
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Olena Vovk	– Ph.D., Associate Professor, Associate Professor of the Artificial Intelligence Systems Department
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Andriy Boychuk	– engineer at Ring company
Pavlo Tymoshenko	– student of the Artificial Intelligence Systems Department

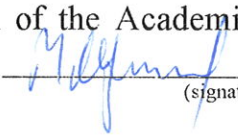
Program Coordinator


(signature)

V. S. Yakovyna
(surname, initials)

The draft of the educational and professional program was discussed and approved at a meeting of the Academic Council of the Institute of Computer Science and Information Technologies

Protocol No. 4-2024/2025 dated "26" October 2023

Chairman of the Academic Council of the Institute of Computer Science and Information Technologies  M.O. Medykovskyy
(signature) (surname, initials)

APPROVED AND PUT INTO EFFECT

By the order of the rector of Lviv Polytechnic National University
from "29" Desember 2023 No. 679-1-10

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Profile of the educational and professional bachelor's program "Computer Science (Artificial Intelligence Systems)" in specialty 122 "Computer Science"

1 – General information	
Full name of the higher education institution and structural unit	Lviv Polytechnic National University
The full title of the qualification in the original language	Bachelor of Computer Science with a specialization in Artificial Intelligence Systems
The official name of the educational program	Computer Science (Artificial Intelligence Systems)
Type of diploma and scope of educational program	Bachelor's degree, single, 240 ECTS credits, 4 years study period
Availability of accreditation	Not accredited
Cycle/level	NQF of Ukraine – level 6, FQ-EHEA – first cycle, QF-LLL – level 6
Prerequisites	Completed general secondary education
Language(s) of instruction	Ukrainian
Basic concepts and their definitions	The program uses basic concepts and their definitions under the Law of Ukraine "On Higher Education"
2 – Purpose of the educational program	
	To provide students with the knowledge, skills and abilities necessary for decision-making in complex systems of various nature using artificial intelligence methods and modern information technologies, fundamental and applied methods of data processing and analysis to solve problems in multiple fields of science, technology, finance, socio-economic and political spheres, global and local environmental issues and various spheres of social and economic life. Be prepared to successfully master more complex programs for scientific researchers in the field of artificial intelligence systems.
3 - Characteristics of the educational program	
Subject area (field of knowledge, specialty)	<i>Object(s) of study and/or activity:</i> mathematical, information, simulation models of real phenomena, objects, systems and processes, subject areas, data and knowledge representation –methods and technologies for obtaining, storing, processing, transmitting and using information, intelligent data analysis and decision-making –theory, analysis, development, efficiency assessment, implementation of algorithms, high-performance computing, including parallel computing and big data. <i>Learning objectives:</i> to train the specialists capable of conducting theoretical and experimental research in the field of computer science; applying mathematical methods and algorithmic principles in modeling, designing, developing and supporting information technologies; developing, implementing and supporting intelligent systems for analyzing and processing data of organizational, technical, natural and socio-economic systems. <i>The theoretical content of the subject area includes</i> modern models, methods, algorithms, technologies, processes,

	and procedures for obtaining, presenting, processing, analyzing, transmitting, and storing data in information systems. <i>Methods, techniques and technologies:</i> mathematical models, methods and algorithms for solving theoretical and applied problems that arise in IT development; modern technologies and programming platforms; methods for collecting, analyzing and consolidating distributed information; technologies and methods for designing, developing and ensuring the quality of IT components; methods of intelligent analysis and data visualization technologies; methods of artificial intelligence, CASE-technologies for modeling and designing IT; technologies of business analysis and data analytics. <i>Tools and equipment include</i> distributed computing systems, computer networks, mobile, cloud, and fog technologies, as well as database management systems and operating systems.
Orientation of the educational program	The program is based on well-known scientific results, taking into account the current state of information technologies; the emphasis is on the willingness to work and acquire skills in computer science and information technology, mathematical and computer modeling of processes and systems of various nature, forecasting, design, optimization, systems analysis and decision-making, analysis and synthesis of data and knowledge, etc. The research line is professionally oriented, and the expert line is practically oriented.
The primary focus of the educational program and specialization	General education in computer science and information technology, as well as the ability to analyze, predict, design and make decisions in complex systems of various nature using artificial intelligence, machine and deep learning methods. Specializations: data analysis, Deploying Machine Learning Systems, applied software, artificial intelligence in robotics.
Features and differences	A feature of the program is the focus on training a specialist who will be able to: - solve algorithmically complex problems; - analyze large volumes of data; - develop algorithms for processing video, images or texts, intelligent robot control systems based on artificial intelligence and machine learning methods - and implement their effective program implementation. There are four lines in total: For the Data Analysis line: Thorough study and knowledge of the architecture of artificial intelligence systems, development of individual software modules of such systems, methods of processing natural language texts, image processing, modeling and analysis of data in complex systems. For the Deploying Machine Learning Systems line. Development of the architecture for artificial intelligence systems, including the creation of individual software modules to automate the deployment of information systems, as well as the processing and analysis of large datasets. For the Applied Software line. Development of cross-platform application environments and components, as well as design and development of data warehouses. For the Artificial Intelligence in Robotics line. Industrial robotics and information systems integration, including components and environments for developing applied robotic systems, as well as computer vision.

4 – Eligibility of graduates of the educational program to employment and further education	
Eligibility for employment	Jobs in the field of data analytics, information technology, and artificial intelligence: IT companies, specialists in the development of mathematical, information and software support for information systems, in the field of information technology.
Further education	They have the right to continue their studies at the second (master's) level of higher education, acquiring additional qualifications in the postgraduate education system.
5 – Teaching and assessment	
Teaching and learning	Lectures, practical classes, coursework, research laboratory work, team projects, independent work based on textbooks, study guides and lecture notes, consultations with teachers, and preparation of the bachelor's thesis qualification work.
Evaluation	Written and oral exams, laboratory reports, oral presentations, and defense of the bachelor's thesis.
6 – Program competencies	
Integral competence (INT)	The ability to solve complex, specialized tasks and practical problems in the field of computer science or during the learning process, which involves the application of information technology theories and methods and is characterized by the complexity and uncertainty of conditions.
General competencies (GC)	GC1. The ability for abstract thinking, analysis and synthesis. GC2. The ability to apply knowledge in practical situations. GC3. Knowledge and understanding of the subject area, as well as an understanding of professional activity. GC4. The ability to communicate in the state language both orally and in writing. GC5. The ability to communicate in a foreign language. GC6. The ability to learn and master modern knowledge. GC7. The ability to search, process and analyze information from various sources. GC8. The ability to generate new ideas (creativity). GC9. The ability to work in a team. GC10. The ability to be critical and self-critical. GC11. The ability to make informed decisions. GC12. The ability to evaluate and ensure the quality of work performed. GC13. The ability to act based on ethical considerations. GC14. The ability to exercise one's rights and responsibilities as a member of society, to realize the values of a civil (free democratic) society and the need for its sustainable development, the rule of law, and the rights and freedoms of man and citizen in Ukraine. GC15. The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and engineering, to use various types and forms of physical activity for active recreation and leading a healthy lifestyle. Features of the Program

	GC16. The ability to read, understand, apply, and develop technical documentation in Ukrainian and foreign languages for the design and development of artificial intelligence systems. GC17. The ability to build connections and relationships with people from other industries, take into account the opinions of colleagues, understand other people, express trust in the team, admit one's mistakes, and avoid and prevent conflicts. To select and prepare information, set goals, and formulate tasks for the implementation of artificial intelligence systems
Professional competencies of the specialty (PC)	PC1. The ability to mathematically formulate and investigate continuous and discrete mathematical models, to justify the choice of methods and approaches for solving theoretical and applied problems in the field of computer science, analysis and interpretation. PC2. The ability to identify statistical patterns of non-deterministic phenomena, to apply computational intelligence methods, in particular statistical, neural network and fuzzy data processing, machine learning and genetic programming methods, etc. PC3. The ability to think logically, draw logical conclusions, use formal languages and models of algorithmic calculations, design, develop and analyze algorithms, evaluate their efficiency and complexity, solvability and unsolvability of algorithmic problems for adequate modeling of subject areas and creation of software and information systems. PC4. The ability to use modern methods of mathematical modeling of objects, processes and phenomena, to develop models and algorithms for numerical solutions of mathematical modeling problems, and to take into account errors in approximate numerical solutions of professional problems. PC5. The ability to carry out a formalized description of operations research tasks in organizational, technical and socio-economic systems of various purposes, determine their optimal solutions, build optimal management models taking into account changes in the economic situation, and optimize management processes in systems of various purposes and levels of hierarchy. PC6. Ability to system thinking, apply the methodology of system analysis to study complex problems of various nature, methods of formalization and solution of system tasks that have conflicting goals, uncertainties and risks. PC7. The ability to apply theoretical and practical foundations of modeling methodology and technology to study the characteristics and behavior of complex objects and systems and to conduct computational experiments with processing and analysis of results. PC8. Ability to design and develop software using various programming paradigms: generalized, object-oriented, functional, and logical, with appropriate models, methods and algorithms of calculations, data structures and control mechanisms. PC9. The ability to implement a multi-tiered computing model based on client-server architecture, including databases, knowledge and data warehouses, to perform distributed processing of large data sets on clusters of standard servers to meet users' computing needs, including on cloud services. PC10. The ability to apply methodologies, technologies and tools to manage the life cycle processes of information and software systems,

	information technology products and services following customer requirements. PC11. The ability to perform intelligent data analysis based on computational intelligence methods, including large and poorly structured data, their operational processing and the visualization of analysis results in the process of solving applied problems. PC12. The ability to organize computing processes in information systems for various purposes, taking into account architecture, configuration, and performance indicators of operating systems and system software. PC13. The ability to develop network software that operates based on various topologies of structured cabling systems, to use computer systems and data transmission networks, and to analyze the quality of computer network performance. PC14. The ability to apply methods and means of ensuring information security, as well as to develop and operate specialized software for protecting the information resources of critical information infrastructure objects. PC15. The ability to analyze and functionally model business processes, build and practically apply functional models of organizational, economic, and production and technical systems, and methods for assessing the risks of their design. PC16. The ability to implement high-performance computing based on cloud services and technologies, parallel and distributed computing in the development and operation of distributed parallel information processing systems. Features of the Program PC17. The ability to apply international standards for assessing the quality of information systems, data visualization, management and maintenance of IT services, and models for assessing the maturity of information systems development processes. PC18. The ability to develop methods and tools for analyzing data of various structures. PC19. The ability to design intelligent information systems
Professional competencies of a professional orientation (PCP)	1. For the Data Analysis line: 1.1) The ability to formulate new hypotheses, to search for and visualize hidden data dependencies using artificial intelligence methods. 1.2) The ability to effectively choose appropriate directions and appropriate methods for solving data analysis problems in the field of information technology and artificial intelligence. 1.3) The ability to analyze unstructured data and to search for dependencies using artificial intelligence methods. 1.4) The ability to use knowledge of the basics of digital signal processing and to use them in the design of machine vision systems, processing of speech signals, and analysis and synthesis of images. 2. For the Deploying Machine Learning Systems line: 2.1) The ability to automatically deploy systems at different levels. 2.2) The ability to analyze big data and develop architectural solutions for big data. 2.3) The ability to deploy and administer systems based on client-server architecture, including databases, knowledge and data warehouses, and

	distributed processing systems for large data sets on clusters of standard servers, including cloud servers. 2.4) The ability to develop the environment and components of MLOps solutions. 3. For the Applied Software line: 3.1) The ability to evaluate and ensure the quality of software code. 3.2) The ability to analyze and manage software requirements and reasonably choose the most effective paradigm and methodology for creating a software product based on customer requirements. 3.3) The ability to design and develop the architecture of software applications in information systems. 3.4) The ability to apply methodologies, technologies and tools to manage the life cycle processes of information and software systems, information technology products and services following customer requirements. 4. For the line of Artificial Intelligence in Robotics: 4.1) The ability to program applied robotic systems. 4.2) The ability to carry out a formal description of tasks in industrial robotics and the integration of information systems. 4.3) The ability to apply intelligent image processing technologies in robotic information systems. 4.4) The ability to implement high-performance computing based on fog services and technologies.
7 – Program learning outcomes	
(PO)	PO1. Apply knowledge of the basic forms and laws of abstract and logical thinking, the basics of the methodology of scientific knowledge, and forms and methods of extracting, analyzing, processing and synthesizing information in the subject area of computer science. PO2. Utilize the modern mathematical apparatus of continuous and discrete analysis, linear algebra, and analytical geometry in professional activities to solve problems of both theoretical and applied nature during the design and implementation of information systems. PO3. Use knowledge of the regularities of random phenomena, their properties and operations on them, models of random processes and modern software environments to solve problems of statistical data processing and build predictive models. PO4. Use methods of computational intelligence, machine learning, neural network and fuzzy data processing, and genetic and evolutionary programming to solve problems of recognition, prediction, classification, identification of control objects, etc. PO5. To design, develop and analyze algorithms for solving computational and logical problems and to evaluate the efficiency and complexity of algorithms based on the application of formal models of algorithms and computable functions. PO6. Use methods of numerical differentiation and integration of functions, solving ordinary differential and integral equations; utilize the features of numerical methods and the possibilities of their adaptation to engineering problems; have skills in software implementation of numerical methods. PO7. Understand the principles of modeling organizational and technical systems and operations; utilize methods of operations

research to solve single- and multi-criteria optimization problems involving linear, integer, nonlinear, and stochastic programming.

PO8. Use the methodology of systems analysis of objects, processes and systems for the tasks of analysis, forecasting, management and design of dynamic processes in macroeconomic, technical, technological and financial objects.

PO9. Develop software models of object-oriented environments, selecting a programming paradigm based on convenience and application quality for implementing methods and algorithms that solve computer science problems.

PO10. Utilize tools for developing client-server applications, design conceptual, logical, and physical database models, develop and optimize queries for them, and create distributed databases, data repositories, and knowledge bases, including those on cloud services, using web programming languages.

PO11 Possess the skills to manage the life cycle of software, information technology products and services following the requirements and limitations of the customer and be able to develop project documentation (feasibility study, technical specifications, business plan, agreement, contract).

PO12. Apply methods and algorithms of computational intelligence and data mining in classification, forecasting, cluster analysis, and search for associative rules using software tools to support multidimensional data analysis based on Data Mining, Text Mining, and Web Mining technologies.

PO13. To be proficient in system programming languages and methods of developing programs that interact with computer system components, to know computer network technologies and architectures, and to have practical skills in computer network administration and their software.

PO14. To be proficient in system programming languages and methods of developing programs that interact with computer system components, to know computer network technologies and architectures, and to have practical skills in computer network administration and their software.

PO15. Apply knowledge of methodology and CASE tools for designing complex systems, methods of structural analysis of systems, and object-oriented design methodology in the development and study of functional models of organizational, economic, production and technical systems.

PO16. Understand the concept of information security, the principles of secure software design, and ensure the security of computer networks in conditions of incompleteness and uncertainty of the source data.

PO17. Perform parallel and distributed computations and apply numerical methods and algorithms for parallel structures and parallel programming languages in the development and operation of parallel and distributed software.

Features of the Program

PO18. Utilize search engine technologies and tools, as well as methods of intellectual analysis of data of various structures (including texts and images), to process, interpret, and generalize data.

	PO19. Analyze the strengths and weaknesses of adopted design and technological decisions using artificial intelligence methods, weigh and assess the opportunities and risks associated with these decisions, and evaluate their effectiveness.
UM	For the Data Analysis line: 1.1) The ability to model and analyze data in information systems. 1.2) The ability to develop analytical data warehouses using appropriate software, using survey results, queries, and features of the chosen method of presenting knowledge. For the Deploying Machine Learning Systems line: 2.1) The ability to develop mathematical models for designed objects and systems in conditions of large data volumes, different structures and data rates. 2.2) The ability to automatically deploy systems built using machine and deep learning models. For the Applied software line: 3.1) The ability to implement high-performance computing based on cloud services and technologies, parallel and distributed computing in the development and operation of artificial intelligence systems. 3.2) The ability to apply methods and means of ensuring information security in created software products and to develop and operate effective and high-quality software following requirements. For the line of Artificial Intelligence in Robotics: 4.1) The ability to develop practical algorithms for applied intelligent robotic systems based on artificial intelligence methods. 4.2) The ability to carry out effective software implementation of applied intelligent robotic systems.
8 – Resource provision for program implementation	
Main characteristics of human resources	Seventy percent of scientific and pedagogical workers involved in teaching professionally oriented disciplines in specialty 122 "Computer Science" hold scientific degrees and academic titles, with 40% having practical work experience in the field.
Main characteristics of material and technical support	Use of modern computer tools and software.
Main characteristics of information and methodological support	Using the virtual learning environment of the Lviv Polytechnic National University and the author's academic staff developments, textbooks, and teaching aids, which bear the seal of the Academic Council of the National University "Lviv Polytechnic", along with materials from the educational platforms Algotester, Coursera, edX, and Prometheus.
9 – Academic mobility	
National credit mobility	Based on bilateral agreements between the Lviv Polytechnic National University and technical universities of Ukraine.
International credit mobility	Based on bilateral agreements between the Lviv Polytechnic National University and higher educational institutions of foreign partner countries.
Education of foreign higher education applicants	Teaching in English is possible.

2. Distribution of the content of the educational and professional program by component groups and preparation cycles

No.	Training cycle	The volume of the educational load of a higher education applicant (credits / %)		
		Mandatory components of the educational and professional program	Elective components of the educational and professional program	Total for the entire period of study
1	2	3	4	5
1.	General training cycle	71 / 29.6	6 / 2.5	77 / 32.1
2.	Professional training cycle	109 / 45.4	54 / 22.5	163 / 67.9
Total for the entire period of study		180 / 75	60 / 25	240 / 100

3. List of components of the educational and professional program

Code	Name of the program component	Component volume in ECTS credits	Final control form
1	2	3	4
Mandatory components of the educational and professional program			
<i>1. General training cycle</i>			
SK1	Foreign language (by professional direction)	9	exam
SK2	History of statehood and culture of Ukraine	3	exam
SK3	Ukrainian language (for professional purposes)	3	differential test
SK4	Philosophy and ethics of artificial intelligence	3	exam
SK5	Algebra and geometry	6	exam
SK6	Discrete mathematics	5	exam
SK7	Mathematical analysis	6	exam
SK8	Probability theory and statistics	6	exam
SK9	Theory of computation, algorithms and data structures	6	exam
SK10	Information theory	5	differential test
SK11	Numerical methods	4	exam
SK12	Operations research	5	exam
SK13	Information security	4	exam
SK14	Business analysis in information systems development	6	exam
Total per cycle:		71	
<i>2. Professional training cycle</i>			
SK15	Object-oriented design and programming	6	exam
SK16	Server-side programming	6	exam
SK17	Computer architecture and operating systems	6	exam
SK18	Functional programming	6	exam
SK19	Computer networks and data transmission protocols	4	exam
SK20	Distributed systems and parallel computing	4	exam
SK21	Client-side programming	5	differential test
SK22	Programming fundamentals	7	exam
SK23	Fundamentals of Artificial Intelligence	5	exam

1	2	3	4
SK24	Development and design of information systems	5	exam
SK25	Database and knowledge organization	6	exam
SK26	Intelligent data analysis and visualization	5	exam
SK27	Fundamentals of occupational health and safety	3	differential test
SK28	IT project management	3.5	exam
SK29	Machine learning	5	exam
SK30	Deep learning and neural networks	5	exam
SK31	Language processing using artificial intelligence methods	6	exam
SK32	Image processing using artificial intelligence methods	5	exam
SK33	Design and technological practice	3	differential test
SK34	Practice on the topic of the bachelor's qualification work	4.5	differential test
SK35	Completion and defense of the bachelor's qualification work	9	
Total per cycle:		109	
Total required components:		180	
Elective components of the educational and professional program			
<i>General training cycle</i>			
Total per cycle:		6	
<i>2. Professional training cycle</i>			
Elective components of block 0100 Data analysis:			
VB11	Data modeling and analysis in information systems	5	exam
VB12	Data analysis and visualization project	5	differential test
VB13	Development environment and components in data modeling and analysis	6	exam
VB14	Analytical data warehouses	6	exam
VB15	Big Data Processing and Analysis	6	differential test
VB16	Cloud services for big data analysis	5	exam
VB17	Project to create a Data Analysis module in an information system	5	differential test
VB18	Architectural techniques and data architecture in information systems	5	exam
VB19	Project to improve Data Analysis module in the information system	5	differential test
Total:		48	
Elective components of block 0200 Deploying Machine Learning Systems:			
VB21	MLOps Basics	5	exam
VB22	MLOps development project	5	differential test
VB23	MLOps solution development environment and components	6	exam
VB24	Systems and data warehouses	6	exam
VB25	Designing big data analysis systems	6	differential test
VB26	Cloud services for working with big data	5	exam
VB27	Project for creating ML infrastructure in the information system	5	differential test
VB28	Architectural techniques and operational infrastructure in information systems	5	exam

1	2	3	4
VB29	Project to improve ML infrastructure in the information system	5	differential test
Total:		48	
<i>Elective components of block 0300 Applied software:</i>			
VB31	Information systems deployment	5	exam
VB32	Information Systems Deployment Project	5	differential test
VB33	Cross-platform application development environment and components	6	exam
VB34	Business analytics in data warehouses	6	exam
VB35	Cross-platform application programming	6	differential test
VB36	Cloud services for application systems and applications	5	exam
VB37	Project to create application software in an information system	5	differential test
VB38	Architectural techniques and architecture of software applications in information systems	5	exam
VB39	Project to improve application software in the information system	5	differential test
Total:		48	
<i>Elective components of block 0400 Artificial Intelligence in Robotics:</i>			
VB41	Fundamentals of Robotics	5	exam
VB42	Project to create an applied robotic system	5	differential test
VB43	Environment and components for developing applied robotic systems	6	exam
VB44	Theory of control of robotics objects	6	exam
VB45	Programming of applied robotic systems	6	differential test
VB46	Industrial robotics and IoT	5	exam
VB47	Robotic system improvement project	5	differential test
VB48	Machine learning and integration solutions in robotics	5	exam
VB49	A project on the application of machine learning in a robotic system	5	differential test
Total:		48	
<i>Elective components of other educational and professional programs</i>			
Total:		6	
Total for the professional training cycle:		54	
Total elective components:		60	
Total for the educational and professional program:		240	

4. Certification form for higher education applicants

Forms of certification of higher education applicants	Certification is carried out in the form of defense of a qualification thesis.
Requirements for qualifying work	The qualification work should involve theoretical, systems engineering, or experimental research on a complex, specialized task or practical problem in the field of computer science, characterized by complexity and uncertainty of conditions and requiring the application of theories and methods of information technology. The qualification work should be free from academic plagiarism, falsification, and fabrication. The qualification work must be published on the official website of the Lviv Polytechnic National University or its structural unit or in the repository of the Lviv Polytechnic National University.

5. The relationship between program competencies and components of the bachelor's educational program "Computer Science (Artificial Intelligence Systems)" in specialty 122 "Computer Science"

Mandatory components

[illegible]

	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9	PC 10	PC 11	PC 12	PC 13	PC 14	PC 15	PC 16	PC 17	PC 18	PC 19
SK1						X											X		
SK2			X			X	X								X				
SK3						X											X		
SK4			X			X	X								X				
SK5	X		X																
SK6	X		X																
SK7	X		X																
SK8	X	X																	
SK9	X		X																
SK10	X	X	X	X	X	X	X	X			X				X	X			
SK11	X			X															
SK12	X				X														
SK13	X													X					
SK14					X	X	X								X		X		
SK15	X											X	X						X
SK16							X												
SK17										X	X								
SK18							X												
SK19										X	X								
SK20														X					
SK21	X							X											
SK22							X												
SK23	X	X																X	X
SK24									X			X	X				X		X
SK25	X							X											
SK26	X	X	X	X	X	X	X	X			X				X	X		X	
SK27	X				X														
SK28	X					X													X
SK29	X	X																X	
SK30	X	X																X	
SK31	X	X																X	
SK32	X	X																X	
SK33	X	X					X	X	X		X	X	X				X	X	X
SK34	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X
SK35	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X

Components of the elective blocks

	GC1	GC2	GC3	GC4	GC5	GC6	GC7	GC8	GC9	GC10	GC11	GC12	GC13	GC14	GC15	GC16	GC17
VB11																	
VB12																X	X
VB13																	
VB14																	
VB15																	
VB16																	
VB17																X	X
VB18																X	X
VB19																X	X
VB21																	
VB22																X	X
VB23																	
VB24																	
VB25																	
VB26																	
VB27																X	X
VB28																X	X
VB29																X	X
VB31																	
VB32																X	X
VB33																	
VB34																	
VB35																	
VB36																	
VB37																X	X
VB38																X	X
VB39																X	X
VB41																	
VB42																X	X
VB43																	
VB44																	
VB45																	
VB46																	
VB47																X	X
VB48																X	X
VB49																X	X

	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8	PC 9	PC 10	PC 11	PC 12	PC 13	PC 14	PC 15	PC 16	PC 17	PC 18	PC 19
VB11																	X	X	
VB12																		X	X
VB13																	X		
VB14																	X	X	
VB15																	X	X	
VB16																	X	X	
VB17																			X
VB18																		X	X
VB19																		X	X
VB21																	X		
VB22																			X
VB23																	X		
VB24																	X	X	
VB25																	X		
VB26																	X		
VB27																			X
VB28																			X
VB29																			X
VB31																	X		
VB32																			X
VB33																	X		
VB34																	X	X	
VB35																	X		
VB36																	X		
VB37																			X
VB38																			X
VB39																		X	X
VB31																	X		
VB32																			X
VB33																	X		
VB34																		X	
VB35																	X		
VB36																	X		X
VB37																			X
VB38																		X	X
VB39																			X

	PCP 11	PCP 12	PCP 13	PCP 14	PCP 21	PCP 22	PCP 23	PCP 24	PCP 31	PCP 32	PCP 33	PCP 34	PCP 41	PCP 42	PCP 43	PCP 44
VB11	X	X	X													
VB12	X	X	X													
VB13		X		X												
VB14		X		X												
VB15	X	X	X	X												
VB16		X		X												
VB17		X		X												
VB18	X	X	X	X												
VB19		X		X												
VB21					X		X	X								
VB22					X		X	X								
VB23					X		X	X								
VB24					X	X	X	X								
VB25						X		X								
VB26					X	X	X	X								
VB27					X		X	X								
VB28					X	X	X	X								
VB29					X		X	X								
VB31									X	X		X				
VB32									X	X		X				
VB33									X	X	X	X				
VB34									X		X	X				
VB35									X	X		X				
VB36									X	X	X	X				
VB37									X	X		X				
VB38									X		X	X				
VB39									X	X	X	X				
VB41														X	X	X
VB42													X		X	X
VB43													X		X	X
VB44														X	X	X
VB45													X		X	X
VB46													X	X	X	X
VB47													X	X	X	X
VB48													X	X	X	X
VB49													X	X	X	X

6. Ensuring program learning outcomes with the appropriate components of the bachelor's educational and professional program "Computer Science (Artificial Intelligence Systems)" in specialty 122 "Computer Science"

Mandatory components

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PO 16	PO 17	PO 18	PO 19
SK1								X			X								
SK2	X																		
SK3								X			X								
SK4	X																		
SK5		X																	
SK6		X																	
SK7		X																	
SK8			X																
SK9					X														
SK10	X																		
SK11						X													
SK12							X												
SK13																X			
SK14								X			X								
SK15															X				
SK16									X										
SK17													X	X					
SK18									X										
SK19													X	X					
SK20																	X		
SK21										X									
SK22									X										
SK23				X															X
SK24											X				X				
SK25										X									
SK26	X											X							
SK27							X												
SK28								X											X
SK29			X	X															
SK30				X														X	
SK31				X														X	
SK32				X														X	
SK33				X					X	X	X	X			X				
SK34	X			X				X	X		X				X			X	X
SK35	X			X				X	X		X				X			X	X

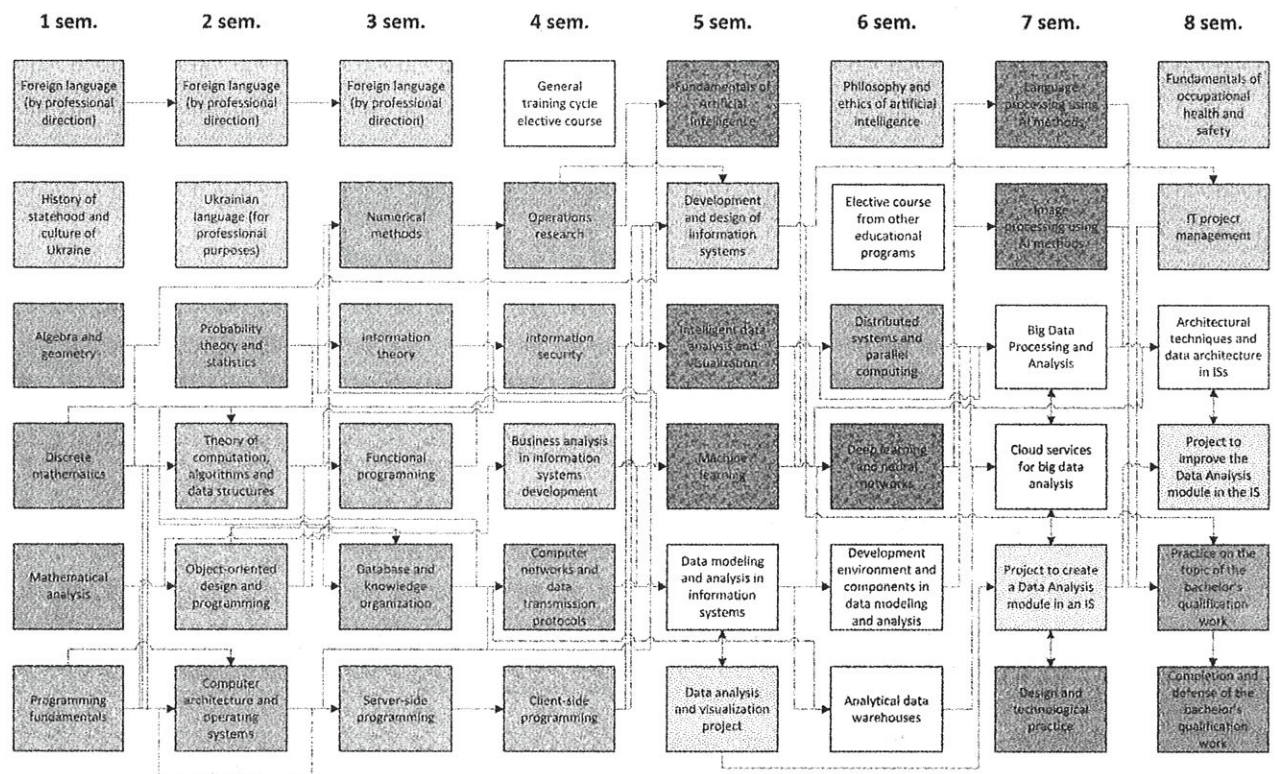
Components of the elective blocks

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PO 16	PO 17	PO 18	PO 19
VB11																		X	
VB12																		X	X
VB13																			
VB14																		X	
VB15																		X	X
VB16																		X	
VB17																			X
VB18																		X	X
VB19																		X	X
VB21																			
VB22																			X
VB23																			
VB24																		X	
VB25																			X
VB26																			
VB27																			X
VB28																			X
VB29																			X
VB31																			
VB32																			X
VB33																			
VB34																		X	
VB35																			X
VB36																			
VB37																			X
VB38																			X
VB39																			X
VB41																			
VB42																			X
VB43																			
VB44																		X	
VB45																			X
VB46																			X
VB47																			X
VB48																		X	X
VB49																			X

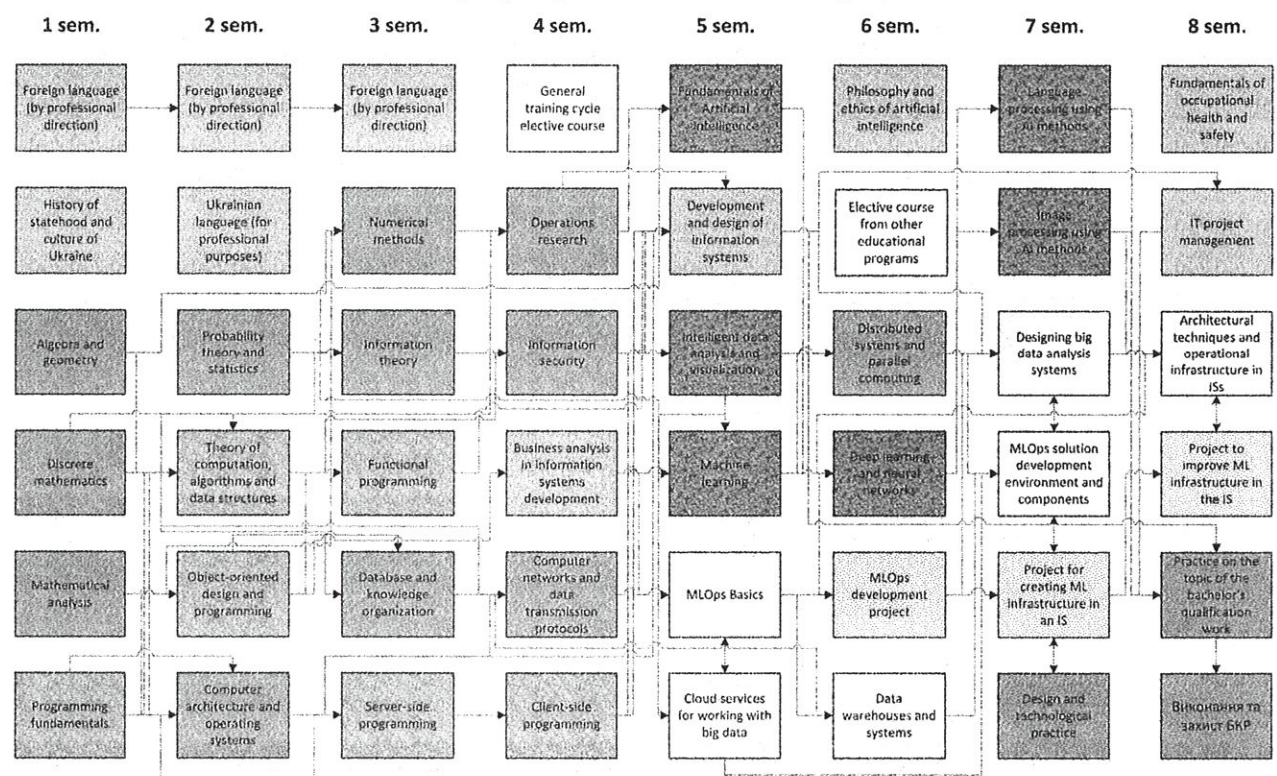
	UM 11	UM 12	UM 21	UM 22	UM 31	UM 32	UM 41	UM 42
VB11	X							
VB12	X							
VB13		X						
VB14		X						
VB15	X	X						
VB16		X						
VB17		X						
VB18	X	X						
VB19		X						
VB21				X				
VB22				X				
VB23				X				
VB24			X	X				
VB25			X					
VB26			X	X				
VB27				X				
VB28			X	X				
VB29				X				
VB31						X		
VB32						X		
VB33					X	X		
VB34					X			
VB35						X		
VB36					X	X		
VB37						X		
VB38					X			
VB39					X	X		
VB41							X	
VB42								X
VB43								X
VB44							X	
VB45								X
VB46							X	X
VB47							X	X
VB48							X	X
VB49							X	X

Structural and logical scheme of training bachelors in the educational and professional program "Computer Science (Artificial Intelligence Systems)" in specialty 122 "Computer Science".

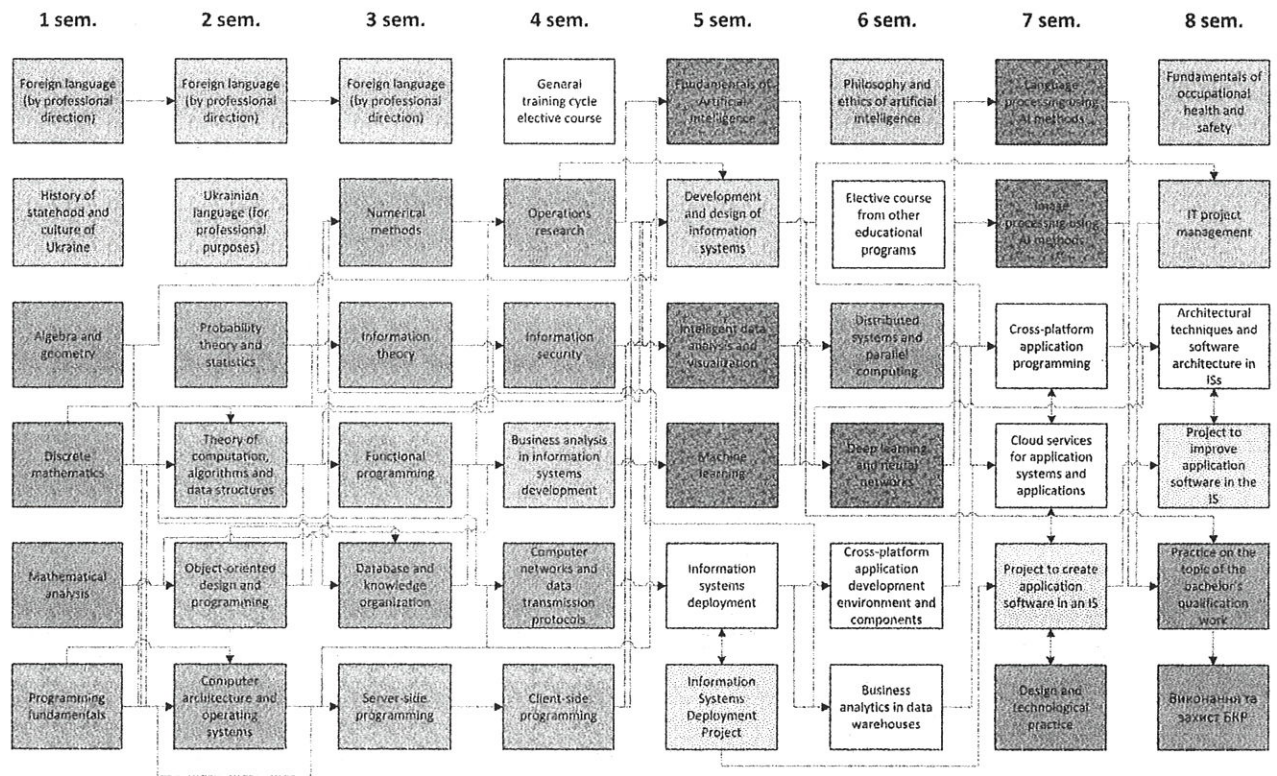
Line 1: Data Analysis



Line 2: Deploying Machine Learning Systems



Line 3: Applied software



Line 4: Artificial Intelligence in Robotics

