Non-profit joint-stock company «Kazakh national research technical University named after K.I. Satbayev»
Institute of metallurgy and industrial engineering
Department of «Software Engineering»

Educational program

"MACHINE LEARNING & DATA SCIENCE"

Master of Technical Sciences

based on the following specialties of the invalidated classifier of specialties:
«6M070400»

1st edition
in accordance with the state standard of higher education 2018

Almaty 2019

СӘТБАЕВ УНИВЕРСИТЕТІ SATBAYEV UNIVERSITY

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Квалификация:
Уровень 7 Национальной рамки квалификаций:
7М0610 Информационно- коммуникационные технологии

Профессиональные компетенции: Разработка программного обеспечения, Анализ данных и Машинное обучение.

Brief description of the program

The main focus of the master's program is on the 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 who is able to independently conduct scientific research, independently develop complex software solutions, work in a team, and navigate modern Information Technologies. The educational program is structured taking into account the current trends in software development and in close relationship with the manufacturing sector.

The development of the educational program was carried out on the basis of 3 documents defining directions and specialization in the field of IT - SWEBOK, the purpose of which is to combine knowledge of software engineering; SE2004 - Study Guide for the Training of University Programs in Software Engineering; CC2005 Guidelines for curriculum development 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 a thematic composition of disciplines and a set of knowledge necessary and sufficient for IT specialists (SWEBOK, SE2004).

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

- State obligatory standard technical and vocational education, approved by the Decree of the Government of the Republic of Kazakhstan dated August 23, 2012 No. 1080 (with changes as of August 15, 2017). Footnote. Clause 1 as amended by the decrees of the Government of the Republic of Kazakhstan dated 25.04.2015 No. 327 (shall be enforced from 09/01/2016); dated 13.05.2016 No. 292 (effective from 01.09.2017).
- Sectoral Qualifications Framework (SQF). Industry: information and communication technologies. Approved by Minutes No. 1 dated December 20, 2016 of the meeting of the Industry Commission in the field of information, informatization, communications and telecommunications.
- The Law of the Republic of Kazakhstan "On Education" dated July 27, 2007 No. 319III ЗРК; - IEEE SWEBOK pooling knowledge of software engineering;
- CC2005 guidelines for developing curriculum for IT professionals;
- SE2004 educational leadership for preparation specialists university programs in software engineering.

The program is designed to implement the principles of the democratic nature of education management, expanding the boundaries of academic freedom and powers of educational institutions, which will provide the training of elite, highly motivated personnel for innovative and knowledge-intensive sectors of the economy.

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

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

The program focuses on the following areas of professional activity:

- Data analysis
- Machine learning
- Artificial Intelligence

Content of the educational program:

General educational complex of disciplines
Data Analysis
Machine Learning
Artificial Intelligence
Disciplines of project management securing

PASSPORT OF THE EDUCATIONAL PROGRAM

1. **Scope and content of the program**

The term of study in the master's program is determined by the amount of acquired academic credits. Upon mastering the established amount of academic credits and achieving the expected learning outcomes for obtaining a master's degree, the master's educational program is considered fully mastered. In the scientific and pedagogical magistracy, at least 120 academic credits for the entire period of study, including all types of educational and scientific activities of the master student.

Planning the content of education, the way of organizing and conducting educational process carried out University and scientific organizationindependently based on credit technology of education.

The master's degree in scientific and pedagogical direction implements educational programs of postgraduate education for the preparation of scientific and scientific and pedagogical personnel for universities and scientific organizations that have in-depth scientific and educational and research preparation.

The content of the Master's degree program consists of:

1) theoretical training, including the study of cycles of basic and major disciplines;
2) practical training of undergraduates: various types of practices, scientific or professional internships;
3) research work, including the implementation of a master's thesis - for a scientific and pedagogical magistracy
4) final certification.

The purpose and objectives of the educational program

Provide practice-oriented training of specialists in scientific activity and production in the field of software development in the field of data analysis, machine learning and artificial intelligence.

Create a conditions for continuous professional self-improvement, development of social and personal competencies (wide cultural outlook, active citizenship, dedication, organization, hard work, sociability, ability to argumentation and adoption of organizational and managerial decisions, possession of modern information technologies, free possession several languages, striving for self-development and adherence to ethical values and a healthy lifestyle, the ability to work in a team, responsibility for the end result of one's professional activity, civic responsibility, tolerance), social mobility and competitiveness in the labor market.

Education level: high
Qualification levels for NQF/ORK: Covers 8 levels.
Professional area *: technical sciences and technologies

Labor activities:
- design and engineering;
- production and technological;
- experimental research;
- organizational and managerial;
- operational;
- scientific.

Objects of professional activity:
- Computing machines, complexes, systems and networks;
- Computer systems for information processing and control;
- Automated control systems;
- Computer software;

Features of the program **:** academic exchange program / credit training system / distance learning
Form of study: full-time
Duration of study: 2 years

2. Requirements for applicants

Prior level education applicants - higher professional education (bachelor's degree). The applicant must have a diploma of the established sample and confirm the level of knowledge of the English language with a certificate or diplomas of the established sample.

The procedure for admitting citizens to a magistracy is established in accordance with the "Standard rules for admission to training in educational organizations that implement 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 pedagogical 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 receive education of this level for the first time.

At the "entrance", a master's student must have all the prerequisites necessary for mastering the corresponding educational master's program. The list of required prerequisites is determined by the higher education institution independently.

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

3. Requirements for Completion and Diploma

Awarded degree/ qualifications: Graduate given the educational program is awarded the academic degree of master of technical sciences.

A graduate who has completed master's programs must possess the following general professional competencies:

- ability by yourself acquire, comprehend structure and use new knowledge and skills in professional activities, develop their 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 disciplines that determine the focus (profile) of the master's program;
- the ability to professionally choose and creatively use modern scientific and technical equipment for solving scientific and practical problems;
- the ability to critically analyze, represent, defend, discuss and disseminate the results of their professional activities;
- proficiency in the preparation and execution of 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, confessional and cultural differences;
- the readiness for communication in oral and written forms in a foreign language to solve the problems of professional activity.

A graduate who has mastered the master's program must have professional competencies, appropriate types professional activities for which the master's program is focused:

research activities:

- ability to form diagnostic solutions of professional tasks by integration fundamental sections sciences and specialized knowledge gained during mastering the master's program;
- ability to independently conduct professional research, experimental information, conclusions and recommendations;
- the ability to create and explore models of objects under study based on the use of in-depth theoretical and practical knowledge in the field of software development;

-research and production activities:

- the ability to independently carry out production and research and production field, laboratory and interpretation work in solving practical problems;
- the ability to professionally operate modern field and laboratory equipment and instruments in the field of the mastered master's program;
- ability use modern methods processing and interpretation of complex information for solving production problems;
- *project activity:*
- the ability to independently compose and submit projects for research and development work;
- readiness to design complex research and development work in solving professional problems;
- *organizational and management activities:*
- the readiness to use the practical skills of organizing and managing research and development work in solving professional problems;
- the readiness for the practical use of regulatory documents in the planning and organization of scientific and industrial work;
- *scientific and pedagogical activity:*
- the ability to conduct seminars, laboratory and practical exercises;
- 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 of mastering the master's program.

4. Working curriculum of the educational program

4.1. Study period 2 year

Year of study	Code	Name of discipline	Component	Credits		lec/lab/pr	Pre-requisites	Code	Name of discipline	Component ECTS	Credits		ec/lab/pr	Pre-requisites
				ECTS	RK						ECTS	RK		
	1 semester								2 semester					
1	LNG 205	Foreign language (professional)	DB VK	5	3	0/0/3		CSE 290	CAP & ACID Fundamentals	DB VK	5	3	2/0/1	
	HUM 201	History and philosophy science	DB VK	4	2	1/0/1		CSE 281	Neural Networks Fundamentals	DB VK	5	3	2/0/1	
	HUM 205	Pedagogy high school	DB VK	4	2	1/0/1		CSE 263	Artificial Intelligence Fundamentals	PD VC	5	2	2/0/1	
	CSE 268	Psychology of management	DB VK	5	2	1/0/1		CSE 260	Theory of Complexity and Computations	PD KV	4	2	1/0/1	
	CSE 293	Scientific Python	DB KV	5	3	2/0/1		CSE 225	Applied Information Theory	PD KV	4	3	1/0/1	
		Math Statistics and Probability Theory	PD VC	5	3	2/0/1			Scientific research work of master student	RW MS	7	2		
		Pedagogical i practice	DB VK	3	3									
		Total:		**30**	**18**				**Total:**		**30**	**15**		
	3 semester							4 semester						
2	CSE 280	Big Data Storage Systems & Computations	PD KV	5	3	2/0/1			Scientific research work of master student	RW MS	9	2		
	CSE 284	Applied Machine Learning & Deep Learning	PD KV	5	3	2/0/1			Research practice	PD	9	2		
	CSE 283	Natural Language Processing	PD KV	4	2	1/0/1			Registration and Master's thesis defense (OIMD)	IA	12	3		
	CSE 285	Microservices and Cloud computing	PD KV	4	2	1/0/1								
	CSE 282	Digital Image Processing	PD KV	4	2	1/0/1								
		Scientific research work of master student	RWMS	8	2									
		Total:		**30**	**14**				**Total:**		**30**	**7**		
									Total:		**120**	**73**		

5. Descriptors of the level and amount of knowledge, abilities, skills and competencies

The 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 acquired competencies expressed in the achieved learning outcomes.

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

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

1) demonstrate evolving knowledge and understanding in the field of software development under study, based on advanced knowledge of the field, when developing and / or applying ideas in the context of research;
2) apply at a professional level their knowledge, understanding and ability 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) clearly and unambiguously communicate information, ideas, conclusions, problems and solutions, both to specialists and non-specialists;
5) learning skills necessary for independent continuation of further education in the studied area.

6. Completion Competencies

6.1 Requirements for key competencies of graduates scientific and pedagogical magistracy, must:
1) have an idea:
- on the role of science and education in public life;
- about modern trends in the development of scientific knowledge;
- about relevant methodological and philosophical problems
natural (social, humanitarian, economic) sciences;
- about 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 the organization of scientific activity;
- psychology of students' cognitive activity in the learning process;
- psychological methods and means of increasing the efficiency and quality of education;
3) be able to:
- use the knowledge gained 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 in different disciplines to solve research problems in new unfamiliar conditions;
- by integrating knowledge, make judgments and make decisions based on incomplete or limited information;
- to apply knowledge of pedagogy and psychology of higher education in their teaching activities;
- apply interactive teaching methods;
- spend information and analytical and informational bibliographic work using modern information technologies;
- to think creatively and be creative in solving new problems and situations;
- be fluent in a foreign language at a professional level, allowing for scientific research and teaching of special disciplines in universities;
- summarize the results of research and analytical work in the form of a dissertation, scientific article, report, analytical note, etc.;
4) have skills:
- research activities, solutions to standard scientific tasks;
- implementation of educational and pedagogical activities on credit technology of education;
- methods of teaching professional disciplines;
- use modern information technologies in educational process;
- professional communication and intercultural communication;
- oratory, correct and logical design of your thoughts in oral and written form;
- expansion and deepening of knowledge necessary for daily 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 the implementation of 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 - The principles of consistency and integrity;
B6 - Systemic / structural analysis methods;
B7 - Software life cycle;
B8-UML- as a basic tool for describing technical systems;
B9 - M process design methods;
B10 - M methods and models of scientific activity;
B11 - M data processing models;
B12 - Basic approaches, tools and models for project management;
B13 - Analysis of the subject area, definition of goals and ways to achieve them;
B14 - Determining the timing of tasks and the formation of technical specifications; B15 - Formalization of the task, prioritization of implementation;
B16 - Selection of optimal solutions to problems;
B17 - Planning the stages of the project;
B18 - Modeling the structure of the subject area;
B19 - Determination of functional and operational requirements for system components;
B20 - Using UML standards to represent technical documentation, diagrams, models;
B21 - Keeping protocols of the project;
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 for solving the 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, definition of goals and ways to achieve them;
P2 - Determining the timing of tasks and the formation of technical specifications;
P3 - Formalization of the task, prioritization 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 represent technical documentation, diagrams, models;
P9 - Keeping protocols of the project;
P10 - Formation of reporting documentation;
P11 - Database model design;
P12 - Develo and design of software interfaces;

P13 - Construction of algorithms for computing processes;
P14 —Building a data processing and analysis model;
P15 - Writing / testing / debugging / maintenance / integration of program codes and products;

O - Human, social and ethical competences

O1 - Possess 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; place and role of philosophy in the life of society and individuals, 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 the methods of decomposition, analysis and synthesis of O5 systems - 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 the information provided at a normal pace, with the subsequent transfer of its content. Conduct an intercultural dialogue, develop and deepen their knowledge, be open to new information; set professional contacts and develop professional communication in a foreign language, carry out business contacts in a foreign language, know the terminology, read literature on the specialty in a foreign language
O6 - Plan the stages of scientific research, organize searches and select relevant information
O7 - To structure and edit information, prepare technical and scientific documentation in accordance with existing requirements;
O8 - Be able to reasonably and clearly build oral and written speech, explain your view of the problem.
O9 - 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 their pedagogical activities, the use of interactive teaching methods.
O11 - 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 - The ability to organize the work of the IT department;
C5 - Ability to organize work on the collection, storage and processing of information used in the field of professional activity.

6.2 Requirements for the research work of a master student in a scientific and pedagogical magistracy:

1) corresponds to the profile of the master's educational program, according to which the master's thesis is performed 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 magistracy includes two types of practices, which are carried out in parallel with theoretical training or in a separate period:
1) pedagogical in the DB cycle - at the university;
2) research in the PD cycle - at the place of the dissertation.

Pedagogical practice is carried out with the aim of developing practical skills in teaching and learning methods. In this case, undergraduates are involved in conducting classes in a bachelor's degree at the discretion of the university.

The research practice of the undergraduate is carried out with the aim of acquainting 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 is for academic recognition only and is not an official proof of education. Not valid without a university degree. The purpose of completing the European annex is to provide sufficient information about the holder of the diploma, the qualification obtained, the level of this qualification, the content of the study program, the results, the functional purpose of the qualification, as well as information about the national education system. The application model that will be used to translate 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 to confirm national higher education for foreign employers. When going abroad for professional recognition, additional legalization of the educational diploma is required. The European Diploma Supplement is completed in English upon individual request and is issued free of charge.

8. Description of disciplines

English (professional)
CODE – LNG205
CREDIT - 5

PURPOSE AND OBJECTIVES OF THE COURSE

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

SHORT DESCRIPTION OF THE COURSE

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

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

As a result of mastering the discipline, the student expands the professional lexical 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 – HUM201
CREDIT - 4

PURPOSE AND OBJECTIVES OF THE COURSE

To reveal the connection between philosophy and science, to 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.

SHORT DESCRIPTION OF THE COURSE

The subject of philosophy of science, dynamics of science, specificity 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, technology and technology, specificity of engineering sciences, ethics of science , social and moral responsibility of a scientist and engineer.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

Know and understand the philosophical issues of science, the main historical stages in the development of science, the leading concepts of the philosophy of science, be able to critically assess and analyze scientific and philosophical problems, understand the specifics of engineering science, possess the skills of analytical thinking and philosophical reflection, be able to substantiate and defend one's position, master techniques conducting discussion and dialogue, possessing 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 affecting the success of learning, interaction, management of subjects of the educational process. The development of psychological pedagogical thinking of undergraduates.

SHORT DESCRIPTION OF THE COURSE

In the course of studying the course, undergraduates get acquainted with the 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 of managing the learning process. Analyze organizational conflicts and ways to resolve them, psychological destruction and deformation of the teacher's personality.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

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 the organization of the learning process in higher education, pedagogical technologies, the patterns of pedagogical communication, the features of educational influences on students, as well as the problems of pedagogical activity.

Philosophy of management

CODE
CREDIT - 4

PURPOSE AND OBJECTIVES OF THE COURSE

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

The main goal of the course is to apply this knowledge to improve the effectiveness of the organization.

SHORT 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 a review of the main roles, skills and functions of management with a focus on management effectiveness, illustrated with real-life examples and case studies.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

Upon completion of the course, students will know: the basics of individual and group behavior; basic theories of motivation; basic leadership theories; concepts of communication, management of conflicts and stress in the 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-REQISIT -

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.

SHORT DESCRIPTION OF THE COURSE

Currently, the Python language is recognized as the most common programming language in data processing tasks. This is due to its simplicity and intuitive syntax, in which communication with the hardware of the computer is abstracted, with a pronounced emphasis on creating small efficient algorithms. The course provides a quick excursion on the syntactic features of the language and strengths.

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

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

As a result of passing the course, students receive the necessary knowledge about the Python language. Obtain knowledge in the field of programming matrix operations and working with data. Will learn use tools downloads, filtration, processing, interpretation of data. Learn to use data analysis models such as classification, clustering, regression. Learn to use effective approaches when writing software code in Python.

Math Statistics and Probability Theory

CODE – CSE293
CREDIT – 5
PRE-REQISIT -

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, Lebesgue measure and integral theory, Radon – Nikodym theorem are considered.

SHORT DESCRIPTION OF THE COURSE

The main focus is on mathematical methods for constructing probable models and the implementation of these methods on real problems of natural science and practical activity. Each family of distributions, be it Poisson, exponential, normal, gamma, etc., is introduced through 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 by analytical calculations. The mathematical apparatus of the theory of probability is presented only to the extent that allows one to correctly introduce new probabilistic models. This approach provides an informal attitude to the use of methods of mathematical statistics - the realization that without building a probabilistic model it is not possible to judge the accuracy and reliability of statistical inference.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

As a result of passing the discipline, students receive the 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-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

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

Objectives:

- Learning the Fundamentals of Data Storage
- Examining Data Access Performance
- Studying Blocking Processes and DeadLock State and Fighting Mechanisms
- Exploring Asynchronous Data Access

SHORT DESCRIPTION OF THE COURSE

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

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

Upon completion of the course, the student will:

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

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

Be able to
- Use various data warehouses for building information systems and software products

Neural Networks Fundamentals

CODE – CSE281
CREDIT – 5
PRE-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

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

SHORT DESCRIPTION OF THE COURSE

At the moment, artificial neural networks are widely used in machine learning problems. This is due to innovative models of teaching them technological progress, allowing them to perform trillions of operations per second using specialized processors. Artificial neural networks are being built in an attempt to resemble biological prototypes. The mathematical model is based on the operations of linear algebra. Challenges facing neural network architects is 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 laborious task, but training and optimization of such networks, as well as testing for performance, is no less laborious.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

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

Artificial Intelligence Fundamentals

CODE – CSE263
CREDIT – 5
PRE-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

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

SHORT DESCRIPTION OF THE COURSE

This course focuses on artificial intelligence (AI), specifically what is known as weak or soft AI, that is, techniques and algorithms that can make software smarter and more useful. While early AI concentrated on creating intelligent machines that mimic human behavior (otherwise known as Strong AI), much of the research and practice of AI today is focused on practical purposes. They involve embedding AI algorithms and techniques into software to give them the properties of intelligence: the ability to learn, optimize, and reason. The course examines optimization algorithms based on imitating natural processes in living and non-living nature, expert systems, clustering algorithms that provide personalization of user service.

KNOWLEDGE, SKILLS TO COMPLETE THE COURSE

At the end 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 the application of human intelligence from a computational point of view
- the main aspects of AI applications for the development of "smart" programs.
- Basic methods of knowledge representation, problem solving and "teaching" programs in the creation of intelligent systems

Be able to
- develop software using the studied set of AI algorithms

Applied Information Theory

CODE – CSE225
CREDIT – 5
PRE-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

The aim of the course is to master the fundamental concepts of information theory. The main objectives of the course:

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

SHORT DESCRIPTION OF THE COURSE

The course focuses on 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 methods, noise immunity coding methods, and signal models. The course provides some techniques for prototyping signal and data processing software based on linear algebra and information theory.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

Upon completion of the course, students will:
Understand
- what is entropy and information,
- what are effective coding methods and noise-immune coding methods
- mathematical models of signals
Know
- Basic concepts of data transmission, methods and algorithms for effective 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 the methods of information theory to solve practical problems (error-correcting coding, cryptography, data processing)

Theory of Complexity and Computations

CODE – CSE260
CREDIT – 4
PRE-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

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

Objectives:
- 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 capacitive complexity

SHORT 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 on finite combinatorial objects. Complexity theory in a number of cases provides answers to questions about the computational and capacitive complexity of algorithms, their relationship to each other. The theory of computational complexity introduces the concept of classes of problems in terms of computational complexity, efficient algorithms that solve problems in polynomial time, and others with an exponential dependence of the solution time on data, considers deterministic and non-deterministic algorithms and their computational complexity.

In particular, considering the problem of determining the prime number of n, we know that it can be solved in time proportional to log (n), at the same time, determining a winning sequence of steps in a chess game is a problem solved by "brute force" or "brute force", which is at least exponentially the same size as the task instance. Complexity theory attempts to clarify such differences by proposing a formal criterion for what it means for a mathematically solvable problem to be feasibly solvable - that is, that it can be solved using a conventional Turing machine in several steps that are proportional to a polynomial function of the size of its input or not polynomial, for example, an exponential function.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

Upon completion of the course, students will:

Understand
- Concepts of computational and capacitive complexity of algorithms
- classes of complexity of algorithms
Know
- The ratio of complexity classes to each other and the limits of the theory application computational complexity
- fundamental differences between problems with different classes of complexity
Be able to
- Apply complexity theory to assess the computational complexity of algorithms.

Big Data Storage Systems & Computations

CODE – CSE280
CREDIT – 5
PRE-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

The aim of the discipline is to master the principles and acquire practical skills in the organization and technologies of storage, transformation and analytical processing of big data.

Course Objectives - development of research skills on the use of tools for working with big data in information systems for solving practical problems.

SHORT 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, ABILITY, SKILLS TO COMPLETE 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:
- to use MapReduce technologies and programs built on the basis of software when working with big data.

Applied Machine Learning & Deep Learning

CODE – CSE284
CREDIT – 5
PRE-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

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

The main objectives of the course:
- Consider the main machine learning models and the tasks they solve - Gain understanding and experience of neural networks
- Consider modern methods of data classification and clustering
- Exploring current research directions for deep learning models

SHORT DESCRIPTION OF THE COURSE

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

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

Upon completion of the course, students will:
Understand
- Features of deep learning models
- Trending research areas in AI
Know
- Challenges and Applications of Deep Learning Models
Be able to
- Use machine learning models

Natural Language Processing

CODE – CSE283
CREDIT – 4
PRE-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

Goal - Mastering the theory and practice of natural language processing (OEE or natural language processing - NLP)
Objectives:
- Explore the main applications of NLP and methods used for word processing
- Master basic word processing skills for solving information retrieval problems, sentiment analysis, information extraction, text classification, etc.

SHORT DESCRIPTION OF THE COURSE

Natural language processing (NLP) is a rapidly developing area of research, the results of which we actively use in the form of speech and text processing technologies. The need for the development of this direction is associated with the huge amount of information generated at the present time. NLP as a research area includes a wide range of applied topics, which include: automatic translation, automatic abstracting, generating responses to requests user, information extraction, information retrieval (information retrieval), sentiment analysis, etc. In solving these problems, linguistic, statistical methods, special language models, machine learning, etc. are used. The course covers theoretical aspects of NLP, including basic knowledge of linguistics, and practical methods of word processing using the Natural Language ToolKit.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

Upon completion of the course, students will:
Understand
- what is NLP,
- what is a statistical model of a language,
- what software methods and algorithms are used in the field of NLP
Know
- Basic concepts of NLP, methods and algorithms for word processing, methods for classifying texts, methods and algorithms for solving basic NLP problems.
Be able to
- Develop NLTK based word processing software
- Apply word processing methods to solve specific information processing tasks

Microservices & Cloud Computing

CODE – CSE285
CREDIT – 4
PRE-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

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

Objectives:
- Exploring the concept of microservices
- Exploring the concept of containerization and orchestration - Exploring the Actor model

SHORT DESCRIPTION OF THE COURSE

The course is built on modern requirements and trends in the construction of loosely coupled scalable information systems. The microservice model regulates the approach of splitting complex solutions, classically built as a monolithic software module into loosely coupled elements that interact with each other through asynchronous messages. That allows you to develop each of the modules independently and focus on the point performance of the system, if necessary. Such systems are distinguished 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 by alternative approaches, since in most cases there is no direct connection between objects of different modules.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

Upon completion of the course, students will:
Understand
- What is microservice and context boundaries
- What is 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-REQISIT -

PURPOSE AND OBJECTIVES OF THE COURSE

Studying the basic principles of digital images presentation, models of working with them and data interpretation - decryption.

SHORT DESCRIPTION OF THE COURSE

The digital image 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 well-established algorithms related to the category of computer vision. The discipline is at the intersection of disciplines such as machine learning, artificial intelligence. Therefore, models of classification and clustering of data are considered, the use of mathematical models for the selection of qualitative and quantitative features of the image.

KNOWLEDGE, ABILITY, SKILLS TO COMPLETE THE COURSE

They will know: What is a digital image. Formal signs and content of digital images. Mathematical models of digital image compression. Mathematical models for filtering and decoding digital images. As a result of taking the course students get the necessary skills to work with digital images by writing specialized software.

The educational program of the scientific and pedagogical magistracy includes two types of practices:
- 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 interrupting the educational process.
The research practice of the undergraduate is carried out with the aim of acquainting 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 student
Research work in the scientific and pedagogical magistracy should:
- correspond to the main problematics 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;
- carried out using modern methods of scientific research;
- contain research (methodological, practical) sections on the main protected provisions;
- be based on advanced international experience in the relevant field of knowledge.
- performed using advanced information technologies;
- contain experimental and research (methodological, practical) sections on the main protected provisions.

Registration and defense of a master's thesis

The purpose of the master's thesis is:
demonstration of the level of scientific / research qualifications of a master student, the ability to independently conduct scientific research, test the ability to solve specific scientific and practical problems, knowledge of the most general methods and techniques for their solution.

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 student of one of the urgent problems of a specific specialty of the corresponding branch of science, which has internal unity and reflects the course and results of the development of the chosen topic. Master's thesis - the outcome research / experimental- research work of a master student, carried out during the entire period of study of a master student.

The defense of a master's thesis is the final stage of the master's preparation. A master's thesis must meet the following requirements:
- the work should conduct research or solve urgent problems in the field of software development;
- the work should be based on the definition of important scientific problems and their solution; - decisions must be scientifically grounded and reliable, have internal unity;
- the thesis should be written individually;

Content