NJSC Kazakh National Research Technical University named after K.I. Satpayev"
Institute of Automation and Information Technologies
Department of Software Engineering

EDUCATIONAL PROGRAM

«Machine Learning & Data Science»
Master degree
in the field of Information and Communication Technologies under the Educational Program
«7M06102- Machine Learning & Data Science»

2nd edition
in accordance with the State Standard of Higher Education 2022

Almaty 2022

The program is drawn up and signed by the parties:
From KazNRTU named after K.I. Satpayeva:

1. Director of the Institute of Automation and Information Technologies (IAaIT), Doctor of Technical Sciences, Professor — R.K. Uskenbaeva
2. Head of the Department of Software Engineering (SE), Ph.D., Associate Professor — A.N. Moldagulova

3. Deputy Director of IAaIT, PhD — A.B. Kasymova

4. Member of the educational and methodological group of the department of SE, PhD — N.K. Mukazhanov

Qualification:
Level 7 of the National Qualifications Framework
7M06 Information and communication technologies

Professional competencies: Artificial Intelligence, Data Science

Brief description of the program

The main focus of the master's program is on an in-depth study of software development technologies in the field of artificial intelligence.

The program is aimed at training a high-quality specialist in accordance with the level of competence, capable of independently conducting scientific research, independently developing complex software solutions, working in a team, and navigating modern Information Technologies. The educational program is structured taking into account current trends in software development and in close connection with the manufacturing sector.

The development of the educational program was carried out on the basis of 3 documents defining directions and specializations in the field of IT - SWEBOK, the purpose of which is to combine knowledge in software engineering; SE2004 - training manual for training specialists in university programs in the field of software engineering; CC2005 - guidelines for the development of training programs for IT professionals. A team of international IT specialists has identified a set of areas of study and a set of disciplines that provide quality training in IT (CC2005), as well as the thematic composition of disciplines and a set of knowledge necessary and sufficient for IT specialists (SWEBOK, SE2004).

This educational program " Machine Learning & Data Science " was developed on the basis of the main regulatory documents:

- State compulsory standard of technical and vocational education, approved by Decree of the Government of the Republic of Kazakhstan dated August 23, 2012 No. 1080 (as amended as of August 15, 2017) **.** Footnote. Clause 1 as amended by the Decree of the Government of the Republic of Kazakhstan dated 04/25/2015 No. 327 (shall be enforced from 09/01/2016); dated 05/13/2016 No. 292 (to come into effect from 09/01/2017).

- Industry Qualification Framework (SQF). Industry: information and communication technologies. Approved by Minutes No. 1 of December 20, 2016 of the meeting of the Industry Commission in the field of information, informatization, communications and telecommunications.

- Law of the Republic of Kazakhstan “On Education” dated July 27, 2007 No. 319-III ZRK;

- IEEE SWEBOK pooling knowledge on software engineering;

- CC2005 guidelines for the development of training programs for IT specialists;

- SE2004 training manual for training specialists in university programs in the field of software engineering.

The program is designed to implement the principles of democratic education management, expanding the boundaries of academic freedom and the powers of

educational institutions, which will ensure the training of elite, highly motivated personnel for innovative and knowledge-intensive sectors of the economy.

The educational program was developed based on an analysis of the labor functions of software engineers, system administrators, and data analysts, as stated in professional standards.

Representatives of Kazakh companies in the field of software product development participated in the development of the educational program.

The program is aimed at the following areas of professional activity:

- Data analysis
- Machine learning
- Artificial intelligence

Contents of the educational program:

- General educational complex of disciplines
- Data Analytics Disciplines
- Machine learning disciplines
- Artificial Intelligence Disciplines
- Disciplines of software development project management

PASSPORT OF THE EDUCATIONAL PROGRAM

1 Scope and content of the program

The duration of master's studies is determined by the volume of completed academic credits. When mastering the established volume of academic credits and achieving the expected learning outcomes for obtaining a master's degree, the master's degree program is considered fully completed. In the scientific and pedagogical master's program there are at least 120 academic credits for the entire period of study, including all types of educational and scientific activities of the master's student.

Planning of the content of education, the method of organizing and conducting the educational process is carried out by the university and scientific organization independently on the basis of credit education technology.

The master's program in scientific and pedagogical direction implements educational programs of postgraduate education for the training of scientific and scientific-pedagogical personnel for universities and scientific organizations with in-depth scientific, pedagogical and research training.

The content of the master's educational program consists of:

1) theoretical training, including the study of cycles of basic and major disciplines;

2) practical training of undergraduates: various types of internships, scientific or professional internships;

3) research work, including the completion of a master’s thesis, for scientific and pedagogical master’s programs

4) final certification.

Purpose and objectives of the educational program

To provide practice-oriented training for research and production specialists in the development of software products in the field of data analysis, machine learning and artificial intelligence.

Create conditions for continuous professional self-improvement, development of social and personal competencies (broad cultural outlook, active citizenship, determination, organization, hard work, communication skills, ability to reason and make organizational and managerial decisions, mastery of modern information technologies, fluency in several languages, desire to self-development and commitment to ethical values and a healthy lifestyle, the ability to work in a team, responsibility for the final result of one's professional activities, civic responsibility, tolerance), social mobility and competitiveness in the labor market.

Level of education: higher
NQF/ORK qualification levels : Covers 8 level.
Area of professional activity*: technical sciences and technologies

Types of work activity:

- design and engineering;
- production and technological;
- experimental research;
- organizational and managerial;
- operational;
- scientific

Objects of professional activity:

- Computers, complexes, systems and networks;
- Computer systems for information processing and management;
- Automated control systems;
- Computer software;

Features of the program* *** : academic exchange program/credit system of education/distance learning
Full-time **form of education**
Duration of training : 2 years

2 **Admission requirements**

The previous level of education of applicants is higher professional education (bachelor's degree). The applicant must have a diploma of the established form and

confirm the level of knowledge of the English language with a certificate or diplomas of the established form.

The procedure for admitting citizens to master's programs is established in accordance with the “Standard Rules for Admission to Study in Educational Organizations Implementing Educational Programs of Postgraduate Education.”

The formation of a contingent of undergraduates is carried out by placing a state educational order for the training of scientific and teaching personnel, as well as paying for training at the expense of citizens’ own funds and other sources. The state provides citizens of the Republic of Kazakhstan with the right to receive, on a competitive basis, in accordance with the state educational order, free postgraduate education if they are receiving education at this level for the first time.

At the “entrance” the master’s student must have all the prerequisites necessary to master the corresponding master’s educational program. The list of necessary prerequisites is determined by the higher education institution independently.

In the absence of the necessary prerequisites, the master's student is allowed to master them on a paid basis.

3 Completion and Diploma Requirements

Awarded degree / qualifications : The graduate of this educational program is awarded the academic degree Master of Technical Sciences.

A graduate who has completed a master's program must have the following general professional competencies:

– the ability to independently acquire, comprehend, structure and use new knowledge and skills in professional activities, to develop one's innovative abilities;

– the ability to independently formulate research goals, establish a sequence for solving professional problems;

– the ability to apply in practice the knowledge of fundamental and applied sections of the disciplines that determine the focus (profile) of the master's program;

– the ability to professionally select and creatively use modern scientific and technical equipment to solve scientific and practical problems;

– the ability to critically analyze, present, defend, discuss and disseminate the results of their professional activities;

– possessing the skills of compiling and preparing scientific and technical documentation, scientific reports, reviews, reports and articles;

– willingness to lead a team in the field of their professional activities, tolerantly perceiving social, ethnic, religious and cultural differences;

– readiness to communicate orally and in writing in a foreign language to solve professional problems.

A graduate who has completed a master's program must have professional competencies corresponding to the types of professional activities that the master's program is focused on:

research activities:

- the ability to formulate diagnostic solutions to professional problems by integrating fundamental sections of science and specialized knowledge acquired during the master's program;
- the ability to independently conduct scientific experiments and research in the professional field, summarize and analyze experimental information, draw conclusions, formulate conclusions and recommendations;
- the ability to create and explore models of the objects under study based on the use of in-depth theoretical and practical knowledge in the field of software development;
- *scientific and production activities:*
- the ability to independently carry out production and scientific-production field, laboratory and interpretive work when solving practical problems;
- the ability to professionally operate modern field and laboratory equipment and instruments in the field of the master's program;

- the ability to use modern methods of processing and interpreting complex information to solve production problems;
- *project activities:*
- the ability to independently draw up and present projects for scientific research and scientific production work;
- readiness to design complex research and scientific-production work when solving professional problems;
- *organizational and managerial activities:*
- readiness to use practical skills in organizing and managing research and scientific and production work in solving professional problems;
- readiness for practical use of regulatory documents in planning and organizing scientific and production work;
- *scientific and pedagogical activities:*
- ability to conduct seminars, laboratory and practical classes;
- the ability to participate in the management of scientific and educational work of students in the field of software development.

When developing a master's program, all general cultural and general professional competencies, as well as professional competencies related to those types of professional activities that the master's program is focused on, are included in the set of required results for mastering the master's program.

4 Working curriculum of the educational program

4.1. Duration of training 2 years

Year of study	Code	Name of the discipline	Component	Loans		Lk / forehead / pr	Prerequisites	Code	Name of the discipline	Component	Loans		Lk / forehead / pr	Prerequisites
				ECTS	RK						ECTS	RK		
1	**1 semester**							**2nd semester**						
	LNG 205	Foreign language (professional)	DB VK	5	3	0/0/3		CSE 290	CAP & ACID Fundamentals	DB KV	5	3	2/0/1	
	HU M20 1	History and philosophy of science	DB VK	4	2	1/0/1		CSE 281	Neural Networks Fundamentals	DB KV	5	3	2/0/1	
	HU M20 5	Higher education pedagogy	DB VK	4	2	1/0/1		CSE 263	Artificial Intelligence Fundamentals	PD VK	5	2	2/0/1	
		Psychology of management	DB VK	4	2	1/0/1		CSE 260	Theory of Complexity and Computations	PD HF	4	2	1/0/1	
	CSE 268	Scientific Python	DB KV	5	3	2/0/1		CSE 225	Applied Information Theory	PD HF	4	3	1/0/1	
	CSE 293	Math Statistics and Probability Theory	PD VK	5	3	2/0/1			Research work of a master's student	NIRM	7	2		
		Teaching practice	DB VK	3	3									
		Total:		**thirty**	**18**				**Total:**		**thirty**	**15**		
2	**3rd semester**							**4th semester**						
	CSE 280	Big Data Storage Systems & Computations	PD HF	5	3	2/0/1			Research work of a master's student	NIRM	9	2		

CSE 284	Applied Machine Learning & Deep Learning	PD HF	5	3	2/0/1			Research practice	PD	9	2		
CSE 283	Natural Language Processing	PD HF	4	2	1/0/1			Preparation and defense of a master's thesis (OiZMD)	IA	12	3		
CSE 285	Microservices and Cloud computing	PD HF	4	2	1/0/1								
CSE 282	Digital Image Processing	PD HF	4	2	1/0/1								
	Research work of a master's student	NIRM	8	2									
	Total:		**thirty**	**14**				**Total:**		**thirty**	**7**		
								Total:		**120**	**73**		

5 **Descriptors of the level and scope of knowledge, abilities, skills and competencies**

Requirements for the level of preparation of a master's student are determined on the basis of the Dublin descriptors of the second level of higher education (master's degree) and reflect the mastered competencies expressed in the achieved learning outcomes.

Learning outcomes are formulated both at the level of the entire master's degree program and at the level of individual modules or academic disciplines.

Descriptors reflect learning outcomes that characterize the student’s abilities:

1) demonstrate evolving knowledge and understanding of the software engineering field under study, based on advanced knowledge of that field, when developing and/or applying ideas in the context of the study;

2) apply at a professional level their knowledge, understanding and abilities to solve problems in a new environment, in a broader interdisciplinary context;

3) collect and interpret information to form judgments, taking into account social, ethical and scientific considerations;

4) communicate information, ideas, findings, problems and solutions clearly and unambiguously to both specialists and non-specialists;

5) learning skills necessary for independent continuation of further education in the field of study.

6 Competencies upon completion of training

6.1 Requirements for key competencies of graduates *of scientific and pedagogical master's programs* must:

1) have an idea:

– about the role of science and education in public life;

– about modern trends in the development of scientific knowledge;

– about current methodological and philosophical problems of natural (social, humanities, economic) sciences;

– on the professional competence of a higher school teacher;

– about the contradictions and socio-economic consequences of globalization processes;

2) know:

– methodology of scientific knowledge;

– principles and structure of scientific activity organization;

– psychology of cognitive activity of students in the learning process;

– psychological methods and means of increasing the effectiveness and quality of education;

3) be able to:

– use acquired knowledge for the original development and application of ideas in the context of scientific research;

– critically analyze existing concepts, theories and approaches to the analysis of processes and phenomena;

– integrate knowledge gained within different disciplines to solve research problems in new unfamiliar conditions;

– by integrating knowledge, make judgments and decisions based on incomplete or limited information;

– apply knowledge of pedagogy and psychology of higher education in their teaching activities;

– apply interactive teaching methods;

– carry out information-analytical and information-bibliographic work using modern information technologies;

– think creatively and creatively approach solving new problems and situations;

– be fluent in a foreign language at a professional level, allowing you to conduct scientific research and teach special disciplines at universities;

– summarize the results of research and analytical work in the form of a dissertation, scientific article, report, analytical note, etc.;

4) have the skills:

– research activities, solving standard scientific problems;

– implementation of educational and pedagogical activities on credit technology of education;

– methods of teaching professional disciplines;
– use of modern information technologies in the educational process;
– professional communication and intercultural communication;
– oratory, correct and logical presentation of one's thoughts in oral and written form;
– expanding and deepening the knowledge necessary for everyday professional activities and continuing education in doctoral studies.

5) be competent:

– in the field of research methodology;
– in the field of scientific and scientific-pedagogical activities in higher educational institutions;
– in matters of modern educational technologies;
– in carrying out scientific projects and research in the professional field;
– in ways to ensure constant updating of knowledge, expansion of professional skills and abilities.

B – Basic knowledge, skills and abilities
B1 – Programming languages;
B2 – Models and types of data analysis;
B3 – Principles and models of artificial intelligence;
B4 – Techniques for modeling, composition and decomposition of systems;
B5 – Principles of consistency and integrity;
B6 – Methods of system/structural analysis;
B7 – Software life cycle;
B8 – UML – as a basic tool for describing technical systems;
B9 – Process design methods;
B10 – Methods and models of conducting scientific activities;
B11 – Models of data processing;
B12 – Basic approaches, tools and models for managing project activities;
B13 - Analysis of the subject area, determination of goals and ways to achieve them;
B14 - Determining deadlines for completing tasks and creating technical specifications;
B15 - Formalization of the task, determining the priority of implementation;
B16 - Selection of optimal solutions to problems;
B17 - Planning stages of project implementation;
B18 - Modeling the structure of the subject area;
B19 — Determination of functional and operational requirements for system components;
B20 - Using UML standards to present technical documentation, diagrams, models;
B21 — Maintaining protocols of project implementation;
B22 — Formation of reporting documentation;
B23 - Creation of models and methods of data analysis;
B24 — Creation of decision-making systems based on Artificial Intelligence models
B25 — About trends in IT
B26 - On the applicability of tools and technologies to solve a problem
B27 - On the adequacy of the designed model
B28 — On the effectiveness of the methods and models used

P – Professional competencies:

P1 - Analysis of the subject area, determination of goals and ways to achieve them;
P2 - Determining deadlines for completing tasks and creating technical specifications;
P3 - Formalization of the task, determining the priority of implementation;
P4 - Selection of optimal solutions to problems;
P5 - Planning the stages of the project;
P6 - Modeling the structure of the subject area;
P7 - Determination of functional and operational requirements for system components;
P8 - Using UML standards to present technical documentation, diagrams, models;
P9 - Maintaining protocols of project implementation;
P10 — Generation of reporting documentation;
P11 - Design of database models;
P12 - Development and design of software interfaces;
P13 - Construction of algorithms for computational processes;
P14 - Building a data processing and analysis model;
P15 — Writing /testing/debugging/maintenance/integration of program codes and products;

O - General human, social and ethical competencies
O1 - Have knowledge of the historical, cultural and scientific achievements of the Republic of Kazakhstan; use data from historical sources and special literature; analyze and evaluate historical facts and events.
O2 - Have a broad social, political and professional outlook
O3 - Have an idea of the subject, functions, main sections and directions of philosophy; the place and role of philosophy in the life of society and man, to apply knowledge of philosophical and methodological principles of cognition in professional activities
O4 - Think logically, master the methods of induction and deduction, determine cause-and-effect relationships; master methods of decomposition, analysis and synthesis of systems
O5 - Knowledge of Kazakh, Russian, foreign languages. Be able to work with scientific and technical literature in Kazakh, Russian and foreign languages; search for scientific and technical information; understand information provided at a normal pace, with the subsequent transfer of its content; There is intercultural dialogue, develop and deepen your knowledge, be open to new information; establish professional contacts and develop professional communication in a foreign language, carry out business contacts in a foreign language, know terminology, read literature on the specialty in a foreign language
O6 - Plan the stages of scientific research, organize searches and select relevant information
O7 - Structure and edit information, prepare technical and scientific documentation in accordance with existing requirements;
O8 - Be able to formulate oral and written speech in a reasoned and clear manner, and explain your view of the problem.
O9 - The ability to critically analyze existing concepts, theories and approaches to the analysis of processes and phenomena.
O10 - Application of knowledge of pedagogy and psychology of higher education in one's teaching activities, the use of interactive teaching methods.
O11 - The ability to summarize the results of research and analytical work in the form of a dissertation, scientific article, report, analytical note, etc.

C – Special and managerial competencies:

C1 - Ability to set goals and plan ways to achieve them;
C2 - Ability to conduct project/operational activities;
C3 - Ability to conduct scientific research;
C4 - Ability to organize the work of an IT department;
C5 - Ability to organize work on collecting, storing and processing information used in the field of professional activity.

6.2 Requirements for research work of a master's student in a scientific and pedagogical master's program:

1) corresponds to the profile of the master's educational program, according to which the master's thesis is being carried out and defended;
2) is relevant and contains scientific novelty and practical significance;
3) is based on modern theoretical, methodological and technological achievements of science and practice;
4) is carried out using modern scientific research methods;
5) contains research (methodological, practical) sections on the main protected provisions;
6) is based on advanced international experience in the relevant field of knowledge.

6.3 Requirements for organizing practices:

The educational program of the scientific and pedagogical master's degree includes two types of internships, which are carried out in parallel with theoretical training or in a separate period:
1) pedagogical in the DB cycle - at a university;
2) research in the PD cycle - at the place where the dissertation was completed.

Pedagogical practice is carried out with the aim of developing practical skills in teaching and learning methods. At the same time, master's students are involved in teaching undergraduate classes at the discretion of the university.

The undergraduate research practice is carried out with the aim of familiarizing himself with the latest theoretical, methodological and technological achievements of domestic and foreign science, modern methods of scientific research, processing and interpretation of experimental data.

7 ECTS Diploma Supplement

The application was developed according to the standards of the European Commission, Council of Europe and UNESCO/CEPES. This document serves only for academic recognition and is not an official confirmation of an educational document. Not valid without a higher education diploma. The purpose of completing the European Annex is to provide sufficient information about the diploma holder, the qualifications he has received, the level of this qualification, the content of the training program, the results, the functional purpose of the qualification, as well as information about the national education system. The application model used to transfer grades uses the European Credit Transfer or Transfer System (ECTS).

The European Diploma Supplement provides an opportunity to continue education at foreign universities, as well as confirm national higher education for foreign employers. When traveling abroad for professional recognition, additional legalization of an education diploma will be required. The European Diploma Supplement is completed in English upon individual request and is issued free of charge.

8 Description of courses

English (professional)
CODE – LNG 205
CREDIT – 5

PURPOSE AND OBJECTIVES OF THE COURSE

Thanks to this course, you will master specific terminology, be able to read specialized literature, and gain the knowledge necessary to carry out effective oral and written communications in a foreign language in your professional activities.

BRIEF DESCRIPTION OF THE COURSE

During the training process, students acquire knowledge of a foreign language, including knowledge of specialized vocabulary, necessary for effective oral and written communications in a foreign language in their professional activities. Practical tasks and methods for developing the required language skills during the learning process include: case method and role-playing games, dialogues, discussions, presentations, listening tasks, work in pairs or groups, various written tasks, grammar tasks and explanations.

KNOWLEDGE, ABILITIES, SKILLS AT COMPLETION OF THE COURSE

As a result of mastering the discipline, the student will expand his professional vocabulary, possess the skills of effective communication in a professional environment, the ability to competently express thoughts in oral and written speech, understand specific terminology and read specialized literature.

History and philosophy of science
CODE – HUM2 01
CREDIT – 4

GOALS AND OBJECTIVES OF THE COURSE

Reveal the connection between philosophy and science, highlight the philosophical problems of science and scientific knowledge, the main stages of the history of science, the leading concepts of the philosophy of science, modern problems of the development of scientific and technical reality.

BRIEF DESCRIPTION OF THE COURSE

The subject of the philosophy of science, the dynamics of science, the specifics of science, science and pre-science, antiquity and the formation of theoretical science, the main stages of the historical development of science, features of classical science, non-classical and post-non-classical science, philosophy of mathematics, physics, engineering and technology, specifics of engineering sciences, ethics of science , social and moral responsibility of a scientist and engineer.

KNOWLEDGE, ABILITIES, SKILLS AT COMPLETION OF THE COURSE

Know and understand the philosophical issues of science, the main historical stages of the development of science, the leading concepts of the philosophy of science, be able to critically evaluate and analyze scientific and philosophical problems, understand the specifics of engineering science, possess the skills of analytical thinking and philosophical reflection, be able to justify and defend their position, master techniques conducting discussion and dialogue, mastering the skills of communication and creativity in their professional activities.

Higher education pedagogy
CODE – HUM205
CREDIT – 4

PURPOSE AND OBJECTIVES OF THE COURSE

The course is aimed at studying the psychological and pedagogical essence of the educational process of higher education; formation of ideas about the main trends in the development of higher education at the present stage, consideration of the methodological foundations of the learning process in higher education, as well as psychological mechanisms influencing the success of learning, interaction, and management of subjects of the educational process. Development of psychological and pedagogical thinking of undergraduates.

BRIEF DESCRIPTION OF THE COURSE

During the course, undergraduates become familiar with didactics of higher education, forms and methods of organizing education in higher education, psychological factors of successful learning, features of psychological influence, mechanisms of educational influence, pedagogical technologies, characteristics of pedagogical communication, mechanisms for managing the learning process. Organizational conflicts and ways to resolve them, psychological destruction and deformations of the teacher's personality are analyzed.

KNOWLEDGE , ABILITIES, SKILLS AT COMPLETION OF THE COURSE

At the end of the course, the undergraduate must know the features of the modern system of higher professional education, the organization of pedagogical research, the characteristics of the subjects of the educational process, the didactic foundations of organizing the learning process in higher education, pedagogical technologies, patterns of pedagogical communication, features of educational influences on students, as well as problems of pedagogical activity.

Psychology of management
CODE -
CREDIT – 4

PURPOSE AND OBJECTIVES OF THE COURSE

The main goal of the course is aimed at studying the behavioral characteristics of individuals and groups of people within organizations; determining psychological and social factors influencing the behavior of employees. Also, much attention will be paid to the issues of internal and external motivation of people.
The main goal of the course is to apply this knowledge to improve the efficiency of the organization.

BRIEF DESCRIPTION OF THE COURSE

The course is designed to provide balanced coverage of all the key elements that make up the discipline. It will briefly review the origins and development of the theory and practice of organizational behavior, followed by an examination of the core roles, skills and functions of management, with an emphasis on management effectiveness, illustrated with real-life examples and case studies.

KNOWLEDGE, ABILITIES, SKILLS AT COMPLETION OF THE COURSE

At the end of the course, students will know: the basics of individual and group behavior; basic theories of motivation; basic theories of leadership; concepts of communications, conflict and stress management in an organization.
will be able to define the different roles of leaders in organizations; look at organizations from the point of view of managers; Understand how effective management contributes to an effective organization.

Scientific Python
CODE – CSE268
CREDIT – 5
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE:

The goal of studying this discipline is for students to master such a powerful tool in data processing as the Python language and the SciKit library , which includes - NumPy - working with matrices, SciPy - data analysis tools, MatplotLib - data visualization tools .

BRIEF DESCRIPTION OF THE COURSE

Currently, Python is recognized as the most common programming language for data processing tasks. This is due to its simplicity and intuitive syntax, which abstracts the connection to the computer hardware with a strong emphasis on creating small, efficient algorithms. The course provides a quick tour of the language's syntactic features and strengths.

The main attention is paid to mechanisms for working with data, such as: loading, filtering, transformation, analysis and interpretation of data using well-known models of classification, clustering, regression, etc. Basic methods of working with matrices and matrix operations based on the NumPy library are studied . MatPlotLib data visualization tools are studied in the form of various types of graphs that allow you to analyze performed operations, calculation results, or understand the nature of the data.

KNOWLEDGE, ABILITIES, SKILLS AT COMPLETION OF THE COURSE

As a result of completing the course, students will receive the necessary knowledge about the Python language. Gain knowledge in the field of programming matrix operations and working with data. They will learn to use tools for loading, filtering, processing, and interpreting data. Learn to use data analysis models such as classification, clustering, regression. Learn to use effective approaches when writing program code in Python.

Math S statistics and Probability Theory
CODE – CSE293
CREDIT – 5
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

The purpose of studying this discipline is to study both methods and models of mathematical statistics. The concepts of conditional mathematical expectation and conditional probability distribution are studied , discrete and continuous distributions, the theory of Lebesgue measure and integral, the Radon– Nikodim theorem are considered .

BRIEF DESCRIPTION OF THE COURSE

The main emphasis is on mathematical methods for constructing probable models and the implementation of these methods on real problems in natural science and practical activities. Each family of distributions, be it Poisson, exponential, normal, gamma, etc., is introduced through the consideration of some real objects that provide a system of mathematical postulates, from which the distributions of the numerical characteristics of these objects are determined through analytical calculations. The mathematical apparatus of probability theory is presented only to the extent that allows the correct introduction of new probabilistic models. This approach provides an informal attitude to the use of methods of mathematical statistics - the awareness that without building a probabilistic model it is not possible to judge the accuracy and reliability of statistical inference. The focus is on methods for calculating the risk of specific statistical rules and problems in statistical decisions with minimal risk.

KNOWLEDGE, ABILITIES, SKILLS AT COMPLETION OF THE COURSE

As a result of completing the discipline, students receive fundamental knowledge of probability theory and mathematical statistics, which are necessary in the subsequent study of disciplines according to the training program.

CAP & ACID Fundamentals
CODE – CSE290
CREDIT – 5
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

The goal is to master the main problems of building distributed and high-performance data storage systems. Abbreviation CAP(Consistency Availability Partition Tollerance) is widely used in the construction of architectural solutions for data storage at various levels, from the simplest relational and non-relational stores to complex distributed systems with partial or full support for the transactional model. ACID - Adomicity , Consistency , Integrity and Durability - are usually referred to as relational data stores, so this course examines this model primarily using the example of such databases. At the same time, the mechanisms for organizing such a model based on other data storage systems are revealed.

Tasks:

- Learn the fundamentals of data storage
- Studying Data Access Performance
- Study of blocking processes and DeadLock state and combat mechanisms
- Exploring asynchronous data access

BRIEF DESCRIPTION OF THE COURSE

The course is built on the basis of studying the theoretical foundations of constructing relational and non-relational data warehouses, transactional models of data isolation and problems of consistency of computing processes. Various data storage paradigms are considered in relation to various tasks. Issues of performance and construction of distributed data storage architectures based on existing software solutions are raised.

KNOWLEDGE , ABILITIES, SKILLS AT COMPLETION OF THE COURSE

Upon completion of the course the student will:

Understand

- Types of data warehouses
- Problems that are solved when building data warehouses
- Data isolation levels in the transactional access model
- Data distribution mechanisms

Know

- Various data stores - relational, non-relational
- fundamental differences between them

Be able to

- Use various data warehouses to build information systems and software products

Neural Networks Fundamentals
CODE – CSE281
CREDIT – 5
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

The purpose of studying this discipline is to master the theoretical basis for constructing artificial neural networks, study the mathematical model for constructing networks with backpropagation of errors, and methods for optimizing training and convergence. Study of various neural network topologies.

BRIEF DESCRIPTION OF THE COURSE

Currently, artificial neural networks are widely used in machine learning tasks. This is due to innovative models of teaching them technological progress, which allows them to perform trillions of operations per second using specialized processors. Artificial neural networks are built in an attempt to resemble biological prototypes. The mathematical model is based on linear algebra operations. The problems that neural network architects face are the selection of a model that best meets the requirements of the subject area and the solution of the problem. The process of modeling new topologies of artificial neural networks is a labor-intensive task, but training and optimization of such networks, as well as performance testing, is no less labor-intensive .

KNOWLEDGE, ABILITIES, SKILLS AT COMPLETION OF THE COURSE

As a result of completing the course, students will receive basic knowledge about artificial neural networks. Learn to create models of the simplest perceptron, a multilayer neural network. Explore learning models and convergence problems. Get acquainted with problems of dimensionality of feature space. This course is a theoretical foundation for continuing to apply practical skills in machine learning.

Artificial Intelligence Fundamentals
CODE – CSE263
CREDIT – 5
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

The purpose of this course is to learn a range of AI algorithms, including some machine learning algorithms.

BRIEF DESCRIPTION OF THE COURSE

This course focuses on artificial intelligence (AI), particularly what is known as weak or soft AI, which are the techniques and algorithms that can make software smarter and more useful. While early AI focused on creating intelligent machines that mimic human behavior (otherwise known as Strong AI), most AI research and practice today focuses on practical purposes. They involve embedding AI algorithms and techniques into software to give them the properties characteristic of intelligence: the ability to learn, optimize, and reason. The course covers optimization algorithms based on simulating natural processes in living and non-living nature, expert systems, clustering algorithms that provide personalized user service, prediction methods based on regression models, feedforward neural networks.

KNOWLEDGE , ABILITIES, SKILLS AT COMPLETION OF THE COURSE
Upon completion of the course students will:
Understand

- what is weak artificial intelligence
- various artificial intelligence methods

Know

- Basic concepts of problem solving in the context of applying human intelligence from a computational perspective
- main aspects of applications of AI technology for the development of smart programs.
- Basic methods of presenting knowledge, solving problems and “training” programs in creating intelligent systems

Be able to

- develop software using a learned set of AI algorithms

Applied Information Theory
CODE – CSE225
CREDIT – 4
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

The goal of the course is to master the fundamental concepts of information theory.
Main objectives of the course:

- Expand the concepts of entropy and information
- Learn to apply methods of quantitative assessment of information
- Reveal theoretical and practical aspects of optimal (efficient) coding
- Reveal the theoretical and practical aspects of noise immunity coding.
- Show models of signals, data transmission systems, modulation and demodulation, signal sampling.
- To instill skills in applying the theory of error-correcting coding in data processing systems.

BRIEF DESCRIPTION OF THE COURSE

The course is devoted to information theory, which is the theoretical basis of information and communication technologies. Information theory explains key aspects of information communication and data processing. The course covers the concepts of entropy, information, optimal coding techniques, noise-resistant coding techniques, and signal models. The course provides some techniques for prototyping signal and data processing software based on linear algebra and information theory.

KNOWLEDGE , ABILITIES, SKILLS AT COMPLETION OF THE COURSE

Upon completion of the course students will:
Understand

- what is entropy and information,
- what are efficient coding methods and noise-resistant coding methods
- mathematical signal models

Know

- Basic concepts of data transmission, methods and algorithms for efficient coding, methods of error-correcting coding, signal models, applications of information theory.

Be able to

- develop software for data processing based on information theory
- apply information theory methods to solve practical problems (noise-resistant coding, cryptography, data processing)

Theory of Complexity and Computations
CODE – CSE260
CREDIT – 4
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

The goal is to master the basic elements of the theory of computational complexity

Tasks:

- Analysis of computational problems and complexity of algorithms
- Analysis of complexity classes of deterministic algorithms
- Analysis of complexity classes of non-deterministic algorithms
- Analysis of classes of computational algorithms by capacity complexity

BRIEF DESCRIPTION OF THE COURSE

Computational complexity theory is a field of theoretical computer science, one of the main tasks of which is the classification and comparison of the practical complexity of solving problems about finite combinatorial objects. In a number of cases, complexity theory provides answers to questions about the computational and capacity complexity of algorithms and their relationship with each other. The theory of computational complexity introduces the concepts of problem classes from the point of view of computational complexity, efficient algorithms that solve problems in polynomial time and others with an exponential dependence of the solution time on the data, considers deterministic and non-deterministic algorithms and their computational complexity.

In particular, considering the problem of determining the primeness of a number n, we know that it can be solved in a time proportional to log (n), while at the same time determining the winning sequence of steps in a chess game is a problem that can be solved by “brute force” or “brute force” methods. , which at least corresponds exponentially in size to the problem instance. Complexity theory attempts to clarify such distinctions by offering a formal criterion of what it means for a mathematically solvable problem to be satisfactorily solvable—that is, that it can be solved by an ordinary Turing machine in several steps that are proportional to a polynomial function of the size of its input or not , for example, an exponential function.

KNOWLEDGE , ABILITIES, SKILLS AT COMPLETION OF THE COURSE

Upon completion of the course students will:

Understand

- Concepts of computational and capacity complexity of algorithms
- algorithm complexity classes

Know

- The relationship between complexity classes and the limits of application of the theory of computational complexity
- fundamental differences between problems with different complexity classes

Be able to

- Apply complexity theory to estimate the computational complexity of algorithms .

Big Data Storage Systems & Computations
CODE – CSE280
CREDIT – 5
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

The goal of the discipline is to master the principles and obtain practical skills in organizing and technologies for storing, transforming and analytical processing of big data.

Course objectives – developing skills in researching the use of tools for working with big data in information systems to solve practical problems.

BRIEF DESCRIPTION OF THE COURSE

The discipline examines the theoretical and practical aspects of using big data technologies in information systems. The lecture course examines trends in the development of infrastructure solutions for processing and storing big data.

KNOWLEDGE , ABILITIES, SKILLS AT COMPLETION OF THE COURSE

must know:

- basic principles of using big data in enterprise architecture;
- basic methods of analytical processing of big data;

should be able to:

- use MapReduce technologies and software packages built on the basis of software when working with big data.

Applied Machine Learning & Deep Learning
CODE – CSE284
CREDIT – 5
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

The goal of the course is to master the basic theory and practice of machine learning methods based on widely used open access libraries. Learn to apply machine learning models in practical software development problems.

Main objectives of the course:

- Consider the main machine learning models and the problems they solve
- Gain an understanding and experience of neural networks
- Consider modern methods of data classification and clustering
- Exploring current trends in deep learning models research

BRIEF DESCRIPTION OF THE COURSE

The course focuses on deep learning models. As a field within machine learning, deep learning models illustrate the quantitative-qualitative transition. New models and their properties require separate study and practice in tuning the metaparameters of such models.

KNOWLEDGE , ABILITIES, SKILLS AT COMPLETION OF THE COURSE

Upon completion of the course students will:

Understand

- Features of deep learning models
- Current directions of research in the field of AI

Know

- Objectives and applications of deep learning models

Be able to

- Use machine learning models

Natural Language Processing
CODE – CSE283
CREDIT – 4
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

Goal - Mastering the theory and practice of natural language processing (NLP or natural language processing - NLP)

Tasks:

- Study the main areas of application of NLP and methods used for text processing
- Master basic text processing skills to solve problems of information retrieval, sentiment analysis, information extraction, text classification, etc.

BRIEF DESCRIPTION OF THE COURSE

Natural language processing language processing , NLP) is a rapidly developing area of research, the results of which in the form of speech and text processing technologies we actively use. The need for development in this area is associated with the huge amount of information currently being generated. NLP as a research area includes a wide range of applied areas, which include: automatic translation, automatic abstracting, generating answers to user queries, information extraction (information extraction), information search (information retrieval), sentiment analysis, etc. To solve these problems, linguistic, statistical methods, special language models, machine learning, etc. are used. The course covers the theoretical aspects of NLP, including basic information from the field of linguistics, and practical methods of text processing using Natural Language ToolKit .

KNOWLEDGE , ABILITIES, SKILLS AT COMPLETION OF THE COURSE

Upon completion of the course students will:

Understand

- what is NLP,
- what is a statistical language model,
- what software methods and algorithms are used in the field of NLP

Know

- Basic concepts of NLP, methods and algorithms for text processing, methods for classifying texts, methods and algorithms for solving basic NLP problems.

Be able to

- Develop word processing software based on NLTK
- Apply word processing techniques to solve specific information processing problems

Microservices & Cloud Computing
CODE – CSE285
CREDIT – 4
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

The goal is to master models for building scalable systems based on microservices technologies .

Tasks:

- Exploring the concept of microservices
- Exploring the concepts of containerization and orchestration
- Exploring the Actor Model

BRIEF DESCRIPTION OF THE COURSE

The course is based on modern requirements and trends towards building loosely coupled scalable information systems. The microservice model regulates the approach of fragmenting complex solutions, classically built as a monolithic software module, into loosely coupled elements that interact with each other through asynchronous messages. This allows you to develop each of the modules independently and focus on specific system performance if necessary. Such systems are characterized by a high degree of fault tolerance, since each component is as autonomous as possible. Such approaches require a revision of classical solutions towards the implementation of the integrity model with alternative approaches, since in most cases there is no direct connection between objects of different modules. Also, the microservices model relies as much as possible on the concept of asynchronous interaction, which imposes its own obligations to model the integrity and guarantee the execution of the operation in each individual case independently.

KNOWLEDGE , ABILITIES, SKILLS AT COMPLETION OF THE COURSE

Upon completion of the course students will:

Understand

- What is a microservice and context boundaries
- What is a container image and container

Know

- Application containerization platforms
- Model Actor

Be able to

- Apply microservice architecture to build scalable information systems

Digital Image Processing
CODE – CSE282
CREDIT – 4
PRE-REQUISITE –

PURPOSE AND OBJECTIVES OF THE COURSE

Studying the basic principles of representing digital images, models for working with them and interpreting data - decoding.

BRIEF DESCRIPTION OF THE COURSE

Digital imaging is an attempt to describe the visual world using digital data methods. Study of color, texture, methods and models of image processing - filtering, decoding. Application of established algorithms belonging to the category of computer vision. The discipline is at the intersection of such disciplines as machine learning and artificial intelligence. Therefore, models of classification and clustering of data, the use of mathematical models to identify qualitative and quantitative features of an image are considered.

KNOWLEDGE, ABILITIES, SKILLS AT COMPLETION OF THE COURSE

They will know : What is a digital image. Formal features and content of digital images. Mathematical models of digital image compression. Mathematical models of filtering and decoding digital images.
As a result of completing the course, students will gain the necessary skills in working with digital images by writing specialized software.

The educational program of the scientific and pedagogical master's degree includes two types of internships:
- pedagogical;
- research.

Pedagogical practice is carried out with the aim of developing practical skills and teaching methods.
Pedagogical practice can be carried out during the period of theoretical training without interruption from the educational process.
The undergraduate research practice is carried out with the aim of familiarizing himself with the latest theoretical, methodological and technological achievements of domestic and foreign science, with modern methods of scientific research, processing and interpretation of experimental data.

Research work of a master's student

Research work in scientific and pedagogical master's programs must:
- correspond to the main issues of the specialty in which the master's thesis is being defended;
- be relevant, contain scientific novelty and practical significance;
- be based on modern theoretical, methodological and technological achievements of science and practice;
- be carried out using modern scientific research methods;
- contain research (methodological, practical) sections on the main protected provisions;
- be based on advanced international experience in the relevant field of knowledge.
- carried out using advanced information technologies;
- contain experimental and research (methodological, practical) sections on the main protected provisions.

Preparation and defense of a master's thesis

The purpose of the master's thesis is:
demonstration of the level of scientific/research qualification of a master's student, the ability to independently conduct scientific research, testing the ability to solve specific scientific and practical problems, knowledge of the most common methods and techniques for solving them.

SHORT DESCRIPTION

A master's thesis is a final qualifying scientific work, which is a generalization of the results of an independent study by a master's student of one of the current problems of a specific specialty of the relevant branch of science, which has internal unity and reflects the progress and results of the development of the chosen topic.
A master's thesis is the result of a master's student's research/experimental research work, carried out throughout the entire period of the master's student's studies.

Defense of the master's thesis is the final stage of master's preparation. The master's thesis must meet the following requirements:
– the work must conduct research or solve current problems in the field of software development;
– the work should be based on identifying important scientific problems and solving them;
– decisions must be scientifically based and reliable, have internal unity;
– the dissertation must be written individually;

Content