MSc Computer Science

First year						
Semester I			**Hours/Week**			
Nr	**M/E**	**Subject**	**L**	**E**	**ECTS**	**Teacher**
1	M	Introduction to data science	2	2	6	Dr. Sc. Korab Rrmoku
2	M	Advanced calculus	2	2	6	Dr. Sc. Behar Baxhaku
3	M	Advanced statistics	2	2	6	Dr. Sc. Edmond Aliaga
4	M	Scientific research methodology	3	1	6	Dr. Sc. Eliot Bytyçi
5	E	Finance and technology (Fintech)	2	2	6	Dr. Sc. Ujkan Bajra
6	E	Functional programming	2	2	6	Dr. Sc. Faton Berisha
		Total semester I	**11**	**8**	**30**	
Semester II			**Hours/Week**			
Nr	**M/E**	**Subject**	**L**	**E**	**ECTS**	**Teacher**
1	M	Seminary	3	1	6	Dr. Sc. Ermir Rogova
2	M	Advanced algebra	2	2	6	Dr. Sc. Armend Shabani
3	M	Machine learning	2	2	6	Dr. Sc. Korab Rrmoku
4	M	Information security and privacy	2	2	6	Dr. Sc. Artan Berisha
5	E	Financial markets	2	2	6	Dr. Sc. Ujkan Bajra
6	E	Computer science and society	3	1	6	Dr. Sc. Eliot Bytyçi
		Total semester II	**12**	**6**	**30**	
Viti II						
Semester III			**Hours/Week**			
Nr	**M/E**	**Subject**	**L**	**E**	**ECTS**	**Teacher**
1	M	Big data	2	2	6	Dr. Sc. Ermir Rogova
2	M	Cloud computing	2	2	6	Dr. Sc. Korab Rrmoku
3	M	Entrepreneurship	2	2	6	Dr. Sc. Ejup Fejza
4	E	Network analysis	2	2	6	Dr. Sc. Korab Rrmoku
5	Z	High performance computing	2	2	6	Dr. Sc. Artan Berisha
6	Z	Information on the web	2	2	6	Dr. Sc. Eliot Bytyçi
7	Z	Image processing	2	2	6	Dr. Sc. Artan Berisha
		Total semester III	**11**	**8**	**30**	
Semester IV			**Hours/Week**			
Nr	**O/Z**	**Subject**	**L**	**E**	**ECTS**	**Teacher**
1	O	Master thesis			30	
		Total semester IV			**30**	

Standard 4.2. The study program intended learning outcomes comply with the National Qualification Framework and the European Qualifications Framework level descriptors. (ESG 1.2)

2.4.1 Short course description

Semester I

Course: Introduction to data science (2+2) 6 ECTS

Course status: Mandatory

Teacher: Prof. Ass. Dr. Korab Rrmoku

Short Description: The course is an introductory overview of topics important to data science. The following topics will be presented to students through lectures by faculty members and guest lectures from industry and research institutions: Working with Data: Acquisition Processing. Save. Cleaning, Summary, structured, unstructured data. Techniques: data analysis and analytics. UNIX. Python: python for data science, statistics. The R Language: Graphics and Data Visualization, Statistics and Machine Learning. MySQL: data manipulation and data searching. Introduction to machine learning and regression: linear and gradient regression. Supervised learning: logistic regression and softmax, classification with KNN, random forest and support vector machines. Unsupervised learning: Clustering, expectation maximization and learning from repetition. Experimentation and data evaluation: questionnaires, precision and recall.

Course objectives: The student will know all the main aspects of data science. The student will learn how to use software tools, manage data, present data and analyze data. The student will also be introduced to other practical, ethical, security and privacy aspects of working in data science. The purpose of the course is to allow the student contact with good practices from industry and research. Visitors from industry and research institutions will be included in the lectures. The purpose of this is for students to meet some professors and potential advisors from different fields, while the practical examples will motivate the student to study.

Expected learning outcomes: After completing this course students will be able to:

• Manage data.
• Choose the right visualization.
• Use basic programming tools for data science.
• Use basic machine learning and statistical models.
• Prepare an exemplary report.
• Recognize potential security, privacy and ethical issues when working with data.
• Choose an appropriate license for work and software.
• Implement good data science practices

Teaching methodology: Lectures, exercises, quizzes, seminar papers, discussions and consultations.

Evaluation methods and criteria:

- Laboratory work and professional project 25%;

- Assignments and presentations during the semester 45%
- Final exam 30%

Concretization/IT tools: Marker, pencil, board, computer lab, projector.

The ratio between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 1:1

Basic literature:

- Shah, C. (2020). A Hands-On Introduction to Data Science. Cambridge: Cambridge University Press.

Additional literature:

- An Introduction to Data Science, Jeffrey S. Saltz - Syracuse University, USA, Jeffrey M. Stanton - Syracuse University, USA
- Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter 3rd Edition
- The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition (Springer Series in Statistics) 2nd Edition

Course: Advanced calculus (2+2) 6 ECTS

Course status: Obligatory

Professor: Prof. Asoc. Dr. Behar Baxhaku

Short description: In this course will be studied: vectors, lines, planes, and parameterization of curves and surfaces; partial derivatives, directional derivatives, and gradients; optimization and critical point analysis, including the method of Lagrange multipliers; integration over curves, surfaces, and solid regions using Cartesian, polar, cylindrical, and spherical coordinates; vector fields, and line and surface integrals for work and flux; and the divergence and curl of vector fields together with applications.

Expected learning outcomes: After successfully completing the course, students should be able to:

- Use different optimization methods on machine learning problems;
- Use vectorial functions to study curves in space, as well as other applications of physics and engineering;
- Compute derivatives using the chain rule or total differentials.
- Apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science;
- Compute multiple integrals in rectangular, polar cylindrical, and spherical coordinates.

- Understand how to change the order of integration and of the major theorems (Green's, Stokes, Gauss) of the course and some physical applications of these.

Teaching methodology: Lectures, discussions, consultations, homework, seminar, colloquia, final exam.
Evaluation methods: The subject will be assessed on the basis of homework 10%; Midterm I: 20%, Midterm II: 20% and the final exam 50%.

Concretization tools: Marker, whiteboard, projector, computer lab.

Relation between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 1:1.
Literature:

- Ron Larson Bruce H Eduards, Multivariable Calculus, Cengage Learning, 2016.
- James Stewart, Calculus, Early Transcendentals, Thomson, 2008.
- J. Callahan, Advanced Calculus, Lecture Notes, Smith College, USA, 2011.

Course: Advanced statistics (2+2) 6 ECTS

Course status: Obligatory

Professor: Prof. Ass. Dr. Edmond Aliaga

Short description: Students will be introduced to the basic concepts of Bayes theory, as well as a number of algorithms and models needed to perform their data analysis using computational tools from this theory.

Course aims: The main goal of this course is to introduce the student to Bayesian statistics, how to apply Bayesian statistics and the underlying algorithms and computational techniques that make Bayesian statistics practically feasible.

Expected learning outcomes: After completing this course the students will be able to:

- Solve typical statistical tasks;
- Select an appropriate model for statistical analysis;
- Interpret statistical results;
- Justify their modelling choices;
- Prepare a exemplary statistical report;
- Use appropriate MCMC methods;
- Design new variants of standard statistical models.

Teaching methodology: Lectures, discussions, exercises, consultations, homework, colloquia, final exam.

Assessment methods: Seminar paper (10%), homework (10%), real project (25%), Final exam (55%).

Concretization / IT tools: Pencil, blackboard, projector and computer.

Ratio between theoretical and practical part of the study: 1:1

Literature:

1. Hoff, P. D., *A first course in Bayesian statistical methods*. Springer Science & Business Media, (2009).
2. Kadane, J. B., *Principles of uncertainty*. CRC Press, (2011).

3. Kruschke, J., *Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan*. Academic Press, (2014).
4. Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B., *Bayesian data analysis*. CRC press, (2013).

Course: Methodology of scientific research (3+1) 6 ECTS

Course status: Obligatory

Professor: Prof. Ass. Dr. Eliot Bytyçi

Short description: This course focuses on the development of research and writing skills in Computer Science. Its main parts are:
1. Empirical methods and their application in research problems
2. Concepts related to other sciences
3. Research methodologies: their advantages and disadvantages

Course objectives: The aim of this course is to acquaint students with the basic ideas, challenges, techniques and problems during scientific research.

Expected learning outcomes: Upon completion of this course the student is able to:
- To introduce research methodologies in computer science
- To understand the strengths and weaknesses of each of these methods.
- How to choose the appropriate research method(s)?
- How to conduct research using these methods?
- What are the threats associated with these methods and how to deal with them then.
- Reporting the results of the research.
- Writing technical articles / research papers.
- Understanding the roles of authors, evaluators. How to review research articles?

Teaching methodology: Lectures and individual work on projects / assignments / seminars.

Assessment methods: Attendance 10%, Class engagement 10%, Tasks / Individual projects (total: 80%): Tasks / Project 1: 40% and Tasks / Project 2: 40%

Concretization / IT tools: Pencil, blackboard, smartboard, and computer.

The ratio between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 3:1

Literature:
1. *Research Design*. *Qualitative*, *Quantitative, and Mixed Methods Approaches*. By John W. Creswell, Fourth Edition. SAGE Publication, 2014
2. The Craft of Research, By Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams , Joseph Bizup, William T. FitzGerald, Third Edition, The University of Chicago Press, 2008
3. The Elements of Style. William Strunk Jr. and E. B. White, Forth Edition, Pearson, 1999
4. Research Methodology By Panneerselvam R, 2nd Edition, PHI, 2014
5. Different research articles that will be discussed in class.

Course: Finance and technology (Fintech) (2+2) 6 ECTS

Course status: Elective

Professor: Prof. Ass. Dr. Ujkan Bajra

Short description: This course (subject) explores the dynamic relationship between finance and technology, examining how technological advances are shaping the landscape of finance, financial markets, products and services.

Course objectives: The course will enable to analyze the impact of technologies such as blockchain, artificial intelligence, machine learning and big data on traditional financial practices and institutions. Through case studies, discussions and hands-on projects, students will gain a comprehensive understanding of the opportunities and challenges presented by the intersection of finance and technology.

Expected learning outcomes: Students taking this course are expected to have prior knowledge of the principles of finance and technology. After completing this course, students should be able to:

- Understand the evolution of financial technology (FinTech) and its importance in the modern financial ecosystem.
- To analyze the roles of blockchain, cryptocurrencies and distributed ledger technology in finance (DeF).
- To evaluate the applications of artificial intelligence and machine learning in financial decision-making processes.
- To examine the use of big data analysis in risk management, investment strategies and customer relations.
- To examine the regulatory challenges and ethical considerations associated with Fintech innovations.
- Develop critical thinking and problem-solving skills through case studies and real-world applications.

Teaching methodology: Lectures, discussions, practical exercises, consultations, homework, tests and exams. The learning process will be mainly supported by the method of discussion (interactive) and argumentation.

Assessment methods: The final grade will be based on the following distribution:

- Homework/workshop 10%.;
- Regular participation 10%.

Assessment of knowledge:

- First test 40%.
- Second test 40%.
- The final exam constitutes 90% of the entire course and is held only for those students who have not passed both periodic tests. Regular attendance is 10% + 90%, the final exam constitutes 100% of the final grade.

Concretization / IT tools: Pencil, blackboard, smartboard, and computer.

The ratio between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 1:1.

Literature:

- "The FinTech Book : The Financial Technology Handbook for Investors , Entrepreneurs , etc Visionaries " by Susanne Chishti and Janos Barberis , Wiley (2016)
- "Blockchain Basics : A Non-Technical Introduction in 25 Steps " by Daniel Drescher
- Selected materials for students about the topics.

Course: Functional programming (2+2) 6 ECTS

Course status: Obligatory

Professor: Prof. Dr. Faton Berisha

Short description: The course provides a comprehensive introduction to the field of functional programming. The course will touch on some of the program analysis methods and supporting theories, as well as contemporary techniques and applications.

Course objectives: The main aim of the course is an exposition on the fundamentals of pure functional programming and the application of functional programming concepts for efficient coding in the main programming languages.

Expected learning outcomes: Upon completion of the course students will be able to:

• Understand the basic principles of clean functional programming and solve problems by applying these principles.

• Be able to encode in the functional Haskell programming language.

• Investigate, evaluate, and compare programs in Haskell for syntactic and semantic correctness, generalizability, reusability, efficiency, and performance properties.

• Apply functional programming techniques to the object-oriented paradigm in the Java programming language.

Teaching methodology: Introductory lectures, discussions and laboratory assignments.

Assessment methods: Periodic exam: 30%, final exam: 40%, laboratory assignments: 30%.

Concretization / IT tools: Standard concretization tools and computer lab.

Ratio between theoretical and practical part of the study: 1:1

Literature:

- S. Thompson, *Haskell: The Craft of Functional Programming*, Addison-Wesley/Pearson, 2011.
- B. C. Pierce, *Types and Programming Languages*. MIT Press, 2002.
- F. Nielson, H. R. Nielson, C. Hankin, *Principles of Program Analysis*, Springer, 2010.

Course: Seminary/Project (3+1) 6 ECTS

Course status: Obligatory

Professor: Prof. Assoc. Dr. Ermir Rogova

Short description: In this course students will choose the topic of the seminar and work in groups to complete it. Students present their progress and mid-term results. Students complete the project with a public presentation of their work. Project topics are compiled by the lecturer from the proposals of faculty and industry members.

Course objectives: The main aim of the course is for students to apply the knowledge gained in other courses in a relevant computer science project.

Expected learning outcomes: Upon successful completion of this course students will be able to:

- Combine procedures, methods, and tools presented in other courses.
- Plan a data science research and development project.
- Organize teamwork.
- Explain their choice of methods and tools needed in the project.
- Critically evaluate their work and the work of others.
- Defend their work and results in front of a panel of data experts.

Teaching methodology: Introductory lectures, discussions and project reviews.

Assessment methods: Intermediate review: 50%; Final Review: 50%.

Concretization / IT tools: Pencil, blackboard, projector and computer.

Ratio between theoretical and practical part of the study: 3:1

Literature:

• Determined by the course holder depending on the seminars

Course: Advanced algebra (2+2) 6 ECTS

Course status: Obligatory

Professor: Prof. Asoc. Dr. Armend Shabani

Short description: In this course we will include the following:

Introduction to linear algebra. Linear and affine transformations. Vector and matrix norms. Quadratic formats. Positive semidefinite matrices. Cholesky decomposition. Perron-Frobenius theorem.

Course objectives: The aim of the course is to deepen students' understanding of the formulation of problems arising from 'Machine Learning' with the methods of Linear Algebra.

Expected learning outcomes: Upon successful completion of this course students will be able to:

- understand the theory of vector spaces, basis and dimension, direct sums and products;
- understand linear transformations and the correspondence between linear transformations and matrices, eigenvalues and eigenvectors, diagonalization of matrices;
- understand the positive semidefinite matrices, the Cholesky decomposition, and the Perron-Frobenius Theorem;
- build skills to apply independently acquired knowledge in problem solving from 'Machine Learning'.

Teaching methodology: Lectures, exercises, homework. The focus is on ongoing homework, individual work using computer and optimization software.

Assessment methods: Continuous assessment (homework, mid-semester assessment) - 50%; Final exam (written or oral exam) - 50%.

Concretization / IT tools: Pencil, blackboard, projector and computer.

The ratio between the theoretical and practical part of the study: 1:1

Literature:

- Charu C. Aggarwal, *Linear Algebra and Optimization for Machine Learning*, Springer, 2020
- *Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning,* Cambridge University Press, 2020

Course: Machine learning (2+2) 6 ECTS

Course status: Mandatory

Teacher: Prof. Ass. Dr. Korab Rrmoku

Short Description: Advanced application of Python and specific libraries for working with data. Key concepts of cloud computing. Regression: linear, multiple, Ridge and Lasso, gradient. Maximization, density estimation. Dimension reduction: linear and principal analysis. Neural networks: architecture, convolution, short-term and long-term memories. Deep learning: model, coding and transformation. Reinforcement learning: conceptualization, Q-learning, bandits. Designing and evaluating ML systems: ML thinking and systems evaluations.

Course objectives: The aim of this course is to present the basics and fundamental principles of machine learning (ML) methods, their fundamental algorithms, and their practical application for knowledge discovery from data, data mining, and for the classification and regression modeling.

Expected learning outcomes: Upon completion of this course, the student will be able to:

- Utilize expertise in various techniques and methods used for data modeling with machine learning.

- Analyze and predict solutions and their consequences for targeted problems using scientific methodology.
- Apply the presented methods to issues arising from the scientific and business environment. They will understand and employ tools for data modeling and mining.

Teaching methodology: Lectures, exercises, seminar papers, discussions and consultations.

Evaluation methods and criteria:

- Laboratory work and professional project 25%;
- Assignments and presentations during the semester 45%
- Final exam 30%

Concretization/IT tools: Marker, pencil, board, computer lab, projector.

The ratio between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 1:1

Basic literature:

Shah, C. (2022). A Hands-On Introduction to Machine Learning. Cambridge: Cambridge University Press.

Additional literature:

- Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition by Aurélien Géron
- Pattern Recognition and Machine Learning (Information Science and Statistics) by Christopher M. Bishop

Course: Security and privacy of information (2+2) 6 ECTS

Course status: Mandatory

Lecturer: Prof. Ass. Dr. Artan Berisha

Short description: The course includes important aspects of information security and privacy such as: security mechanisms, security services (principles and practical applications of authentication, confidentiality, integrity, non-denial, access control, registration and alert), public key infrastructure, standards (2700X) and key organizations (ISO, IETF, W3C), authentication, authorization (examples of standardized solutions like RADIUS and Diameter). Also it is included network security such: transport layer and application layer including Internet of Things and Cloud security (examples of protocols are IPSec, TLS, S/MIME).

Course objectives: The aim of the course is to educate students to be able to actively provide security and privacy in modern information systems, whether they are system administrators or developers of new solutions.

Expected learning outcomes: Upon completion of this course students will be able to:

- understand concepts in information security
- develop simpler solutions in this area,
- know about security and privacy standards,
- will understand cryptographic protocols,
- to offer solutions for information security and privacy,
- be able to define the security policy.

Teaching methodology: Lectures, exercises, quizzes, seminar papers, discussions and consultations.

Evaluation methods:

Hands-on work: 30%
First midterm: 35% (optional)
Second midterm: 35% (optional)
Final exam: 70% (if midterm results were not satisfactory)

Concretization tools / IT: Marker, sponge, table, computer lab, projector.

The ratio between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 1: 1

Literature

- William Stallings - Cryptography and Network Security - Principles and Practice, Global Edition-Pearson (2022)
- D. Trček: Information Systems Security and Privacy, Springer, New York, Heidelberg, 2006.

- Selected online papers

Course: Financial markets (2+2) 6 ECTS

Course status: Elective

Professor: Prof. Ass. Dr. Ujkan Bajra

Short description: This course enables students to learn how financial markets (such as bonds, stocks, and currency exchange) work and how they impact the economy, other institutions, business profits, and our daily lives. It allows students to understand how markets operate and what the implications are in the real world in order to make investment decisions.

Course goals: The acquisition of theoretical and practical knowledge in the field of financial markets, financial instruments, and financial institutions.

Expected learning outcomes: Students who will take this course are expected to have prior knowledge of the basics of financial markets. Upon completion of this course, students will be able to:

- Understand the key concepts of financial markets, their products, prices, risks, and market participants. This provides practical support to be able to understand financial information and work in financial markets.
- Learn how to make investment decisions by applying theory to the real world according to their needs and the characteristics of products and markets.
- Understand how financial markets should be organized, particularly money and capital markets.
- In summary, the course provides analytical skills to understand concepts related to the money market, bond market, foreign exchange market, stock market, and derivative markets.

Teaching methodology: Lectures, discussions, hands-on exercises, consultations, homework, tests, and exams.

Evaluation methods: The final grade will be based on the following distribution:

- Homework/seminar assignments 10%.
- Regular attendance 10%.

Knowledge evaluation:

- First test 40%.
- Second test 40%.
- Final exam accounts for 90% of the entire course and is only held for those students who did not pass both periodic tests. Regular attendance is 10% + 90%, the final exam accounts for 100% of the final grade.

Concretization tools/TI: table, projector, computer

Report between theory and practice: 1:1

Literature:

Mishkin, Frederic S. Financial markets and institutions / Frederic S. Mishkin, Stanley G. Eakins. -- 7th ed, 2012. [with translation into the Albanian language].

Frank J. Fabozzi, Franko Modigliani, "Capital Markets – Institutions and Instruments", Prentice Hall, Englewood Cliffs, New York, 1994.

Hendrik S. Houthakker, Peter Williamson, "The economics of Financial Markets", Oxford University Press, NY 1996.

Andrew Shisholm, "An Introduction to Capital Markets", John Wiley & Sons, Ltd., New York, 2002.

Course: Computer science and society (3+1) 6 ECTS

Course status: Elective

Professor: Prof. Ass. Dr. Eliot Bytyçi

Short description: This course introduces the key concepts of the relationship between computer science and society. Its main parts are:
- Privacy,
- Risks of computer systems,
- Ethical issues,
- Social networks
- Intellectual property

Course objectives: The aim of this course is to explore various issues related to computer science and society, to stimulate discussion among students on issues such as privacy, ethics, social networks and intellectual property.

Expected learning outcomes: Upon completion of this course the student is able to:
-be able to distinguish the good and bad that computer science can bring us,
-be able to analyze ethical issues related to computer science.
-to be able to use the best possible methods for using computer science for the benefit of humanity.

Teaching methodology: Lectures and individual work on projects / assignments / seminars.

Assessment methods: Attendance 10%, Individual projects (total: 90%): Assignment / Project 1: 45% and Assignment / Project 2: 45%.

Concretization / IT tools: Pencil, blackboard, smartboard, and computer.

The ratio between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 3:1

Literature:

1. Computers and Society: Modern Perspectives, Ronald M. Baecker. Oxford University Press, 2019.
2. Computers, Ethics, and Society by M. David Ermann and Michele S. Shau, Oxford University Press, 2002.
3. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet, Sara Baase, Prentice-Hall, 2008.

Course: Big data (2+0) 6 ECTS

Course status: Mandatory

Professor: Prof. Asoc. Dr. Ermir Rogova

Short description: This course will cover the topics: Introduction to Big Data. Big data features. Big data and data science. Relational databases and big data. Distributed data systems. Hadoop Ecosystem. Great data management. Structured and semi-structured data models. Non-relational data

models (NoSQL). Database models and database systems for big data. Domain specific languages for big data. Monitoring of big data systems. Large data processing. Search and retrieval. Paradigms for data computation. Processing of pipelines and collectors. Basic algorithmic building blocks and models. Hadoop Spark.Data Analysis with Big Data. Data analysis tools. Basic statistics. Collection. Associations. Predictive modeling. MLib spark machine learning library. Analysis of big data and graphs. NoSQL graph databases for big data. Neo4j graphic database. Search for graphs with CYPHER. Basic graph analysis with Neo4j and CYPHER. Practical aspects of big data analysis. Heterogeneous data processing. Data flow processing.

Course objectives: The course aims to acquaint the student with the concepts and practices of modern distributed data tools. The course prepares students for competent use of big data tools in theory and practice.

Expected learning outcomes: Upon completion of this course students will be able to:

• Determine if the problem in question is a big data problem.
• Formalize the problem using an appropriate data model.
• Choose the right tools and frameworks for big data.
• Critically evaluate the required calculation resources for current and future loads.
• Use Big Data Machinery (MLib) learning frameworks.
• Implement custom learning algorithms.

Teaching methodology: Lectures, exercises, quizzes, seminar papers, discussions and consultations.

Evaluation methods:

- Seminaric papers and quizes 30%,
- First midterm 35%,
- Second midterm 35%
- Final exam 70% (instead of midterms, if the results were unsatisfactory)

Concretization tools / IT: Marker, sponge, table, computer lab, projector.

The ratio between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 2: 1

Literature

- R. Buyya, R. N. Calheiros, A. V. Dastjerdi, Big Data: Principles and Paradigms. Morgan Kaufmann, 2016.
- O. Mendelevitch, C. Stella, D. Eadline. Practical Data Science with Hadoop and Spark: Designing and Building Effective Analytics at Scale (1st ed.). Addison-Wesley, 2016
- F. Kane. Hands-on data science and Python machine learning : perform data mining and machine learning efficiently using Python and Spark. Packt Publishing, 2017.J
- Baton, R. Van Bruggen. Learning Neo4j, 2nd edition, Packt Publishing, 2017.
- Selected online papers

Course: Cloud Computing (2+2) 6 ECTS

Course status: Mandatory

Teacher: Prof. Ass. Dr. Korab Rrmoku

Course Description: Introduction to paradigms and fundamental concepts in the Cloud. Key actors and characteristics of the Cloud. Service models in the Cloud (IaaS, PaaS, SaaS). Services supporting infrastructure in the Cloud. Virtualization in the Cloud. Implementation models in the Cloud. Reliability in the Cloud. Replication in the Cloud. Data handling in the Cloud. Security and privacy in the Cloud. Resource management in the Cloud.

Course objectives: The aim of the course is to provide a thorough understanding of the field of cloud computing in computer science, covering all levels of service orientation (XaaS). It aims to ensure knowledge of infrastructure, platforms, and applications in the form of services, familiarize students with design patterns, architectural models, and best practices, and understand the importance of innovative applications in networks.

Expected learning outcomes:

Upon successful completion of the course, a student will be able to:

- Develop cloud-based software solutions
- Understand the characteristics of public and private clouds
- Comprehend cloud infrastructure and architecture.
- Understand the original architecture of the cloud and apply it in development
- Master the development of microservices
- Understand and use models for microservices development
- Use containers and container orchestration
- Be capable of developing SaaS applications

Teaching methodology: Lectures, Exercises, Quizzes, Laboratory Work, Laboratory Work, discussions, mid-term exams, final exam

Evaluation methods and criteria:

• Research project and presentation on a Cloud platform – 25%

• Assignments and presentations throughout the semester – 25%

• Final exam – 50%

Concretization tools: laptop, projector, lab computers, marker, eraser.
Report between theoretical and practical lecture hours: The course ratio is 1:1

Literature:

- Cloud Computing: Concepts, Technology & Architecture (The Pearson Service Technology Series from Thomas Erl) 1st Edition, by Thomas Erl, Ricardo Puttini, Zaigham Mahmood
- Cloud Computing: Theory and Practice Second Edition, by Dan C. Marinescu
- Barrie Sosinsky, Cloud Computing Bible, Wiley
- George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly

Course: Entrepreneurship (3+0) 6 ECTS

Course status: Mandatory

Professor: Prof. Asoc. Dr. Ejup Fejza

Short description: This course presents an overview of entrepreneurship as a process and as a management style. It examines the challenges and issues that independent entrepreneurs and entrepreneurial managers face both from a theoretical and practical perspective.

Course goals: The goals of this course are to help students to understand and explain the concepts of entrepreneurship, enterprise and new business ventures and also developing a thinking framework as

it provides a scheme for clarifying factors and issues that are critical to a business opportunity situation, help to show the decisions and actions that may be relevant to it and identify the elements necessary to be able to utilize its potential.

Expected learning outcomes: By the end of the course the student will be able to:

• Critically assesses the theoretical (economic) role of entrepreneurs in a liberal market economy.

• Identify and evaluate the factors that affect entrepreneurial activity and behavior

• Identify and evaluate a number of types and models of enterprises and innovation

• Understand and appreciate the role and use of innovation and creativity in creating and supporting entrepreneurial actions and behaviors

• Assesses the challenges that an entrepreneur faces in the planning and launch phases of a new venture, but also at later stages of growth

• Critically evaluate entrepreneurial settings and innovative and entrepreneurial behaviors through exposure to current business situations and experiences through case studies and real life examples

• Demonstrate research and analytical skills in assessing entrepreneurial opportunities and practices

• Assesses various factors and inputs that affect the business creation process

• Demonstrate critical skills in current entrepreneurship research, including assessing gaps in existing knowledge.

• Conduct a feasibility analysis for an initial enterprise

Teaching methodology: lectures, discutions, seminar work, final exam.

Evaluation methods: seminar work (25%), final test (75%).

Concretisation tools/TI: blackboard, projector, computer

Report between theory and practice: 3:0

Literature:

- Barringer, B. and Ireland, R. (2010) *Entrepreneurship: Successfully Launching New Ventures*, 3rd edition, Prentice Hall.
- David Stokes & Nick Wilson: Small Business Management and Entrepreneurship, 6th edition, 2017,
- Chell, E. (2001) *Entrepreneurship: Globalisation, Innovation and Development*. Thompson Learning, London
- Krasniqi, B. A. (2012). *Entrepreneurship and small business development in Kosova*. Nova Science Publishers.
- Drucker, P. (1985) *Innovation & Entrepreneurship: Practice and Principles.* Harper & Row Publishers, U.S.A

Course: Network Analysis (2+2) 6 ECTS

Course status: Elective

Teacher: Prof. Ass. Dr. Korab Rrmoku

Course Description: Introduction to network analysis. Social networks. Network elements: density and rarity, network scale, weighted networks. The small world: paths and distances, trees, components, and connectivity. Hubs: centrality measures, centrality distribution, the friendship paradox. Weight and orientation of social networks: web, Page rank, network weights. Network models: random networks, small world, configuration model. Communities: basic definitions, community detection, evaluation methods. Network dynamics: information and influence, epidemic spreading, opinion dynamics.

Course objectives: The course aims at familiarizing the student with the theoretical fundamentals of network science and analysis, and the practicalities of applying network analysis to real-world problems.

Expected learning outcomes:

After successfully completing the course, students should be able to:
• Apply the network science approach to data analysis.
• Evaluate different types of methods and models.
• Choose the correct approach for the problem at hand.
• Interpret network analysis results
• Identify potential issues.

Teaching methodology: Lectures, Exercises, Quizzes, Laboratory Work, Laboratory Work, discussions, mid-term exams, final exam

Evaluation methods and criteria: attendance and class activity (10%), semesterly practical project I (30%), laboratory work & exercises (15%), final exam (45%)

Concretization tools: laptop, projector, lab computers, marker, eraser.
Report between theoretical and practical lecture hours: The report is 1:1

Literature:

- Menczer, F., Fortunato, S., & Davis, C. A. (2020). A First Course in Network Science. Cambridge: Cambridge University Press.
- Barabási, A.-L., Network Science (Cambridge University Press, 2016).
- Easley, D. & Kleinberg, J., Networks, Crowds, and Markets (Cambridge University Press, 2010)

Course: High performance computing (2+2) 6 ECTS

Course status: Elective

Professor: Prof. Ass. Dr. Artan Berisha

Short description: In this course we will learn about parallel and distributed computing, modern parallel architectures, parallel languages and programming environments, parallel algorithms, parallel performance.

Course objectives: To get the theoretical and practical knowledge from the areas of parallel and distributed systems, parallel programming and processing, needed to excel the computation of the problem at hand using modern computing platforms and tools. Parallelize problems from science and engineering by structuring the problem, choosing the appropriate hardware and programming concept to generate an efficient solution. Gain knowledge to work with high performance infrastructure.

Expected learning outcomes: After successfully completing the course, students should be able to:

- Design programs for modern parallel architectures,
- Choose the appropriate hardware to speed up a particular algorithm,
- Perform performance analysis of computer code,
- Identify parts of the code that can be sped up,
- Use the high performance computing architecture,
- Connect the theory and practice of parallel and distributed systems.

Teaching methodology: Lectures, discussions, consultations, homework, seminar, colloquia, final exam.

Evaluation methods: Hands-on work: 30%; First midterm: 35% (optional)

Second midterm: 35% (optional); Final exam: 70% (if midterm results were not satisfactory)

Concretization tools: Marker, whiteboard, projector, computer lab.

Relation between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 1:1

Literature:

1. Wen-Mei WH, Kirk DB, El Hajj I. Programming Massively Parallel Processors: A Hands-on Approach. Morgan Kaufmann; 2022 May 28.

2. Introduction to High Performance Scientific Computing, by V. Eijkhout et al. (Creative Commons, 2015)

3. P.S. Pacheco. An Introduction to Parallel Programming, 2nd Edition, Morgan Kaufman, 2011.

Course: Web information (2+2) 6 ECTS

Course status: Obligatory

Professor: Prof. Ass. Dr. Eliot Bytyçi

Short description: This course will cover topics: Information retrieval and web search, Basic information retrieval concepts, Information retrieval models, Importance of Feedback, Evaluation measures, Pre-processing of text and web page, Inverted index and compression Latent Semantic Indexing, Web Search, Meta-Search: Combining Multiple Rankings, Online Crawling, An Essential Crawling Algorithm, Implementation Issues, Universal Crawling, Concentrated Crawling, Local Crawling, Extraction structured data, Wrapper induction, Scale-based wrapper learning, Automatic wrapper generation, String matching and tree matching, Multiple alignment, DOM tree building, Single-page drawing with single list or in multi-page, Information integration, Scheme level matching, Domain level and scale level matching, Combining similarities, Match 1: m, Integration of online query interfaces, Building a unified global query interface, Opinion Mining and Emotion Analysis, Document Feeling Classification, Sentence Subjectivity and Sentence Classification, Lexicon Opinion Expansion, Mining of Aspect-Based Opinion, Search and Return Opinion.

Course objectives: The main objective of this course is to teach students how to develop programs for Internet search (including superficial website and in-depth web search) and for extracting structural data from both websites, static and dynamic. In addition to the basic concepts of internet search and retrieval, students will learn about relevant techniques and approaches. After the course, if successful, students will be able to develop programs for automated web search and structured data retrieval from websites (including on-line social media search and retrieval).

Expected learning outcomes: Upon completion of this course students will be able to:

- summarize the most important approaches and techniques for searching and retrieving data from the Internet
- select the approaches and techniques that are most appropriate for individual problems in extracting and retrieving information online.
- develop applications for data acquisition and analysis,
- build new algorithms for searching and retrieving data online,
- explain the behavior and time complexity of specific Internet search algorithms,
- integrate and use various open source field solutions.

Teaching methodology: Lectures, exercises, quizzes, seminar papers, discussions and consultations.

Evaluation methods:

- Seminar papers and quizzes 30%,
- First midterm 35%,
- Second midterm 35%
- Final exam 70% (instead of midterms, if the results were unsatisfactory)

Concretization tools / IT: Marker, sponge, table, computer lab, projector.

The ratio between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 1:1

Literature

- Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (Data-Centric Systems and Applications, Springer, August 2013
- Ricardo Baeza-Yates , Berthier Ribeiro-Neto: Modern Information Retrieval: The Concepts and Technology behind Search, 2nd Edition, ACM Press Books, 2010

Course: Image processing (2+2) 6 ECTS

Course status: Elective

Professor: Prof. Ass. Dr. Artan Berisha

Short description: In this course we will learn about medical image processing, image feature extraction (Fourie transforms, Karhunen-Loeve transformations), noise removal, spectral analysis (morphological properties), classification and image segmentation.

Course objectives: The student should be able to process medical images, extract image features, remove various noises, classify images and use standardized medical image databases (MIT/BIH DB, LTST DB, TPEHG DG, EEGMMI DS).

Expected learning outcomes: Upon completion of this course students will be able to:

- know computer technologies and automated image analysis procedures to develop automated analyzers to aid in diagnostics,
- analyze medical images in the frequency domain,
- develop algorithms for detecting and classifying events in medical images,
- analyze 2D and 3D tomographic images,
- develop algorithms for delineation, segmentation and visualization of anatomical structures in tomographic images.

Teaching methodology: Lectures, discussions, consultations, homework, seminar, colloquia, final exam.

Evaluation methods: Hands-on work: 30%; First midterm: 35% (optional); Second midterm: 35% (optional); Final exam: 70% (if midterm results were not satisfactory).

Concretization tools: Marker, whiteboard, projector, computer lab.

Relation between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 1:1

Literature:

Kayvan Najarian, Robert Splinter, Biomedical Signal and Image Processing, CRC Press, 2012.

Gonzales Rafael C., Woods Richard E. Digital Image Processing, Pearson Prentice Hall, 2008.

Course: **Master Thesis ()** 30 ECTS

Course status: Mandatory

Teacher:

Short Description: This course aims to prepare and complete the Master thesis.

Course objectives: The aim of the course is to get an overview of the broad field of the master thesis topic, to get acquainted with the relevant literature, to understand the problems addressed and to find appropriate theoretical and programming solutions, and finally to write the thesis and produce the necessary computer support.

Expected learning outcomes: Upon completion of this course the student is able to:

- Get acquainted with the challenge of individual research work; get acquainted with the existing literature and solutions.
- Find new ways for the presented problems.
- Know how to gain knowledge and experience in individual solution of theoretical and practical problems, writing technical texts and presenting the results and solutions obtained.
- Recognize the advantages of selected approaches in computer science and information in solving specific practical tasks.
- Know how to present problems and their solutions in the form of a written and oral presentation.

Teaching methodology: Consultative meetings and individual work on projects / tasks / seminars.

Evaluation methods: Final exam: 100%

Concretization tools: Pencil, blackboard, projector and computer.

Relation between the theoretical and practical part of the study: The ratio between the theoretical and practical part is 3: 0

Literature:

1. Justin Zobel, Writing for Computer Science, second edition, Springer, 2004.
2. D. Evans and P. Gruba, How to Write a Better Thesis, Second edition, Melbourne University Press, Melbourne, 2002.
3. Herman T.: Ethics and Technology: Controversies, Questions, and Strategies for Ethical Computing, Wiley; 3 edition, 2010.

2.4.2 SWOT analysis for the content of the educational process

A. Strengths
- Program comparable to the programs of the University of Ljubljana.
- Continuity (connection) between courses and construction of courses above those of the Bachelor level.
- Adequately and professionally prepare students.

B. Weaknesses
- Lack of licensed software for the development of some computer subjects.
- Lack of anti-plagiarism software.

C. Opportunities
- Transferring the credits of various courses taken through the ERASMUS+ program, especially in the new Data Science programs.

D. Threats/Challenges
- Supply of laboratories with new and various equipment.
- Offering more professional subjects from different disciplines of computer science.