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Student's Handbook

Master of Data Science

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Preamble

In this handbook the students find the student's educational plan and annotations to all its units. The units are grouped: core unites are obligatory' selective units suppose the free choice of student to take any of the proposed ones, the number of selective units to pass in each semester is given in the table below. All the courses are mathematics and computer science oriented and covers the areas of modern Data Science. At the end of studies student defend their diploma works.

As a result of this educational programme the students gain the following competences.

Knowledge and understanding:

- knowledge and understanding of theoretical basis of Data Science, the ability to formalize the problem and to use mathematical methods for analysis of formalized models in different domain knowledge areas;

- knowledge of applied problems, which could be investigated with modern mathematical methods, knowledge and understanding of methods for construction and qualitative and quantitative analysis of complex mathematical models of natural, technogenic, economic and social objects and processes;

- ability to collect and analyze data (including big data) to ensure the quality of project decision-making; ability to analyze methods of distributed processing of big data, to verify their consistency, stability to network separation and the computing complexity; use statistical methods for bid data analysis and processing;

- ability to apply existing and develop new algorithms for solving interdisciplinary problems in the field of Data Science and mathematics;

- ability to use existing and to develop their own models of computing systems; ability to develop software in accordance with formulated requirements, taking into account available resources and limitations, to describe, analyze and optimize architectural solutions for information and computer systems in different areas;

- ability to integrate knowledge and solve complex problems of managing software projects in wide or multidisciplinary contexts;

- ability to conduct scientific research, set and solve new theoretical and applied problems, develop new innovative methods of solving and analyzing results; ability to choose an adequate mathematical apparatus, use known theoretical concepts and facts to solve specific research problems;

- ability to present the scientific results according to the standards and requirements to the scientific texts in computer science;

- ability to conduct scientific and pedagogical activities in higher education institutions.

Application of knowledge and understanding:

-apply a systematic approach, integrating knowledge from other disciplines taking into account non-technical aspects, when solving problems in the chosen specialization and conducting research, justify the choice of methods for solving a specialized problem, critically evaluate the results obtained and defend the decisions made;

- communicate effectively at professional and social levels, including oral and written communication in a foreign language; present and discuss the results obtained and transfer the acquired knowledge, formalize the results of the research in the form of a completed work, present and defend its content;

- use specialized conceptual knowledge that includes modern scientific achievements in the field of mathematics, data science and computer science in general as the basis for original thinking and conducting research, critical understanding of problems in the field of computer science and at the boundaries of fields of knowledge;

- use specialized mathematical and data science problem-solving skills necessary to conduct research and/or implement innovative activities to develop new knowledge and procedures; effectively use modern mathematical apparatus in professional activities to solve theoretical and applied problems in Data Science;

- apply the classification and essence of modern global problems, the main directions of their solution, their reflection on Ukrainian reality to study modern political, economic and social processes in the world and Ukraine;

- apply existing knowledge of mathematical theories to pose new problems, put forward hypotheses, formulate and prove new mathematical results and analyze them; apply the theorems and methods of modern branches of functional analysis, in particular the basic facts about Banach and Hilbert spaces and operators in them, elements of the spectral theory of operators, the theory of Fourier series in Hilbert spaces and the basic facts about the Fourier transform to investigate spaces and operators;

- develop mathematical models, methods, algorithms for data analysis software (including big data); create new algorithms for solving problems in the interdisciplinary field of computer science and mathematics, evaluate their effectiveness and limitations on their application; conduct research in the interdisciplinary field of computer science and mathematics;

- collect, formalize, systematize, and analyze the needs and requirements for an information or computer system; develop a conceptual model, architectural solutions for an information or computer system for various purposes and apply mathematical methods for their analysis, evaluation and quality assurance;

- use modern technologies in the process of intelligent multidimensional data analysis; solve professional problems using methods of classification, forecasting, cluster analysis, search for associative rules;

- apply the results of scientific research to improve the efficiency of products and services in the area of data science and information technology in general.

Forming judgments:

- formulate, analyze and solve problems related to computer science and to data science in particular in the process software development and scientific research.

EDUCATIONAL PROGRAMME

Educational Programme

Code	Unit Name	ECTS Credits	Credit\exam	Semester
	Core Units			
CU01	Global Problems of the Present	3	credit	1
CU02	Scientific Research Course Work	6	credit	1,2
CU03	Functional Analysis for Data Analysis	5	Exam	1
CU04	Mathematical Statistics	5	Exam	1
CU05	Databases and Data Storages Technologies	5	Exam	1
CU06	Machine Learning: Theory and Algorithms I	6	Exam	1
CU07	Machine Learning: Theory and Algorithms II	5	Exam	2
CU08	Numerical Methods for Data Analysis	5	Exam	2
CU09	Big Data Processing	5	credit	2
CU10	Parallel and Distributed Computing	6	Exam	2
CU11	Scientific and Research Practice	20	Exam	4
CU12	Prediploma Practice (on-the-job)	6	credit	4
CU13	Qualification Thesis Preparation	4	Exam	4
	Core Units Summary (ECTS)	**81**		
	Selective Units			
SU2.2.1	Unit 1	3	credit	1
SU2.2.2	Unit 2	6	Exam	2
SU2.2.3	Unit 3	6	Exam	3
SU2.2.4	Unit 4	6	Exam	3
SU2.2.5	Unit 5	6	Exam	3

SU2.2.6	Unit 6	6	Exam	3
SU2.2.7	Unit 7	6	Exam	3
	Selective Units Summary (ECTS)	**39**		
	Units Summary (ECTS)	**120**		

Name	**Mathematical Statistics**
Programme	master
Semester	1
ECTS credits , Exam / Credit	5 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	Statistics deals with the question of how to obtain information about a larger totality from data sets (samples) using mathematical methods. The students • learn the theory of mathematical statistics comprehensively and apply it to applied problems, especially of bio- and econometric nature • are familiar with the most important estimation and testing methods, • structure complex problems related to the analysis of data and select appropriate methods and techniques to solve them, • model data inference problems from application areas, develop solutions using statistical methods and interpret the results, • are familiar with regression methods and appropriate numerical techniques
Topics	1. Statistical hypothesis testing 2. Multivariate analysis of variance 3. Discriminant analysis 4. Factor analysis 5. Cluster analysis 6. Advanced regression methods 7. Introduction to time series and autocorrelation

Name	**Functional Analysis for Data Analysis**
Programme	master
Semester	1
ECTS credits , Exam / Credit	5 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	**Knowledge**: Students are acquainted with theory of finite dimensional spaces, vectors, matrices in R^n, basic concepts of sets, functions, general topology, basic concepts in the theory of Banach and Hilbert Spaces, basics of functional spaces. **Comprehension**: Students understand the connection between linear algebra and analysis, and the geometric viewpoint on function spaces. They are aware of crucial differences between finite-dimensional and infinite-dimensional vector spaces. **Application**: Students are able to develop an understanding of kernel methods (e.g., support vector machines) based on their knowledge of Hilbert spaces, and to solve specific problems in data analysis.
Topics	Metric and normed spaces; Banach Spaces; Inner product and Hilbert Spaces; Hilbert Bases; Linear operators; applications to L2: Fourier series; Spectral theory for compact self-adjoint operators; Kernel methods and their applications to data analysis.

Name	**Databases and Data Storages Technologies**
Programme	master
Semester	1
ECTS credits , Exam / Credit	5 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	This course explores the foundations and advanced concepts of data storage technologies and database architectures essential for modern data-intensive applications. Students will gain a comprehensive understanding of how data is structured, stored, retrieved, and scaled in traditional relational databases and emerging NoSQL systems. Emphasis is placed on techniques for high availability, horizontal scaling, distributed data processing, and analytical workloads. The course prepares learners for real-world challenges involving big data, cloud storage, and high-performance transactional and analytical systems.
Topics	1. Introduction to Database Storage Systems. 2. File Organization and Access Methods. Heap and B-tree data structures. 3. Performance Optimization Techniques. Query optimization strategies. Indexing. 4. NoSQL. CAP theorem and BASE properties. 5. NoSQL data models (document, key-value, column-family, graph) 6. Database Partitioning. Horizontal and vertical partitioning. 7. Database Sharding. 8. Database Replication. Master-slave and multi-master replication. Synchronous and asynchronous replication. 9. Backup, Recovery, and Archiving. Backup strategies. Recovery mechanisms.

Name	**Machine Learning: Theory and Algorithms I**
Programme	master
Semester	1
ECTS credits , Exam / Credit	6 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	This first of the two machine learning courses is theoretical and is devoted to the mathematical foundations of this field. The aim is to give some general formal framework for machine learning problems, to formulate general approaches to algorithms and to establish connections with different part of mathematics.
Topics	1. the notions of PAC (probably approximately correct) learning, uniform convergence and VC-dimension 2. using this framework for a first introduction to some concrete algorithms, namely a. linear predictors and boosting, b. model selection and validation, c. convex learning problems, d. regularization and stability, e. stochastic gradient descent, f. dimensionality reduction,

	g. support vector machines, h. decision trees, i. neural networks.

Name	**Machine Learning: Theory and Algorithms II**
Programme	master
Semester	2
ECTS credits , Exam / Credit	5 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	The aim of the course is introducing students to the theoretical foundations and algorithms of machine learning, their practical implementation and application to solving real data analysis problems, forming students' practical skills in working with data and solving applied data analysis problems. As part of the course, students should get information about tasks solved using machine learning methods, the principles of building and using relevant models.
Topics	1. Basic concepts of machine learning: setting the problem of learning by precedents 2. Machine methods of object classification: approximation and regularization of empirical risk; method of support vectors; metric methods of classification; probabilistic formulation of the classification problem; optimal Bayesian decision rule; non-parametric classification; discriminant analysis; classification of a mixture of distributions 3. Regression analysis models 4. Combinational and advanced methods of machine learning: logical and combination methods of classification; random forests from decision trees of classification and rank classification.

Name	**Numerical Methods for Data Analysis**
Programme	master
Semester	2
ECTS credits , Exam / Credit	5 ECTS, Credit, 2 hours lectures and 2 hours practical work per week
Short description	The aim of the course is introducing the students to modern tools for a symbolic and numerical computation is applications to problems of algebra, analysis, differential equations and Data analysis. The course is based on MAPLE software. Lecture course focuses on mathematical background of the computer applications; the practical part is devoted to realizations of the lecture presented background.
Topics	1. exact and numeric methods in Calculus, including multivariate conditional extrema; 2. exact and numeric methods in solving systems of multivariate polynomial equations including Grobner Basis and Regular Chains; 3. exact and numeric methods in Linear Algebra including polynomial interpolation, least squares approximation, singular value decomposition;

	4. exact and numeric methods in differential equations including visualization; 5. exact and numeric methods in partial differential equations; 6. optimization, including problems of linear, quadratic and non-linear program.

Name	**Big Data Processing**
Programme	master
Semester	2
ECTS credits , Exam / Credit	5 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	This course introduces students to the principles, tools, and techniques used in processing and analyzing large-scale data. Emphasizing both theory and practice, the course covers distributed computing models, storage systems, and processing frameworks that underpin modern big data applications. Through hands-on labs and real-world examples, students will learn how to build and work with big data using platforms like Hadoop, Spark and NoSQL databases like Cassandra. By the end of the course, students will be equipped to handle the challenges of big data in industry and research environments.
Topics	1. OLAP (Online Analytical Processing). OLTP vs OLAP systems. Star and snowflake schemas. 2. MOLAP, ROLAP, HOLAP models. 3. Cube operations. Roll-up, drill-down, slice, dice and pivot. 4. Introduction to Big Data. Characteristics of Big Data (Volume, Velocity, Variety, Veracity, Value) 5. Data Storage and Management. Distributed File Systems. NoSQL Database Cassandra. 6. Distributed Computing Models. MapReduce programming model. 7. Apache Spark 8. Apache Kafka 9. Big Data on the Cloud. Azure Data Lake.

Name	**Parallel and Distributed Computing**
Programme	master
Semester	2
ECTS credits , Exam / Credit	5 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	The course is designed to meet students with specific notions and algorithms of distributed computing. The course includes an explanation of the following subjects: clocks in distributed systems, snapshots of system configurations, wave algorithms, deadlocks in distributed systems, elections in distributed systems and others.
Topics	1. Distributed computing and its features. 2. Modelling of distributed computing. 3. Time in distributed systems.

	4. The message propagation problem and wavelet algorithms. 5. The problem of capturing a configuration snapshot. 6. The problem of recognizing "deadlocks". 7. The problem of recognizing completions of a distributed algorithm. 8. The problem of garbage collection in distributed systems. 9. Routing problem. 10. The problem of organizing elections in distributed systems.

Name	**Scientific Research Course Work**
Programme	master
Semester	1, 2
ECTS credits , Exam / Credit	6 ECTS, 4 hours practical work per week
Short description	Students learn to work with big data sets, which includes their analysis and processing, dimensionality reduction, visualisation techniques, and inaccurate or missing data handling. They also learn to apply analytical and predictive methods such as generalised linear models and singular value decomposition. The course includes team work project to work on complex Data Science problems, find and implement their solutions.
Topics	1. Techniques for processing and managing big data 2. Dimensionality reduction approaches, including PCA and manifold learning 3. Visualisation and interpretation of data 4. Handling data sets with inaccurate or missing 5. Singular value decomposition method 6. Classification and clustering algorithms 7. Practical implementation of Data Science methods.

Elective Units

Name	**Data Mining Techniques in Cybersecurity Solutions**
Programme	master
Semester	1
ECTS credits , Exam / Credit	3 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	Students learn to apply methods and algorithms of computational data mining in classification, forecasting, cluster analysis, and search for associative rules using software tools to support multidimensional data analysis based on DataMining, TextMining, and WebMining technologies.
Topics	1. Review of existing systems, frameworks, and software tools based on

	data mining in countering cybersecurity and building an ISMS. 2. CRISP-DM (The Cross Industry Standard Process for Data Mining) - a cross-industry standard for the process of data analysis and decision support. History of creation, development and application 3. Analysis of the most dangerous and popular types of vulnerabilities in information systems. Application of intelligent systems for detecting and countering intrusions 4. Neural network approach in countering cybercrime. Malicious machine learning and countering it

Name	**Theory of Programming**
Programme	master
Semester	1
ECTS credits , Exam / Credit	6 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	The course is designed to provide a deep understanding of the basic concepts of programming theory including the concept of a programming paradigm, and a computational model and explain the practical consequences of the principal results of theoretical results.
Topics	1. Basic concepts of programming. 2. Computional models and programming paradigms. 3. Principal notions and results of computational theory: automaton-based models, computability and decidability. Godel enumeration, an universal program, Rice and Rice-Shapiro theorems. 4. Typeless lambda calculus. 5. Functional programming paradigm. 6. Simple typed lambda calculus. 7. Other typed lambda calculus. 8. The concept of certified programming.

Name	**Software Engineering**
Programme	master
Semester	1
ECTS credits , Exam / Credit	5 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	The course is teaching students to the application of a systematic, disciplined, quantifiable approach to the development, operation and maintenance of software with respect to international standards. All the phases of the whole process are considered. In practice students work with their individual projects and prepare technical documentation according to international standards. Team work is supposed. CASE tools are applied.
Topics	1. Phases and models of Software Life Cycle (SLF), historical review, extreme and agile methodologies. 2. Working with requirements: requirements elicitation, classification,

	structuring, documentation, and verification. Requirements' attributes. User requirements document. 3. Requirements specification: logical model construction, functional and functional requirements specification. System requirements document. Requirements traceability. 4. Architectural design: architectural models, views and viewpoints. Physical model construction, architectural components description. Architectural design document. 5. Detailed design: coding, verification and validation. Unit, integration and system testing: methods and tools. Detailed design document. 6. Transfer to customer, system operation and maintenance: procedures, artifacts, acceptance testing, preliminary and final acceptance. Project history document.

Name	**Software Project Management**
Programme	master
Semester	1
ECTS credits , Exam / Credit	6 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	The course is teaching students to apply international standards with respect to the specifics of the project and organization; be able to choose tools for project management; develop project management planning; estimate the necessary resources and duration of the project; apply knowledge of cost management models in the project and calculate the cost of the project using special software; apply knowledge of risk management models, be able to conduct qualitative and quantitative risk analysis; analyze the plan and make its adjustments at all stages of the life cycle; work in a team.
Topics	1. The concept and history of the emergence of software project management, basic documents. Software life cycle with respect to types of organizations, main processes. 2. Project integration management and Project scope management. Project development methodologies. 3. Project planning, project time management, methods and tools. 4. Project cost management: evaluation models (COCOMO, COCOMOII, SLIM), methods, tools. 5. Project human resource management and project communication management. 6. Project risk management: models, methods, tools.

Name	**Homology theory and topological data analysis**
Programme	master

Semester	2
ECTS credits , Exam / Credit	3 ECTS, Credit, 2 hours lectures and 2 hours practical work per week
Short description	This is a continuation of the courses «Topology» (general) and «Basic algebraic topology» , though a short remainder of all the necessary topological preliminaries will be given. The course focuses on homology invariants and their applications.
Topics	1. the algebraic properties of chain complexes, 2. standard homology theories (simplicial, singular, and cellular), the connection between them, and the basics of cohomology theory, 3. the applications of simplicial homology to the study of metric spaces representing data and finding their «hidden» topological structure through the construction of so-called persistent homology.

Name	**Data Analysis with Power BI and Python**
Programme	master
Semester	2
ECTS credits , Exam / Credit	6 ECTS, Credit, 2 hours lectures and 2 hours practical work per week
Short description	The course "Data Analysis with Power BI and Python" provides a comprehensive introduction to using Power BI and Python for data analysis tasks. Students will learn how to leverage the power of Power BI, a popular business intelligence tool, to connect to various data sources, transform and clean data, create interactive visualizations, and generate meaningful insights. Additionally, the course covers the integration of Python, a versatile programming language, with Power BI to perform advanced data manipulation, statistical analysis, and machine learning tasks. By combining the strengths of Power BI and Python, participants will gain the skills needed to extract valuable information from complex datasets, make data-driven decisions, and effectively communicate their findings.
Topics	1. Introduction to Power BI and Python for Data Analysis 2. Data Import and Transformation in Power BI 3. Creating Interactive Visualizations in Power BI 4. Data Cleaning and Preprocessing Techniques in Python 5. Exploratory Data Analysis with Python 6. Statistical Analysis and Hypothesis Testing using Power BI and Python 7. Time Series Analysis and Forecasting with Power BI and Python 8. Machine Learning Techniques for Data Analysis in Python 9. Advanced Data Visualization with Power BI and Python 10. Integrating Power BI and Python for Real-time Data Analysis

Name	Stochastic Methods in Data Science
Programme	master
Semester	3
ECTS credits , Exam / Credit	6 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	The course is teaching students to modern methods of statistical analysis and construction of statistical models that can be used to identify patterns inherent in data of various types, basic concepts of non-parametric statistics; stages of statistical analysis: exploratory analysis, proposing and testing hypotheses, estimating distribution parameters, dimensionality reduction. The course is aimed at developing theoretical and probabilistic intuition when applying the methods of mathematical statistics to build mathematical models of real random phenomena.
Topics	1. Elements of probabilistic and stochastic modeling 2. Statistical properties of Markov models and hidden Markov models 3. Non-parametric (rank) methods of mathematical statistics 4. Nonparametric models of variance analysis and linear regression 5. Statistical methods of data classification and dimensionality reduction 6. Linear discriminant analysis Sequential Wald analysis 7. Regression models for categorical dependent variables 8. Statistical methods of data dimensionality reduction 9. Statistical methods of text analysis.

Name	Introduction to cryptography
Programme	master
Semester	3
ECTS credits , Exam / Credit	6 ECTS, Credit, 2 hours lectures and 2 hours practical work per week
Short description	The main goal of the course is to teach future specialists the basics of public key cryptography, as well as the necessary knowledge of number theory. Main tasks of the course are to teach students the basics of algorithmic aspects of arithmetic and their application in modern cryptography
Topics	Information on number theory 1. Complexity of arithmetic operations. 2. Euclid's algorithm and its complexity. 3. Simple numbers. Factoriality of the ring of integers. 4. Comparison and rings of remainders. 5. Overview of field theory. 6. Finite fields. 7. Quadratic remainders. Quadratic law of reciprocity. 8. Calculation of the square root in a finite field. Elements of cryptography.

	1. "Classic" cryptography. 2. RSA cryptographic system. 3. Checking numbers for simplicity. Fermat, Solovey-Strassen, Miller-Rabin tests. 4. Decomposition of numbers into factors: Pollard's ρ-method, method of factor bases. 5. Discrete logarithm. Diffie-Hellman cryptographic systems.

Name	**Numerical methods for statistics**
Programme	master
Semester	3
ECTS credits , Exam / Credit	6 ECTS, Credit, 2 hours lectures and 2 hours practical work per week
Short description	-The students know numerical algorithms used in statistics. - The students understand the use of numerical methods for concrete stochastic problems. - Students can analyse the efficiency and approximation properties of algorithms and recognise the limits of the applicability of methods. - Students can evaluate the application possibilities of numerical methods with regard to efficiency and precision.
Topics	1. Computing probability functions 2. Optimization and nonlinear equations 3. Nonlinear regression methods 4. Numerical integration and Monte Carlo methods 5. Markov chain Monte Carlo methods 6. Sorting and fast algorithms

Name	**Dynamical systems**
Programme	master
Semester	3
ECTS credits , Exam / Credit	6 ECTS, Credit, 2 hours lectures and 2 hours practical work per week
Short	The students will: • get acquainted with the basics of the theory of dynamical systems

description	• study different approaches to the investigation of qualitative behaviour of solutions to partial differential equations
Topics	1. Discrete and continuous dynamical systems 2. Trajectories and invariant sets 3. Lyapunov stability 4. 1D continuous systems. 2D continuous systems. Poincaré-Bendixson theory 5. Bifurcation theory 6. Dissipative dynamical systems. Asymptotic smoothness and compactness. Global attractors 7. Gradient systems

Name	**Formal Concepts Analysis**
Programme	master
Semester	3
ECTS credits, Exam / Credit	6 ECTS, Credit, 2 hours lectures and 2 hours practical work per week
Short description	Formal Concept Analysis (FCA) is a mathematical theory of data analysis using formal contexts and concept lattices. It is a way of deriving concept hierarchy from a collection of objects and their properties.
Topics	1. Ordered Sets, Latices and Galois Connections. 2. Concept Lattices of Contexts 3. The Basic Theorem 4. Implications 5. Canonical Basis 6. Applications.

Name	**Approximation of Data with Neural Networks**
Programme	master
Semester	3
ECTS credits , Exam / Credit	6 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	The purpose of teaching the academic discipline is to provide an idea of applied software tools based on neural networks, as well as instrumental software for learning neural networks, and to prepare students for the use of neural network technologies in professional activities. Students should know: the principles of setting tasks for solving using neural networks; data presentation methods for learning and using neural

	networks; methods of learning neural networks and evaluating the quality of learning neural networks; stages of problem solving using neural networks. Students should be able to: navigate different types of application systems based on the use of neural networks; to navigate in different methods of presenting data for neural network training; choose and set a task to be solved by a neural network; choose a neural network model to solve the problem.
Topics	1. The main types of networks for data approximation 2. Iterative methods of learning neural networks (NN) 3. Approximation of functions of many NN variables 4. Designing a multilayer perceptron 5. Radial base network 6. Neural networks in Matlab.

Name	**Reinforcment Learning**
Programme	master
Semester	3
ECTS credits , Exam / Credit	6 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	The reinforcement learning course designed to deepen students' knowledge in the field of reinforcement learning. It covers both theoretical and practical aspects, focusing on the principles and methods underlying reinforcement learning. Students use the Python language and the PyTorch framework.
Topics	1. Markov Decision Processes 2. Value Functions and Q-Functions 3. Policies and Strategies 4. Gradient-based Methods 5. Reinforcement Learning with Reinforcement 6. Planning and Control 7. Neural Network Approaches to Reinforcement Learning.

Name	**Machine Learning Peculiarities in Applied Areas**
Programme	master
Semester	3
ECTS credits , Exam / Credit	6 ECTS, Exam, 2 hours lectures and 2 hours practical work per week
Short description	Machine Learning Peculiarities in Applied Areas is an advanced master's level course that delves into the specific challenges and considerations when applying machine learning techniques to different domains and industries.

	The course explores the nuances and peculiarities that arise when working with real-world data and provides students with the knowledge and skills to address these challenges effectively. Through case studies and practical projects, students will gain expertise in applying machine learning algorithms to various applied areas.
Topics	1. Healthcare Applications: Medical imaging analysis: Computer-aided diagnosis, image segmentation, and anomaly detection; Clinical decision support systems: Predictive modeling for disease diagnosis and treatment recommendations; Health monitoring and wearable devices: Sensor data analysis for early detection and prevention. 2. Natural Language Processing (NLP) and Text Mining: Sentiment analysis and opinion mining: Understanding and extracting sentiment from textual data; Named entity recognition and text classification: Information extraction and document categorization; Machine translation and language generation: Automatic translation and text synthesis. 3. Financial Data Analytics: Stock market prediction: Time series analysis and forecasting techniques; Fraud detection: Anomaly detection and pattern recognition in financial transactions; Credit risk assessment: Predictive modeling for credit scoring and loan approval. 4. Image and Video Processing: Object recognition and detection: Identifying objects and their locations in images and videos; Video analysis and action recognition: Understanding activities and events in video sequences; Image generation and style transfer: Creating artificial images and modifying their visual styles. 5. Internet of Things (IoT) and Sensor Data Analytics: Sensor data preprocessing and fusion: Handling noisy and heterogeneous sensor data; Anomaly detection and fault diagnosis: Identifying abnormal behavior in sensor readings; Predictive maintenance: Prognostics and health management using machine learning techniques. 6. Recommender Systems: Collaborative filtering: Personalized recommendations based on user behavior and preferences; Content-based filtering: Recommendations based on item features and user profiles; Hybrid recommender systems: Combining collaborative and content-based approaches for improved recommendations.

Name	**Partial Differential Equations**
Programme	master
Semester	3
ECTS credits , Exam / Credit	6 ECTS, Credit, 2 hours lectures and 2 hours practical work per week
Short description	- Students know the main types of PDEs, basic facts on existence and uniqueness of solutions and theory of functional spaces . - Students can construct approximate solutions to PDEs and check the convergence of the schemes and estimate the precision. -Students can apply the theory to real problems modelled by PDEs.
Topics	1. Basics of the theory of distributions and Sobolev spaces.

	2. Elliptic PDEs. Lax-Milgram theorem. 3. Parabolic equations. Galerkin approximations. 4. Hyperbolic equations. Gronwall's estimates.